Savitribai Phule Pune University

Three Year BSc (Blended) Degree Course

Syllabus

(To Be Implemented from Academic Year 2016-17

Introduction

The SPPU instituted the innovative Bachelors in Science degree known as **BSc (Blended)** in collaboration with the University of Melbourne (UOM), Australia and the Indian Institute of Science Education and Research Pune (IISERP) to strengthen science education at the undergraduate level.

The SPPU is among the top universities in the country and has been in the forefront for initiating innovative programs. The UOM is ranked #1 in Australia and it has been among the top 50 in the world. IISERP established by the Government of India to strengthen science education and research in the country has attained national and international recognition in a short span of a decade. It offers an holistic BS – MS program in Science covering the basic science disciplines.

The BSc (Blended) program is a joint initiative of SPPU-UOM-IISERP offering a transparent and internationally recognized bachelors degree in science underlining clearly the teaching objectives and learning outcome . In the first two years of the degree program all four basic sciences (biology, chemistry, mathematics and physics) will be taught providing basic knowledge with specialization in one of them in the third year. The UOM and IISERP will provide with support in terms of special lectures, workshops, and quality assurance.

Objectives

- To introduce the fundamentals of science education
- To enrich students' knowledge in all basic sciences
- To help the students to build interdisciplinary approach
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career in academics and industry

Highlights of the Program

- The course will be run in collaboration with UOM and IISERP
- Special lectures by expert faculty from IISER and other institutes.
- The UOM will provide online teaching of some topics from the syllabus.
- The course will be accredited by the UOM
- The degree will be considered on par with that of UOM and the students will be eligible to pursue higher studies at UOM and other Universities in Australia
- The students will be imparted solid training to enable them to pursue Masters and Integrated PhD degrees in reputed institutes such as IITs, IISERs and Central Universities

Eligibility

1. First Year B.Sc (Blended)

Higher Secondary School Certificate (10+2) or its equivalent Examination in Science stream with Mathematics as one of the subjects.

2. Second Year B.Sc.

Students are not directly admitted to second year of B.Sc.(Blended) course. Those who complete first year BSc (Blended) course are promoted to second year.

3. Third Year B. Sc.

Students are not directly admitted to third year of B.Sc. (Blended) course. Those who complete first year and Second year **Proposed Curriculum Structure for the BSc (Blended) Program (Semesters 1-4)** examination of BSc (Blended) are promoted to Third year B.Sc. (Blended) course

Reservation and relaxation will be as per the Government rules.

Course Structure

Duration: The duration of (B.Sc.Blended) Degree Program shall be three years.

Medium of Instruction: The medium of instruction for the course shall be English.

The course is a semester and credit system based course and is divided into six semesters of 14 weeks each. The total number of credits for each semester is 23 making a total of 92 credits during the first two years with instruction in all the four subjects (biology, chemistry, mathematics s and physics). In the third year, the student specializes in one of the subjects. For example, the entire third year is devoted to Biosciences fo those pursuing BSC (Blended) Biosciences. The advantage for a student opting for Biosciences specialization in the third year BSc (Blended) is the possibility to pursue Masters degree in life sciences/biosciences in reputed institutes.

At **first year of under-graduation**, students will be given the basic information that includes – all basic science subjects as mentioned above. The topics include general and organic chemistry, calculus, introductory classical physics, waves, gravitation, unifying themes in biology, diversity of life etc. Relevant experimentation on these topics are included in practical courses. They will also be introduced to scientific writing and communication skills.

At the **second year under-graduation** level , students will be introduced to linear algebra, vectors, complex numbers, computing, electricity, magnetism, special relativity, physical chemistry, inorganic chemistry, reactions and synthesis, cell biology, genetic control principles of physiology, both animal and plant physiology, mechanism of evolution, and population biology etc. The relevant practical experiments are included to enrich the student's knowledge.

At the **third year under-graduation**, eight theory papers which include six core and two optional papers are taught during the two semesters which deal with broad areas in one of the specializations. (Biosciences, Chemistry, Mathematics or Physics).

Examination and Grading

The course is based on credit system and the examination process consists of two parts: continuous assessment (internal 50%) and end semester examination (50%) with 50% each. The internal assessment will consist of one mid semester examination and at least two quizzes one before the mid semester and after mid semester. The grading will be as per the university norms applicable to credit system.

University Terms

Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only duly admitted students. The term shall be granted only on minimum 80 percent attendance at theory and practical course and satisfactory performance during the term.

Intake capacity of student: 48

Proposed Curriculum Structure for the BSc (Blended) Program (Semesters 1-4)

Number of weeks in a semester: 14 (excluding holidays and one week mid semester examination)

Nomenclature: BO: Biology. CHM: Chemistry. MTH: Mathematics. PHY: Physics. HSS: Humanities and Social Sciences

1 Credit = 1 Contact hour per week both for theory and lab courses

Semester	Code	Name	Credits	Lectures	Tutorial	Practical	Total
Semester 1	MTH101	Maths 1: Calculus	5	42	28		70
Semester1	PHY101	Physics 1: ntroductory classical physics	3	36	6		42
Semester 1	CHM101	Chemistry 1: General Chemistry – Chemistry of life	3	36	6		42
Semester 1	BO101	Biology 1: Diversity of Life	3	36	6		42
Semester 1	LAB101	Science Lab101	3			42	42
Semester 1	LAB111	Science Lab111	3			42	42
Semester 1	HSS101	English: Critical Reading, Writing, Communication	3	14	28	42	42

Semester 2	MTH102	Maths 2: Algebra	5	42	28		70
Semester 2	PHY102	Physics 2: Modern physics	3	36	6		42
Semester 2	CHM102	Chemistry 2: Physical and norganic	3	36	6		42
Semester 2	BO102	Biology 2: Cell Biology	3	36	6		42
Semester 2	DC102	Computing	3			42	42
Semester 2	LAB102	Science Lab 102	3			42	42
Semester 2	LAB112	Science Lab 112	3			42	42

Semester 3	MTH201	Maths 3: Vector Calculus, and Probability and Statistics 1	5	42	28		70
Semester 3	PHY 201	Physics 3:	3	36	6		42

Proposed Curriculum Structure for the BSc (Blended) Program (Semesters 1-4)

		Quantum mechanics and Thermodynamics					
Semester 3	CHM201	Chemistry 3: Reactions and synthesis	3	36	6		42
Semester 3	BO202	Biology 3: Functional biology	3	36	6		42
Semester 3	CHMLAB3	IChemistry Lab 3	3			42	42
Semester 3	BOLAB3	Biology Lab 3	3			42	42
Semester 3	PHYLAB3	Physics Lab 3	3			42	42

Semester 4	MTH202	Maths 4: Differential Equations, and Probability and Statistics 2	5	42	28		70
Semester 4	PHY202	Physics 4: Electricity, magnetism and Optics	3	36	6		42
Semester 4	CHM202	Chemistry 4: Structure and properties	3	36	6		42
Semester 4	BO202	Biology 4: Genetics Evolution and Ecology	3	36	6		42
Semester 4	CHMLAB4	IChemistry Lab 4	3			42	42
Semester 4	PHYLAB4	Physics Lab 4	3			42	42
Semester 4	BOLAB4	Biology Lab 4	3			42	42

BSc (Blended) Curriculum Years 1 and 2

MATHS 101	PHYSICS 101	CHEMISTRY 101	BIOLOGY 101
Differential Calculus: Graphs of functions of one variable, trigonometric functions and their inverses, derivatives of inverse trigonometric functions, implicit differentiation, related rates. Partial derivatives, chain rule for partial derivatives, directional derivatives, tangent planes, extrema for functions of several variables and double integrals. **Integral Calculus:** Fundamental theorem of calculus, integration by trigonometric and algebraic substitutions, use of partial fractions with application to areas and volumes. Riemann integration, further techniques of integration and applications, improper integrals; **Differential Equations:** First order differential equations, second order linear differential equations with constant coefficients.	**Classical mechanics:** Newton's laws of motion. Momentum and impulse. Translational, vibrational and rotational energy. Simple harmonic motion. Rigid body rotations **Waves and oscillations:** eflection, refraction, superposition, resonance, energy transport, absorption, Doppler effect. Applications to water waves, acoustics, seismology **ravitation:** Newton's law of gravity, Kepler's Laws. Applications to astrophysics including orbital motion, escape velocity, apparent weightlessness **Fluids:** Pressure, buoyancy, fluid flow, viscosity, surface tension. Applications to hydraulics, biology, biophysics, atmospheric physics, aerodynamics **Optics:** Geometrical optics including dispersion, lenses, mirrors, interference, diffraction, polarisation. Applications to microscopy, imaging, vision,	**eneral Chemistry:** Stoichiometry, equilibrium chemistry, acids and bases, valency, electrostatics, states of matter, The Periodic Table **Organic Chemistry:** Alkanes, alkenes, alkynes, benzene, acids, aldehydes, ketones, functional groups, elimination reactions, addition and substitution reactions (nucleophilic and electrophilic). **The Chemistry of Life**: Stereochemistry and biomolecular chirality. Biopolymers	**Unifying themes in biology:** Cell theory, origin of life = origin of the cell, life's raw ingredients, RNA polymers, DNA as the basis for life, life evolves, evolutionary relationships are summarised as classifications, the tree of life **Biological evolution**: evolution of complexity, unicellular to multicellular, structural organization -symmetrical and asymmetrical **Diversity of Life:** principles of taxonomy and systematics, Domains and kingdoms of life, Evolutionary relationships, Tree of life – Prokaryotes**,** Protists, Fungi, Plants, Animals.Viruses and Prions

	crystallography		
MATHS 102	**PHYSICS 102**	**CHEMISTRY 102**	**BIOLOGY 102**
Analysis: Limits of real-valued functions, continuity and differentiability; Mean Value Theorem and applications; Taylor polynomials; sequences and infinite series; **Vectors:** dot product, scalar and vector projections, plane curves specified by vector equations. **Complex numbers:** arithmetic of complex numbers, sketching regions in the complex plane, De Moivre's Theorem, roots of polynomials, the Fundamental Theorem of Algebra. **Linear Algebra:** Systems of linear equations, matrices and determinants; vectors in real n-space, cross product, scalar triple product, lines and planes; vector spaces, linear independence, basis, dimension; linear transformations, eigenvalues, eigenvectors; inner pr	**Electricity and magnetism:** Electric charge and field, conductors and insulators, electric potential, capacitance, resistance, electric circuits, magnetic field, Faraday's law of induction, Maxwell's equations, electromagnetic waves. Applications to electronics, household electricity and power supply, magnetosphere, communications **Special relativity:** Frame transformations, relativity of space and time, modification of classical mechanics, mass-energy equivalence. Applications to particle physics, twin paradox **Quantum physics:** photons, blackbody radiation, matter waves, quantisation in atoms, interaction of light with matter, x-rays. Application to atomic physics, lasers, and spectroscopy **Nuclear physics:** Atomic nucleus, radioactive decay, half-life,	**Physical Chemistry:** Kinetic theory of gases, energy, thermodynamic laws, redox chemistry and electrochemistry, chemical kinetics, structure determination, elementary quantum theory, atomic structure, atomic spectra, spectroscopy. **Inorganic Chemistry:** Periodic behaviour of structure, bonding and chemical properties of Groups 1,2, 13-18. Transition metal chemistry (Groups 3-12). Coordination chemistry	**Cell biology:** Structure and function of cell components – nucleus, chloroplast, golgi, endoplasmic reticulum, mitochondria, lysosomes, vesicles, membrane, cell wall, flagella and cilia, plasmodesmata, cytoskeleton, spore, glycocalyx. **Endosymbiosis:** chloroplast and mitochondria. **Cell division:** binary, budding, mitosis and meiosis, cell cycle, differentiation, aging and death **Multicellularity**: stem cells, embryonic development, cells/tissues/organs, signalling **enetic control:** genetic code and central dogma of life, Gene expression – prokaryotic, eukaryotic, RNA interference

	ionising radiation, nuclear fission and fusion. Application to nuclear energy, radiation safety, nucleogenesis, carbon dating		
MATHS 201	**PHYSICS 201**	**CHEMISTRY 201**	**BIOLOGY 201**
Vector Calculus: Functions of several variables; limits, continuity, differentiability, the chain rule, Jacobian, Taylor polynomials and Lagrange multipliers. Vector calculus; vector fields, flow lines, curvature, torsion, gradient, divergence, curl and Laplacian. Integrals over paths and surfaces topics; line, surface and volume integrals; change of variables; averages, moments of inertia, centre of mass; Green's theorem, Divergence theorem in the plane, Gauss' divergence theorem, Stokes' theorem; curvilinear coordinates. **Probability and Statistics 1:** Probability theory basis of statistical inference. Probability and, random variables are introduced; applications to common univariate probability models. Joint behaviour of random	**Quantum mechanics:** Quantum theory of light, the particle nature of matter, matter waves, quantum mechanics in one dimension and tunnelling phenomena, atomic and molecular orbitals, the chemical bond. Applications to atoms, molecules, particle in a box. **Thermodynamics:** Thermal equilibrium, ideal gas and kinetic theory, equipartition of energy, heat and work, heat capacity, latent heat, enthalpy, thermodynamic processes; thermal systems and statistics, interacting systems, statistics of large systems, entropy, temperature and heat, pressure, chemical potential; heat engines, Carnot cycle, refrigerators, heat engines, throttling process; Helmholtz and Gibbs Free energies, and phase transformations	**Reactions and synthesis:** Synthesis and design of organic and inorganic molecules, molecular architecture and the energy transformations associated with chemical and physical processes. Topics covered include synthesis of simple polyfunctional organic compounds, thermodynamically controlled reactions of s-, p- and d- block elements and thermodynamics	**Principles of physiology:**Energy management, maintenance of homeostasis, salts and water, metabolic processes (anabolism, catabolism), respiration and fermentation, regulation of metabolism (molecular signaling, genetic), growth kinetics, survival strategies (symbiosis, defense) **Animal physiology (Human)**:Respiration, digestion, nutrition and metabolism. Nervous system, Endocrine system, Excretion and osmo-regulation (water and salt balance), Cardiovascular system. Thermal regulation, Reproduction and development **Plant physiology:**Water balance. Mineral nutrition and nutrient assimilation, Solute transport across membranes; Phloem translocation; Photosynthesis; espiration and lipid metabolism;

variables, conditional probability, Markov chains. Distributions of functions of random variables are considered; techniques to obtain the exact and approximate distributions of sums of random variables. Applications to normal approximations to discrete distributions and by obtaining the exact and approximate distributions of some commonly used statistics.			Secondary metabolism and defense; Growth and development (signal transduction, cell walls, growth and development, light responses, hormones); Control of flowering; Abiotic stress **Microbial physiology:**Aerobic and anaerobic respiration;Extremophiles; Symbiotic associations; Enzymes
MATHS 202	**PHYSICS 202**	**CHEMISTRY 202**	**BIOLOGY 202**
Differential Equations: Linear differential equations, both ordinary and partial, use of linear algebra to provide the general structure of solutions for ordinary differential equations and linear systems. Initial value problems, boundary value problems and eigenvalue problems arising from common classes of partial differential equations. Laplace transform methods; separation of variables applied to simple second order partial differential equations. Fourier series solutions of the heat and wave equations; Fourier transforms.	**Electricity and Magnetism:** Electric field, Gauss's law in integral and differential form, scalar potential and gradient, Poisson and Laplace equations), the magnetic field (e.g. Ampere's law in integral and differential forms), Maxwell's equations in vacuum (differential forms), Maxwell's equations in matter (polarization, electric displacement, magnetic vector potential), time-varying electric and magnetic fields (Maxwell's equations in general form, wave equations for E and B, plane electromagnetic wave, Poynting	**Structure and properties:**Stereochemical and electronic properties of molecules and the methods central to their study. Important elements of the subject include the spectroscopic characterisation and quantification of materials by a range of spectroscopic techniques, molecular orbital techniques and the application of approaches based on molecular symmetry and group theory to the understanding of molecular properties, stereo-selective reactions, bonding and spectroscopy. These topics have applications to advanced	**Mechanisms of evolution:** Mendelian genetics**;** Genetic diversity (mutation, recombination)**;** Genetic structure of populations (random mating/Hardy-Weinberg equilibrium)**;** Selection**;** Speciation and species concepts**;** Mechanisms of speciation (geographical, sexual, temporal, ecological) **Population biology:** Nature of populations**;** Distribution and abundance of populations**;** Density independent, density dependent growth**;** Managing populations for production**;** Conservation biology**;**

Probability and Statistics 2: Classical and Bayesian statistical methods; maximum likelihood, sufficiency, unbiased estimation, confidence intervals, hypothesis testing and significance levels. Applications include distribution free methods, goodness of fit tests, correlation and regression; the analysis of one-way and two-way classifications.	vector) **Optics:** Fourier optics, Fourier transforms in 1 and 2D, Dirac delta function and comb, discrete Fourier transforms and the sampling theorem, convolution, cross and autocorrelation. Fresnel and Fraunhofer diffraction, Polarized light including production and control of polarisation	materials, light emitting polymers, chemical analysis and catalysis in biological and industrial systems	Epidemiology **Community ecology:** Nature of communities**;** Community structure**;** Intracommunity interactions**;** Symbiosis**;** Predation**;** Competition**;** Host-parasite interactions**;** Niche**;** Dynamics of communities (perturbation and succession)**;** Biomes (communities on a global scale) **Ecosystems:** Pond ecosystem; Food chains and webs; Pyramids (numbers, biomass, energy); Productivity (Primary and secondary); Biogeochemical cycles (water, C, N, P)

BSc (Blended) Mathematics

MATHS 101: Calculus Lectures: 42: Tutorials: 28

Differential Calculus: Graphs of functions of one variable, trigonometric functions and their inverses, derivatives of inverse trigonometric functions, implicit differentiation, related rates. Partial derivatives, chain rule for partial derivatives, directional derivatives, tangent planes, extrema for functions of several variables and double integrals.

Integral Calculus: Fundamental theorem of calculus, integration by trigonometric and algebraic substitutions, use of partial fractions with application to areas and volumes. iemann integration, further techniques of integration and applications, improper integrals;

ifferential Equations: First order differential equations, second order linear differential equations with constant coefficients.

MATHS 102: Analysis and Linear Algebra Lectures: 42: Tutorials: 28

Analysis: Limits of real-valued functions, continuity and differentiability; Mean Value Theorem and applications; Taylor polynomials; sequences and infinite series;

Vectors: dot product, scalar and vector projections, plane curves specified by vector equations.

Complex numbers: arithmetic of complex numbers, sketching regions in the complex plane, De Moivre's Theorem, roots of polynomials, the Fundamental Theorem of Algebra.

Linear Algebra: Systems of linear equations, matrices and determinants; vectors in real n-space, cross product, scalar triple product, lines and planes; vector spaces, linear independence, basis, dimension; linear transformations, eigenvalues, eigenvectors; inner pr

MATHS 201: Vector Calculus and Probability and Statistics 1 Lectures: 42: Tutorials: 28

Vector Calculus: Functions of several variables; limits, continuity, differentiability, the chain rule, Jacobian, Taylor polynomials and Lagrange multipliers. Vector calculus; vector fields, flow lines, curvature, torsion, gradient, divergence, curl and Laplacian. Integrals over paths and surfaces topics; line, surface and volume integrals; change of variables; averages, moments of inertia, centre of mass; Green's theorem, Divergence theorem in the plane, Gauss' divergence theorem, Stokes' theorem; curvilinear coordinates.

Probability and Statistics 1: Probability theory basis of statistical inference. Probability and, random variables are introduced; applications to common univariate probability models. Joint behaviour of random variables, conditional probability, Markov chains. Distributions of functions of random variables are considered; techniques to obtain the exact and approximate distributions of sums of random variables. Applications to normal approximations to discrete distributions and by obtaining the exact and approximate distributions of some commonly used statistics.

MATHS 202: Differential Equations and Probability and Statistics 2 Lectures: 42: Tutorials: 28
Differential Equations: Linear differential equations, both ordinary and partial, use of linear algebra to provide the general structure of solutions for ordinary differential equations and linear systems. Initial value problems, boundary value problems and eigenvalue problems arising from common classes of partial differential equations. Laplace transform methods; separation of variables applied to simple second order partial differential equations. Fourier series solutions of the heat and wave equations; Fourier transforms.**l** **Probability and Statistics 2:** Classical and Bayesian statistical methods; maximum likelihood, sufficiency, unbiased estimation, confidence intervals, hypothesis testing and significance levels. Applications include distribution free methods, goodness of fit tests, correlation and regression; the analysis of one-way and two-way classifications.

<u>BSc (Blended) Syllabus for Physics</u>

Physics 101: Year 1, Semester 1

Classical mechanics: _ Newton's laws of motion. _ Momentum and impulse. _ Translational, vibrational and rotational energy. _ Simple harmonic motion. _ Rigid body rotations _ Applications to biological and physical systems	10 Lectures
Waves and oscillations: _ Reflection, refraction, superposition, _ Resonance, energy transport, absorption, _ Doppler effect. _ Applications to water waves, acoustics, seismology	8 Lectures
Gravitation: _ Newton's law of gravity, _ Kepler's Laws. _ Applications to astrophysics including orbital motion, escape velocity, apparent weightlessness	6 Lectures
Fluids: _ Pressure, _ Buoyancy _ Fluid flow _ Viscosity _ Surface tension _ Applications to hydraulics, biophysics, atmospheric physics, aerodynamics	6 Lectures
Optics: _ Geometrical optics _ Dispersion, _ Lenses, mirrors, _ Interference, Diffraction, _ Polarisation. _ Applications to microscopy, imaging, vision, crystallography	6 Lectures

Physics 102: Year 1, Semester 2

Electricity and magnetism: _ Electric charge and field, _ Conductors and insulators, _ Electric potential, _ Capacitance, _ Resistance, _ Electric circuits _ Magnetic field, Biot-Savart law _ Faraday's law of induction, _ Maxwell's equations, _ Electromagnetic waves.	18 Lectures
Special relativity: _ Frame transformations, _ Relativity of space and time, _ Modification of classical mechanics, _ Mass-energy equivalence.	6 Lectures
Quantum physics: _ Photons, _ Blackbody radiation, _ Matter waves, _ Quantisation in atoms, _ Interaction of light with matter, x-rays.	6 Lectures
Nuclear physics: _ Atomic nucleus, _ Radioactive decay, half-life, _ Ionising radiation, _ Nuclear fission and fusion. _ Nuclear energy, radiation safety, nucleogenesis,	6 Lectures

Physics 201: Year 2, Semester 1

Quantum mechanics: _ Quantum theory of light _ The particle nature of matter _ Matter waves _ Quantum mechanics in one dimension _ Particle in a box: three-dimensional generalization. _ Tunnelling phenomena, _ The chemical bond. _ Atomic and molecular orbital theory, _ Valence bond theory _ Applications to atoms, molecules	18 Lectures
Thermodynamics: _ Thermal equilibrium _ Ideal gas and kinetic theory, _ Equipartition of energy _ Heat and work _ Heat capacity, latent heat, enthalpy _ Thermodynamic processes; _ Thermal systems and statistics, _ Interacting systems, _ Statistics of large systems, entropy _ Temperature and heat, _ Pressure _ Chemical potential _ Heat engines _ Carnot cycle, _ Refrigerators, heat engines, throttling process; _ Helmholtz and Gibbs Free energies _ Phase transformations	18 Lectures

Physics 202: Year 2, Semester 2

Electricity and Magnetism: _ Electric field, _ Gauss's law in integral and differential form, _ Scalar potential and gradient, _ Poisson and Laplace equations), _ Ampere's law in integral and differential forms, _ Maxwell's equations in vacuum (differential forms), _ Maxwell's equations in matter (polarization, electric displacement, magnetic vector potential), _ Time-varying electric and magnetic fields _ Maxwell's equations in general form, _ Wave equations for E and B, _ Plane electromagnetic wave _ Poynting vector _ Applications to electronics, materials, neural networks, telecommunication	20 Lectures
Optics: _ Fourier optics _ Fourier transforms in 1 and 2D, _ Dirac delta function and comb, _ Discrete Fourier transforms _ Nyquist-Shannon sampling theorem _ Convolution, cross and autocorrelation. _ Fresnel and Fraunhofer diffraction _ Paraxial approximation _ Polarized light including production and control of polarisation _ Applications to optical and X-ray imaging systems	16 Lectures

<u>**BSc (Blended) – Proposed Chemistry Syllabus Years 1 and 2**</u>

Chemistry 101 (Year 1, Semester 1)

General and Organic Chemistry

The subject provides an introduction to general chemistry, organic chemistry, and the chemistry of some important biological molecules.

General Chemistry (14 Lectures)

The Periodic Table	1
Molecular Structure and Bonding • Lewis structures Formal charge Resonance • VSEPR – predicting the shapes of molecules Polarity of molecules • Covalent Bonding alence bond theory (Localized Electron model) • Molecular orbital theory • Intermolecular forces	2
Water – the biological solvent Physical characteristics and chemical properties	1
Carbon – the basis of life	1
3D molecular structure and isomerism Isomerism Stereoisomerism	1
Small inorganic molecules of biological importance Phosphates and phosphoric acid Nitrogen Oxygen	1
Acids and Bases • The Nature of Acids and Bases • Lowry Bronsted Theory • Lewis Acids/Bases • Dissociation of Carboxylic Acids • Amine Basicity • Acid Strength • The pH Scale • Calculating the pH of Strong Acid Solutions • Calculating the pH of Weak Acid Solutions • Bases • Strategy for Solving Acid-Base Problems: A Summary • Buffers • Polyprotic acids • Gas solubility	2
Stoichiometry	1
Chemical Kinetics	2

Reaction Rates Rate Laws: An Introduction Determining the Form of the Rate Law The Integrated Rate Law Rate Laws: A Summary Reaction Mechanisms The Steady-State Approximation A Model for Chemical Kinetics Catalysis	
Chemical Equilibrium • The Equilibrium Condition • The Equilibrium Constant • Equilibrium Expressions Involving Pressures • Heterogeneous Equilibria • Applications of the Equilibrium Constant • Solving Equilibrium Problems	2

Organic Chemistry (17 Lectures)

Structure and Bonding Alkanes(spO^{3}Hybridisation) • Covalent bonding - H_2 • s-bonding and spV^{3}hybridisation in methane and ethane • Structural isomerism • Methane, ethane, nomenclature of saturated hydrocarbons • Conformational isomerism: ethane, butane • Stereochemistry, Optical activity, enantiomers and their physical/chemical properties. Racemates. • Designation of absolute configuration • Diastereoisomers • Meso compounds • Cycloalkanes • Conformational isomerism of cyclohexanes	2
Structure and Bonding Alkenes(sp^2 Hybridisation) • sp^2 hybridisation, s and p bonding in ethene • Nomenclature of alkenes • Geometrical isomerism • Conjugated alkenes	2
Benzene and its derivatives • Kekulé structures/resonance • Nomenclature of substituted benzenes	1
Structure and Bonding of Alkynes (sp hybridisation) • sp hybridisation, s and p bonding in ethyne • Nomenclature of alkynes	1
Functional Groups- • Haloalkanes • Alcohols • Ethers	1

• Amines • Carbonyl compounds • Carboxylic acids and derivatives	
Electrophiles and Nucleophiles Arrow conventions Organic acids and bases Strengths of acids and bases: electronegativity, hybridisation, resonance	2
Nucleophilic substitution reactions Nucleophiles and electrophiles SN1 and SN2 reactions. Determination of mechanism by stereochemical and kinetic methods Properties of good leaving groups Properties of good nucleophiles	1
Elimination reactions E1 and E2 reactions. Determination of mechanism by stereochemical and kinetic methods Dehydration of alcohols	1
Addition reactions Markovnikov's rule Hydration of alkenes	1
Electrophilic aromatic substitution reactions Substitution reactions of benzene: halogenation, nitration, sulfonation, Friedel-Crafts acylation and alkylation	1
Nucleophilic addition reactions Addition to carbonyl groups by cyanide, Grignard reagents, acetylide anions Synthesis and chemistry of acids, amides, esters, acyl chlorides and anhydrides	1
rganic redox reactions Reductions: Catalytic hydrogenation, hydride reagents Oxidations: Benzylic oxidation Oxidation of primary alcohols to aldehydes then carboxylic acids by Cr(VI) reagents Oxidation of secondary alcohols to ketones by Cr(VI) reagents	1

Chemistry of Life (7 lectures)

Stereochemistry and Biomolecular chirality	2
Concatenation and Biopolymers Polypeptides NucleicAcids Lipids Sugars Cellulose Isoprenes and Turpenoids	5

Chemistry 102 (Year 1, Semester 2)

Physical and Inorganic Chemistry

The subject provides an introduction to physical and inorganic chemistry.

Physical Chemistry (15 Lectures)

Gases, Kinetic Theory • Early Experiments • The Gas Laws of Boyle, Charles and Avogadro • The Ideal Gas Law • Gas Stoichiometry • Dalton's Law of Partial Pressures • Collisions of Gas Particles with the Container Walls • Intermolecular Collisions • Real Gases • Chemistry in the Atmosphere	4
Thermodynamics • The Nature of Energy • Enthalpy • Thermodynamics of Ideal Gases • Calorimetry • Hess's Law • Standard Enthalpies of Formation	4
Spontaneity, Entropy and Free Energy • Spontaneous processes • Entropy • The 2nd law of thermodynamics • Free energy • Free energy and equilibrium	2
Spectroscopy and Determination of Structure • The EM Spectrum • Mass spectrometry / combustion analysis information available from molecular formulae • Infrared spectroscopy • Nuclear magnetic resonance spectroscopy: 1H and 13C	3
Elementary quantum theory	2

Inorganic Chemistry 2.1– (21Lectures)

Ionic Compounds and their Solutions • Ions: electron configurations and sizes • Lattice energy • Solubility equilibria and solubility products	2
Structures of Solids • X-ray diffraction • Metallic bonding • Sphere packing models • Structures of metals • Structures of ionic compounds • **Silicates**	3

Main Group Chemistry • Structures of the elements • Chemistry of main group compounds	4
Redox reactions and electrochemistry Galvanic cells and a quantitative treatment of standard reduction potential Concentration dependence of reduction potential - Nernst equation - Concentration cells - Equilibrium constants - Solubility constants Batteries - Primary, secondary fuel cells Corrosion - Overpotential Electrolysis	4
The transition metals : a survey Electron configurations Oxidation states and ionisation energies Reduction potentials First-row transition metals Ores and extraction of the metal Stable oxidation states	1
Coordination Chemistry Coordination compounds Oxidation number, coordination number Lewis acid-Lewis base interaction Ligands: properties, donor atom, denticity Iron nutrition Nomenclature Isomerism of coordination compounds Structural isomers, ionization, linkage, coordination Stereoisomerism - geometrical, optical	4
Bonding in complex ions Crystal-field model Octahedral complexes - Colour and Spectrochemical series - High- and low- spin complexes - Magnetism Other coordination geometries: - Tetrahedral and square planar	2
Transition metals in biological systems Abundance of transition metals in humans	1

Chemistry 201 (Year 2, Semester 1)

Reactions and Synthesis

This subject covers key concepts associated with the synthesis and design of organic and inorganic molecules, molecular architecture and the energy transformations associated with chemical and physical processes. Topics covered include synthesis of simple polyfunctional organic compounds, thermodynamically controlled reactions of s-, p- and d- block elements and thermodynamics. In the last three weeks of the subject students will be able to choose between lecture modules with a focus on theory of advanced materials or biological chemistry. These topics have applications in drug discovery, chemical industry, nanotechnology, and energy harnessing through conventional and alternative energy sources.

Upon completion of this subject students should:

- have developed an understanding of molecular properties and energetics and be able to apply these concepts to the synthesis of organic and inorganic compounds;
- know approaches to the synthesis and some reactions of simple polyfunctional organic compounds;
- be able to distinguish between kinetically and thermodynamically controlled reactions and to apply these concepts to rationalise synthetic transformations;
- understand basic thermodynamic concepts and the application of these approaches to real solutions, mixtures and phase equilibria;
- have a knowledge of the main factors controlling the substitution and redox reactions of main group and transition metal elements.

1	Organic Synthesis C-C bond Forming Reactions	Grignard Reagents and Organolithiums. Formation and reaction with Carbonyl compounds.
2	Organometallic Reagents in Synthesis	Applications of Organocerium and Organocuprate reagents.
3	Carbonyl Compounds and Reactions	Carbonyl compounds, tautomerism as a general phenomen, keto-enol tautomerism of carbonyl compounds, mechanism of keto-enol tautomerism
4		Generating enolate anions, suitable base catalysts for enolising aldehydes, ketones ester and β-dicarbonyl compounds, general α-substitution reaction
5		Reactions of enols and enolates, α-substitution with H/D Stereochemical consequences and deuterium incorporation. Halogenation of carbonyl compounds. The haloform reaction
6		Halogenation of carbonyls, Hell-Volhard-Zelinsky reaction. Synthetic applications of □-halo

		carbonyl compounds
7		Alkylation of enolates, LDA, scope and limitations
8		Aldol reaction, mechanism and retrosynthesis, inter-and- intra-molecular variants, mixed Aldol reaction
9		Claisen reaction, mechanism and retrosynthesis, mixed Claisen and Deickman reaction.
10		Malonate Diester Chemistry, Acetoacetate chemistry, Synthesis of substituted acetic acid and acetone derivatives. Scope, Mechanism and Retrosynthesis.
11		Michael addition Chemistry, reaction of enolates with various Michael electrophiles
12		Kinetic and Thermodynamic enolates, Enamines and silylenol ethers
13	Energy Transformations and Thermodynamics Will need to be selective with the choice of topics here (unless space found by removing topic(s) from following section.	Introduction, Energy conversion: chemical combustion, Green Energy – solar energy and light harvesting, ocean thermal energy, bioreactors Energy storage systems, fuel cells, the fly-wheel, underground thermal energy storage, hydroelectricity, superconducting magnetic energy storage
9	Energy quantization and Boltzmann distribution	The atomic and molecular basis of energies (kinetic and potential), energy quantization and the Schrodinger Equation, distribution of energy over quantum states – the Boltzmann distribution
15		Heat, work first law of thermodynamics, molecular basis of enthalpy and it's temperature dependence Reversible versus irreversible processes in terms of expansion/compression of ideal gases, free expansion, adiabatic processes, adiabatic expansion/compression of deal gases
16		Entropy and the direction of spontaneous change, statistical mechanical (molecular) view of entropy, entropy and the Second Law of thermodynamics Entropy as a state function, the Third Law of thermodynamics, absolute entropies and absolute zero, the Clausius Inequality, entropy change as a result of work, temperature, phase change (Trouton's Rule)
17 18 19		Gibbs Free energy and spontaneity, Helmholtz Free energy, standard free energies, free energy as a function of pressure and temperature The Fundamental equation, properties of internal energy and Maxwell's relations
20 21		Thermodynamics criteria for chemical and phase equilibria, chemical potential and partial molar quantities, the Gibbs Free Energy minimum and equilibrium, extent of reaction and equilibrium constant, molecular description of equilibrium, response of equilibria to temperature

22 23		Thermodynamics of liquids and liquid mixtures, chemical potentials of liquids, ideal liquid mixtures and Raoult's Law, Henry's Law, vapor pressure diagrams, liquid-liquid phase diagrams Free energy and entropy of mixing, excess functions and real solutions, solute and solvent activity, activity coefficient
24		Colligative properties, osmotic pressure
25	I. Redox (and important acid-base) Reactions	Oxidation of elements by halogens and dioxygen. Metal and main group halides and oxides. Discussion of selected syntheses, chemistry and structures of halides and oxides including amphoteric behaviour and hydroxide/aqua ion formation. Thermodynamic vs kinetic control of reactions.
26		Thermodynamic aspects of halide and oxide formation. Thermodynamic parameters, their estimation and uses of tabulations. Born-Haber cycle and construction and uses of Ellingham diagrams for these systems. (Electrides and sodides?)
27		Oxidation of metals by protons etc. and generation of aqua ions. Comparison of TM and main group systems and hydrolysis in TM aqua ions (acid-base chemistry of coordinated water-hydroxide-oxo ligands). Connection between electrochemical and thermodynamic parameters. Construction and uses of Latimer and Frost diagrams.
28		Interpretations of Frost diagrams exemplified by the more complex chemistry of main group elements, such as nitrogen. Thermodynamic content of plots (free energy of formation vs oxidation state) and predictive power.
29		Nernst equation revisited and construction and uses of Poubaix diagrams combining redox and acid base reactions. Comparison of chemistry of representative elements as reflected in Pourbaix diagrams.
30	II. Exchange reactions.	Solid/gas phase systems exemplified by transport reactions and preparation of solid-state materials, in vulcanology, halogen lamps etc. Solution examples of double decomposition (metathesis). Solubility trends. Common ion effect.
31		Hard/soft acid/base theory. Thermodynamic basis for HSAB theory. Usefulness in predicting direction of equilibrium and solubility.
32	III. Substitution Reactions.	Typical reactions and synthetic applications and examples. Inert and labile complexes. Stability (K, □) and factors affecting stability (metals,

		ligands). Irving-Williams series, Chelate effect. Applications of chelate effect. Siderophores. antioxidants, garden products, chelation therapy in medicine.
33		Mechanism of substitution reactions. Square planar Pt complexes and applications. Trans effect. Pt chemistry. Applications in synthesis of action of chemotherapeutic agents.
34		Dissociative, interchange and associative mechanisms in substitution, racemization *etc* in octahedral complexes.
35		Combination of substitution and redox chemistry in TM systems. Co(III) syntheses, Cr(II) catalysed substitution. Electron transfer, inner- and outer-sphere reactions.
36	IV. Metal centred reactions.	Template reactions and reactions of coordinated ligands. Atom transfer reactions (redox reactions). Metal directed ligand syntheses

Chemistry 202 (Year 2, Semester 2)

Structure and Properties

This subject covers key concepts related to the stereochemical and electronic properties of molecules and the methods central to their study. Important elements of the subject include the spectroscopic characterisation and quantification of materials by a range of spectroscopic techniques, molecular orbital techniques and the application of approaches based on molecular symmetry and group theory to the understanding of molecular properties, stereo-selective reactions, bonding and spectroscopy. These topics have applications to advanced materials, light emitting polymers, chemical analysis and catalysis in biological and industrial systems.

Upon completion of this subject students should;

- be able to classify molecules according to their symmetry and to relate their physical properties (e.g. dipole moment, isomerism) to the molecular symmetry;
- have a basic knowledge of the basis and application of spectroscopic techniques that are conducted in the presence (NMR, EPR) or absence (IR, Raman, UV-Vis.) of an applied magnetic field;
- be able to apply molecular orbital theory to simple homo- and heteronuclear diatomic molecules and polyatomic molecules;
- be able to apply simple Huckel approaches to arrays of atoms having orbitals of pi symmetry;
- be able to identify systems that are aromatic or antiaromatic in character and to have a knowledge of their basic reactions;
- be able to describe the changes in bonding that occur to small molecules (e.g. CO) on binding to a transition metal and to be able to apply these concepts to the catalysis of reactions of those species.

1	Molecular shape and simple electronic structure, Isomerism	Introduction – scope of course Orbitals, hybridization and shapes of molecules, sterochemical consequences of tetrahedral carbon (isomers, enantiomers, R/S, D/L, optical rotation)
2	Stereochemistry – optical activity	Molecules with more than one chiral centre (diastereomers, meso compounds, separation of racemic mixtures)
3	Symmetry	Symmetry operations and elements
4		Assignment of point groups Leading to definition of components of character tables (irreducible representations, characters – at least the interpretation of the sign of the character)

5		Simple applications Label molecular shapes, isomers Identify chiral molecules Physical properties – *e.g.* dipole moment, possible optical isomers Orbital symmetry labels (*e.g.* s, p & d orbitals in T_d, O_h, D_{4h})
6	Stereochemistry and Reactions	Prochirality, chirality in Nature, Sterochemistry on atoms other than carbon, Retrosynthetic analysis
7	Stereochemistry and mechanism	Stereochemistry and Mechanism (nucleophilic substitution, elimination from non-cyclic compounds)
8		Alkene addition reactions – Hydrogenation, halogenation, HX addition. Elimination Reactions epoxide ring forming reactions
9	Zeeman effect	Effect on the energies of a system by application of a magnetic field; Magnetochemistry, spin and orbital contribution to the magnetic moment
10	Magnetic resonance spectroscopies	EPR spectroscopy, hyperfine coupling application to organic radicals and to transition metal complexes
11		Nuclear Magnetic Resonance (NMR), energies of nuclei in magnetic fields
12		Chemical shift and the δ scale, resonance of different nuclei, shielding, spin-orbit coupling and coupling constants, molecular symmetry
13		^{13}C NMR, ^{1}H NMR, integration, multiplicity, chemical shift typical ranges
14	Spectroscopy and Molecular Structure	Introduction to molecular spectroscopy and spectroscopic transitions, absorbance, transmittance, the Beer-Lambert Law, intensities of spectroscopic transitions
15	Molecular Vibrational	Quantised vibration and simply harmonic oscillator model, wavefunctions,
16		Molecular vibrational modes, vibrational spectroscopy infrared and Raman spectroscopy 3N-5, 3N-6 vibrational degrees of freedom
17	Group theory: Irreducible representations	Definition of reducible and irreducible representations, Use of group theory to determine the irreducible representation
18	Vibrational symmetry and IR/Raman activity of normal modes	Symmetry properties of the vibrational degrees of freedom and to deduce IR, Raman activity. Use of internal coordinates to get symmetry properties of a subset of bands
19	Vibrational spectroscopy: Local mode approximation	Characteristic infrared absorptions (alkyl CH, alcohol, amine RNH_2 and R_2NH, carboxylic acid, amide, ester, ketone, aldehyde, nitrile RCN, alkyne, alkene, aromatic), fingerprint regions, interpretation of IR spectra
20	Molecular orbital theory	Electronic spectroscopy requires understanding of electronic structure leading to Molecular orbital theory – HOMO, LUMO

21		Diatomic molecules, LCAO-MO, Symmetry of MO's
22		Photoelectron spectroscopy
22		Generalisation of the application of MO approaches to polyatomic molecules
23		Hückel Theory
24 25 26	Aromaticity and the reactions of compounds with delocalised □ orbitals	Aromatic and Heterocyclic Chemistry. Benzene and Aromaticity/Antiaromaticity, Reactions of Aromatic Compounds Electrophilic aromatic substitution. Reactions of Polycyclic and Heteroaromatic Compounds. Reactions via Aromatic Transition States Electrophilic aromatic substitution on naphthalene. Electrophilic aromatic substitution on heteroaromatics (*e.g.* pyridine and pyrrol). Non C-based aromatic systems
27	Electronic spectroscopy	Chromophores and excited electronic states, electronic transitions, UV-Vis spectroscopy, Franck-Condon Principle, Franck-Condon factors
28		Fates of electronic excited states – fluorescence and phosphorescence, non-radiative transitions, internal conversion and intersystem crossing, fluorescence spectra
29		Applications – light emitting polymers
30	Organometallic chemistry	Organometallic chemistry. Types and broad applications of organometallic complexes and catalysts. Ligand types and examples.
31		Group 1 (LiR) and group 2 (Grignard) and p-block chemistries. EPR spectroscopy as a tool to probe electron distribution in carbocyclic and organometallic species
32		Covalent interactions in coordination compounds – rationalisation of spectrochemical series in terms of bonding interactions
33		Binary metal carbonyl complexes Synergistic bonding and the 18-electron rule. IR and NMR spectroscopy
34		Substitution at metal carbonyl. Other organometallic ligand types and complexes thereof. Alkyne and alkene complexes. *etc.*
35		Redox reaction in organometallic chemistry. Hydrogen complexes and oxidative addition reactions. Reductive elimination reactions. Activation and reactions of organometallic ligands. Insertions, migrations.
36	Catalysis involving transition metals	Catalytic systems. Water gas shift reaction, hydrogenations, acetic acid process etc. Metallocene complexes and their chemistry leading to advanced polymerization catalysts etc.

BSc (Blended) Syllabus for Biology

Biology 101 (Year 1, Semester 1)

Evolution and diversity of life

This course will introduce the concepts of chemical and biological evolution and their contribution to the evolution of diversity of life forms. Students will learn different theories on the evolution of life and evolution of complexity. It will also provide the basics of biological classification and introduction to major domains and kingdoms of biological diversity, and the structure and biology of these organisms.

Unifying themes in Biology *(4 lectures)*

Cell theory and the origin of life

(Cell theory, living organisms are made of cells, cells are smallest organizational unit of life, origin of life=origin of cell; life is defined by replication, mutation, metabolism

Chemical evolution of life

(RNA polymers and the origins of information storage and replication, containment of molecules in cell-like compartments, DNA as the basis for life)

Life evolves

Evolution and natural selection

Evolution of complexity

Unicellular to multicellular
Structural organization – symmetrical and asymmetrical

Evolutionary relationships *(4 lectures)*

Evolutionary relationships (phylogenies) are summarized in classifications
Principles of phylogenetics and systematics; synapomorphy and monophyly
Taxonomy and the naming of organisms

Domains and kingdoms of life *(2 lectures)*

Five kingdoms model; the tree of life

Diversity, structure and biology of major groups *(24 Lectures)*

Emphasizing the major evolutionary features and the evolution of body plans

Prokaryotes: Bacteria and Archaea

Protists (Slime moulds, amoebae, primary plastids – red and green algae, secondary plastids – brown algae lineage, dinoflagellates and apicomplexans, euglenoids)
Fungi (Structure and growth, nitrition, reproduction, fugal phyla, mutualisms, fungi and humans)
Plants (Alternation of generations and the land plant life cycle, bryophytes, evolution of vascular tissue, lycophytes and ferns, seed plants, the seed and secondary growth, cycads and Ginkgo, conifer diversity and biology, Angiosperm structure, biology and diversity, the flower, double fertilization.
Animals (Simple animals – sponges to flatworms; annelids, molluscs, nematodes and arthropods; echinoderms; chordates

Viruses and Prions *(2 lectures)*

Viruses are subcellular organisms

Biology 102 (Year 1, Semester 2)

Cell biology

This course will introduce the basic unit of life, or the cell, and its structural and functional elements. Students will learn the components of a cells and their functioning, cell division, contribution of a cell to form multicellular units, and flow of genetic information within a biological system through the central dogma of life.

Structure and function of cell components (24 lectures)

Membranes
Plasma membrane and glycocalyx
Nucleus
Ribosomes
Endoplasmic reticulum
Plasmodesmata
Golgi and vesicles
Lysosomes
Vacuoles
Mitochondria
Plastids, Chloroplast
Microbodies
Cytoskeleton
Flagella, Cilia
Cell wall

Endosymbiosis (4 lectures)

Chloroplast
Mitochondria

Genetic code and central dogma of life (2 lectures)

Nucleic acids, one gene-one polypeptide hypothesis, chromosome structure, DNA synthesis, transcription, translation, protein synthesis, protein targeting and processing

Gene expression (2 lectures)

prokaryotic, eukaryotic, RNA interference

Cell division (2 lectures)

binary, budding, mitosis and meiosis, cell cycle, differentiation, aging, and death

Developmental control in multicellular systems ***(2 lectures)***

stem cells; embryonic development and pattern formation; cells, tissues, and organs; signaling and developmental controls. Examples from animals and plants.

Biology 201 (Year 2, Semester 1)

Physiology

In this course, the learning objective is to integrate cell and molecular biology in the context of anatomy and physiology of various systems including plants, animals and microbes.

Principles of physiology (Introduction) *(6 lectures)*

- Energy management, maintenance of homeostasis, metabolic processes
- Homeostasis - Salts and water
- Cellular Respiration (processing of glucose and lipids: glycolysis, B-oxidation, Krebs cycle, electron transport chain, fermentation.
- Metabolic processes (Anabolism, Catabolism)
- Regulation of metabolism (molecular (signaling), genetic)

Animal physiology (Human) *(14 lectures)*

- Respiration, digestion, nutrition and metabolism
- Nervous system
- Endocrine system
- Excretion and osmo-regulation (Water and Salt Balance)
- Cardiovascular system
- Thermal regulation
- Reproduction and development (Introduction)

Plant physiology *(14 lectures)*

- Water balance
- Mineral nutrition and nutrient assimilation
- Solute transport across membranes
- Phloem translocation
- Photosynthesis
- Respiration and lipid metabolism
- Secondary metabolism and defense
- Growth and development (signal transduction, cell walls, light responses, hormones, control of flowering
- Abiotic stress

Microbial physiology *(2 lectures)*

- Aerobic and anaerobic respiration
- Extremophiles
- Symbiotic associations
- Enzymes

Biology 202 (Year 2, Semester 2)

Genetics, evolution and ecology

The purpose of this course is to introduce the higher levels of biological organizations by examining aspects of population genetics, ecology and evolutionary biology.

Genetics, and mechanisms of evolution ***(12 lectures)***

- Mendelian genetics (segregation of alleles, independent assortment)
- Beyond Mendel (multigene inheritance, sex-linkage, gene interaction, gene linkage,
- Genetic diversity (mutation, recombination)
- Genetic structure of populations (random mating/Hardy-Weinberg
- equilibrium. Mutation, selection, drift, inbreeding)
  Selection
- Speciation and species concepts
- Mechanisms of speciation (geographical, sexual, temporal, ecological)

Population biology ***(8 lectures)***

- Nature of populations
- Distribution and abundance of populations
- Density independent, density dependent growth
- Managing populations for production
- Conservation biology
- Demography and Epidemiology

Community ecology

Nature of communities ***(10 lectures)***

- Community structure
- Intracommunity interactions
- Symbiosis
- Predation
- Competition
- Host-parasite interactions
- Niche
- Dynamics of communities (perturbation and succession)
- Biomes (communities on a global scale)

Ecosystems

- Pond ecosystem
- Food chains and webs ***(6 lectures)***
- Pyramids (numbers, biomass, energy)
- Productivity (Primary and secondary)
  Biogeochemical cycles (Water , C, N, P)