SYLLABUS

Master of Science

In

B.Sc. /M.Sc. Basic Sciences

(5 Years Integrated Programme)

Babasaheb Bhimrao Ambedkar University
(A Central University)
Vidya Vihar, Raebareli Road
Lucknow-226025

Objectives of B.Sc./ M.Sc. Basic Science programme

The courses offered in the undergraduate programme at BBAU, Lucknow form part of a comprehensive programme that will enable the students to understand the basic laws of nature and develop necessary skills to apply them to any desired area or discipline. The program is planned as a student centric collaborative learning. Students get trained for a career in basic sciences or any related applied science ortechnology.

General Pattern

The courses offered during the first two years (Semesters I to IV) are meant as basic and introductory courses in Biology, Chemistry, Mathematics and Physics. These are common and mandatory for all students. They include four theory courses and three lab courses from each stream. These courses are meant to give a flavor of the various approaches and analyses and to prepare the students for advanced courses in later years of study. In addition, there will be Interdisciplinary Courses for computational skills and mathematical methods as well as Trans-disciplinary Courses on Scientific Inquiry and Conceptual Inquiry.

In the third and fourth years (Semesters V-VIII), students have the freedom to choose advanced courses based on their interest and inclination. The courses offered in the first two years would help them to make an informed judgment to determine their real interest and their aptitude for a given subject. The fifth year will be devoted to a thesis by research, which completes the requirements of the program.

Credits and Coursework

Every student has to register for approximately 24 credits in a semester. During Semesters I-IV, she/he has to register for all the courses offered. During Semester V-VIII, she/he can register for up to 30 credits per semester, the minimum being 24. Each credit earned requires 4 hours of study per week.

DETAILS OF COURSES

The list of courses offered from each discipline with brief contents and lists of reference books is given below. Other relevant details like objectives, topic in detail, pattern of assessment, additional books for study and reference etc. will be prepared by the course instructor and communicated to the students well in advance before start of each semester.

BIOLOGY

The overarching philosophy of the curriculum in Biology stems from one of the primary mandates of the BBAU - to expose undergraduate students to interdisciplinary research in the basic sciences, and provide them with the necessary skills, knowledge and training to pursue successful careers in science.

The first four semesters serve as an introduction to Biology. Keeping in mind the diversity amongst the incoming students in their school education, we introduce all students to the unity and diversity of biology and the hierarchy of organization of biological systems. We emphasize the distinctness of biological systems while demonstrating the continuum from the physical/chemical world to Biology.The courses in these semesters introduce variation, evolution, diversity and the irreducible complexity of life and biological systems. The unity of life is presented through a thorough description of biology at sub-organismal (reductionist as well as systems view) and organismal levels. At the sub-organismal reductionist level, students are introduced to the building blocks of life (biochemistry and molecular biology), information perpetuation and transfer (genetics), cells as the basic functional unit of life (cell biology) and higher levels of organization (tissue systems and physiology). In terms of the systems view at the sub-organismal level, the students learn about design principles of biological systems (systems biology) and the development of the organism. In organismal biology, students focus on interactions of the organisms with the environment, dynamics of populations/ communities and evolution at various temporal and structuralscales.

Courses in the third and fourth years cover in greater detail the content introduced in the first two years. Courses such as cell and molecular biology, biophysics and biochemistry, physiology, genetics, biostatistics and evolution and ecology comprise core courses that allow students to obtain a deeper understanding of biology. Advanced courses in areas such as immunology, neurobiology, disease biology, developmental biology, ecology, epigenetics, etc., provide students an opportunity to gain a specialized and comprehensive understanding of those fields.Building on the foundations in physical, mathematical, chemical and information sciences, the Biology curriculum integrates concepts, examples and techniques from other disciplines. Experts from other disciplines regularly contribute to courses in Biology, and the curriculum emphasizes quantitative and computational applications in biology through courses in mathematical biology, biostatistics, bioinformatics, biophysics, chemical biology and computational biology.There is a strong emphasis on using current primary literature in the classroom. This ensures a continually updated content, and at the same time, trains students to read, understand, and critically evaluate the primary scientificliterature.

Participatory teaching techniques such as group learning, assignments and student presentations are actively used.To encourage research-based learning techniques, our lab courses of the first three semesters are designed with small open-ended experimental modules. Third and fourth year students are encouraged to participate in lab training/theory projects in Biology research groups in addition to the classroom-based courses. These provide an opportunity to independently design and carry out laboratory and/or theoretical projects and participate in reading projects.

In the final (fifth) year, students undertake an independent, stand-alone research project. The project can be carried out in any laboratory within or outside Lucknow. The goal is to develop the technical, analytical and cognitive skills necessary to pursue a career in scientific research. The goal is to expose students to contemporary research practices and tools including literature reviews, advanced techniques, data collection and analysis, and also in scientific writing and presentation. This is the culmination of the training from the previous years and is an opportunity to directly participate in the process of knowledge production in Biology.

CHEMISTRY

The General Chemistry course covered during the first semester will lay the foundation for advanced concepts in chemistry. Here the students would be exposed to a general overview of chemistry in everyday life. Some topics covered include units, measurement, periodicity, thermodynamics, kinetics, bonds, spectroscopy, solutions, chirality and biochemistry. This course serves as the common backbone for the ensuing three semesters of physical, inorganic and organic chemistry, all accompanied by laboratory courses. The laboratory course has been designed to complement classroom interactions. Together, these seven courses in the first four semesters should sufficiently prepare a student for advanced courses in chemistry and serve as the minimum for anyone who wishes to major in other disciplines of science such as physics or biology.

The Ideology behind the Chemistry Program

The chemistry program has been broadly divided into three groups: physical chemistry, inorganic chemistry and organic chemistry. Each semester has at least "core" course from these groups that a student may opt for. They are also arranged in sequence so that all topics in a particular group are covered by the end of the eighth semester.

Suggestions to Students wanting to "Major in Chemistry"

Students who wish to study chemistry as the major subject of interest may opt for a majority of the core courses offered each semester and as many electives as possible in chemistry. Several sequences are available for students to choose from such as organic, inorganic and physical chemistry. If the student is interested in inter-disciplinary areas, one could choose from three available options, materials science, chemical physics and chemical biology. Of course, other combinations of courses yielding the right mix for chemistry and other disciplines might also be possible. In addition, students are allowed to register for two lab/theory projects during their third and fourth years as an electivecourse.

Inter-disciplinary courses in Chemistry

Inter-disciplinary courses are divided roughly into three streams:

1. Chemical Physics: These cover courses in the interface of physics and chemistry and include Symmetry and Group Theory, Advanced Molecular Spectroscopy, Statistical Thermodynamics, and Quantum Chemistry and Solid State Chemistry. When combined with suitable physics courses, a student can have a good exposure to both chemistry andphysics.
2. Chemical Biology: Several courses in the interface of chemistry and biology are offered by the chemistry division. Starting from the sixth semester, a sequence of courses of Bioorganic Chemistry, Chemical Biology and Medicinal Chemistry can complement relevant course in biology division to cover advanced topics in the interface of these twostreams.
3. Materials Science: Courses offered under this broad section would cover areas that are common to chemistry, physics and to some extent biology. Starting from fifth semester a series of courses such as Self-assembly in Chemistry, Solid-state chemistry, Polymer chemistry and Advanced materials chemistry will give good insights to relevant courses both in physics and biology. Further, the courses offered under this section would be useful to all the students who want to specialize in any branch of organic, inorganic or physicalchemistry.

MATHEMATICS

Very basic mathematics, by which one means the bare minimum that any scientist should be familiar with, is treated in the following six core courses in the first four semesters: Single Variable Calculus, Multi Variable Calculus, Introduction to Computing, Linear Algebra, Probability & Statistics, and Introduction to Proofs.

The Ideology behind the Mathematics Program

Mathematics, or at least basic Mathematics, very broadly interpreted, has five themes or subjects: Algebra, Analysis, Geometry & Topology, Discrete Mathematics and Applicable Mathematics. In reality, these subjects seamlessly and indistinguishably blend into each other and such a coarse classification is purely for didactic purposes.

Courses in the Third and Fourth Year

1. For each of the above themes, there is a sequence of four courses through the four semesters in the third and fourth years. They are asfollows:
2. *Algebra:* Group Theory; Vector Spaces, Rings and Modules; GaloisTheory; Algebraic NumberTheory
3. *Analysis:* Analysis (which means basic analysis); Measure Theory &Integration; Functional Analysis; ComplexAnalysis
4. *Geometry & Topology:* Elementary Geometry; Point Set Topology;Differential Geometry; AlgebraicTopology
5. *Discrete Mathematics:* Combinatorics & Number Theory; GraphTheory; Algorithms; Cryptography
6. *Applicable Mathematics:* Statistics; Ordinary Differential Equations;Mathematical Biology; Partial DifferentialEquations

Suggestions to Students wanting to "Major in Mathematics"

Students wanting to major in Mathematics should choose four out of the above five sequences and go through all the courses in that sequence for a solid foundation in that theme. All the courses in each of these 5 sequences are for 4 credits. Someexamples:

1. A student wanting to focus on what is traditionally called *PureMathematics* could choose Algebra, Analysis, Geometry & Topology,and Discrete Mathematicssequences.
2. A student wanting to focus on what is traditionally called *AppliedMathematics* could choose Analysis, Geometry & Topology, DiscreteMathematics, and Applicable Mathematicssequences.

The above examples are mere suggestions because the epithets of *pure* and *applied* are totally artificial: there is nothing impure about applicable mathematics and much of pure mathematics has evolved out ofapplications.

Some clusters or prerequisites:

1. Applicable Mathematics sequence needs the Analysissequence.
2. Geometry & Topology sequence can benefit from the Analysissequence.
3. Discrete Mathematics sequence can benefit from the Algebrasequence.

The bottom line: Students should choose sequences based on what excites them the most in

Mathematics. Students also have one reading project course per semester where they can diversify and explore other subjects within mathematics. Based on students' interests, and available faculty, the course structure has the provision for topics courses. For example, one can have a course on "Representation Theory" under "Topics in Algebra", or a course on "Lie Theory" under "Topics in Analysis" in the 7th or 8th semesters. Topics courses will often have certain prerequisites that will be announced by the instructor well ahead of time. Students are also required to take courses from at least two different disciplines in their 5th and 6th semesters (= thirdyear).

PHYSICS

The courses offered in Physics at BBAU form part of a comprehensive program at the level of a Bachelor's and Master's degree (BSc and MSc). The Physics program aims to enable students to understand the basic laws of nature and develop the necessary skills and tools to apply this understanding to other areas and disciplines. Here students are prepared for careers in basic physics as well as in related applied sciences or technology.
The courses offered in Physics for the B.Sc/ M.Sc program are structured in two levels.

Courses in Semesters I-IV: Introduction to the World of Physics
The first level spans courses offered during the first four semesters of the B.Sc./ M.Sc. Program. These courses are common and mandatory for all students. Based on their interests, the students specialize after completing the fourth semester. For this reason, the first level courses are designed to cover the basic concepts in physics in a very comprehensive manner, since they could be the only physics courses taken by students specializing in other disciplines. These courses are meant to give a flavor of the various approaches and analyses in Physics as well as to prepare them for advanced courses in later years of study.

The four World of Physics courses in the first four semesters offer all students an exposure to both the rigour and breadth of physics, concentrating mainly on mechanics, waves and matter, electricity and magnetism, and quantum physics. There are three Laboratory Courses that expose them to key experiments and teach them skills in handling basic equipment. In addition, there are two Interdisciplinary Courses offered during this period: Mathematical Methods that provides the basic mathematical tools needed for a program in science, and Thermodynamics that provides an introduction to the concepts needed for the further study of physics andchemistry.

Courses in Semesters V-VIII
The courses at the second level of the program are designed for students who have chosen to specialize primarily in physics. These are in-depth courses with a strong emphasis on developing problem-solving skills.The basic requirements for graduation during semesters V-VIII, consist of 4 courses of 6 credits each. These are core courses meant for detailed and in-depth study covering all the basic areas of Physics. A student planning a career in Physics is expected to take all of them. These include Mathematical Methods, Classical Mechanics and Electrodynamics, two courses in Quantum Mechanics, Statistical Mechanics, Condensed Matter Physics, Nuclear and Particle physics, Atomic and Molecular Physics and Classical and Quantum Optics. In addition, advanced courses are Statistical Mechanics, Condensed Matter Physics, Quantum Information and Gravitation and Cosmology. Four Laboratory courses are offered, one in each semester, which will train students in advanced-level experiments and the use of modern equipment.The courses at this levelare

designed to train students to enter into a career as experimental or theoretical physicists. For this purpose, students are encouraged to follow their own inclinations and can take any combination of basic theoretical courses including current research topics, as well as advanced laboratory courses, along with courses like electronics and experimental methods.

Interdisciplinary Courses

The pattern of course work followed at BBAU permits students specializing in other disciplines or areas, also to take courses from Physics. Thevarious courses like; Mathematical Methods, Nonlinear Dynamics, Fluid Dynamics, Nanoscale Physics and Material Science are offered such that students interested in other disciplines also benefit from them.Similarly, a student interested in a career in Physics and interdisciplinary areas related to Physics, can take courses from other disciplines. Some such courses are Neurobiology, Genetics, Biophysics etc from Biology; Statistical Thermodynamics, Symmetry and Group Theory, Quantum Chemistry etc from Chemistry; and Differential Geometry, Statistics, Complex Analysis etc from Mathematics. During Semesters V and VI, students have to take at least one course from another discipline.

Semester Projects

Unique to the BBAU undergraduate program is the laboratory training/theory project offered in each semester during the four semesters V-VIII. This gives an opportunity to work under the guidance of a faculty member on a topic of mutual interest to earn six credits. This allows students to slowly build a solid platform from which they may launch themselves into a more challenging fifth-year research project later on. Any specialization or advanced training needed, in addition to the courses offered, can be achieved through careful choice of this lab training/theory projectcourse.

Semester IX-X

During the final two semesters of the program, students do an extended project for six credits that result in the M.Sc. thesis.

COURSE STRUCTURE FOR B.Sc./M.Sc. BASIC SCIENCES

COURSE STRUCTURE FOR B.Sc./M.Sc. BASIC SCIENCES

1st Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-101	World of Biology I: Introduction Biology	70	30	4
IBS-101a*	Biomolecules	35	15	2
IBS-101b*	Microbial Genetics	35	15	2
IBS-102	World of Chemistry I: General Chemistry	70	30	4
IBS-102a*	Bioorganic Chemistry	35	15	2
IBS-102b*	Chemoinformatics	35	15	2
IBS-103	World of Mathematics I: Basic Mathematics	70	30	4
IBS-103a*	Differentiation, integration and their applications	35	15	2
IBS-103b*	Vector analysis (fundamental)	35	15	2
IBS-104	World of Physics I:Mechanics	70	30	4
IBS-104a*	Mathematical Physics-I	35	15	2
IBS-104b*	Classical Mechanics	35	15	2
MPDC-105	Remedial Language	15		1
Total Credits				24+1

2nd Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-201	World of Biology II:Introduction of Cell Biology andBiochemistry	70	30	4
IBS-201a*	Cellular Basis of Structure and Function in Biology	35	15	2
IBS-201b*	Biophysics I	35	15	2
IBS-202	World of Chemistry II: Physical Chemistry	70	30	4
IBS-202a*	Statistical Thermodynamics	35	15	2
IBS-202b*	Quantum Chemistry	35	15	2
IBS-203	World of Mathematics II: Multi Variable Calculus	70	30	4
IBS-203a*	Ordinary differential equations	35	15	2
IBS-203b*	Vector calculus	35	15	2
IBS-204	World of Physics II: Waves and Matter	70	30	4
IBS-204a*	Mathematical Physics-I	35	15	2
IBS-204b*	Fluid Dynamics	35	15	2
MPDC-205	Moral Studies	15		1
Total Credits				24+1

3rd Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-301	World of Biology III: Evolution and Ecology	70	30	4
IBS-301a*	Biophysics II	35	15	2
IBS-301b*	Neurobiology I	35	15	2
IBS-302	World of Chemistry III: Inorganic Chemistry	70	30	4
IBS-302a*	Heterocyclic chemistry	35	15	2
IBS-302b*	Environmental and Green chemistry	35	15	2
IBS-303	World of Mathematics III: Linear Algebra	70	30	4
IBS-303a*	Laplace transform	35	15	2
IBS-303b*	Numerical analysis	35	15	2
IBS-304	World of Physics III: Electricity & Magnetism	70	30	4
IBS-304a*	Quantum Physics	35	15	2
IBS-304b*	Nanotechnology	35	15	2
MPDC-305	Community Service	15		1
Total Credits				24+1

4th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-401	World of Biology IV: Biology of Systems	70	30	4
IBS-401a*	Vaccines	35	15	2
IBS-401b*	Neurobiology II	35	15	2
IBS-402	World of Chemistry IV: Organic Chemistry	70	30	4
IBS-402a*	Polymer chemistry	35	15	2
IBS-402b*	Physical Organic Chemistry	35	15	2
IBS-403	World of Mathematics IV: Probability and Statistics	70	30	4
IBS-403a*	Dynamics of rigid bodies	35	15	2
IBS-403b*	Moment of inertia &Conservation of energy	35	15	2
IBS-404	World of Physics IV: Quantum Physics	70	30	4
IBS-404a*	Atomic and Molecular Physics	35	15	2
IBS-404b*	Electromagnetism	35	15	2
MPDC-405	Ambedkar Studies	15		1
Total Credits				24+1

5th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	Sessional	
IBS-501	Animal Physiology I	105	45	6
IBS-502	Advanced Molecular Biology	105	45	6
IBS-503	Advanced Cell Biology	70	30	4
IBS-504	Biostatistics	35	15	2
IBS-505	Animal Behaviour	35	15	2
IBS-506	Lab Course	105	45	6
IBS-507	Advanced Organic Chemistry Laboratory	105	45	6
IBS-508	Symmetry and Group Theory	105	45	6
IBS-509	Self-assembly in Chemistry	70	30	4
IBS-510	Main Group Chemistry	35	15	2
IBS-511	Separation Principles and Techniques	35	15	2
IBS-512	Lab Course	105	45	6
IBS-513	Group Theory	105	45	6
IBS-514	Elementary Geometry	105	45	6
IBS-515	Analysis	70	30	4
IBS-516	Topics in Algebra	35	15	2
IBS-517	Topics in Geometry & Topology	35	15	2
IBS-518	Topics in Discrete Mathematics	105	45	6
IBS-519	Mathematical Methods in Physics	105	45	6
IBS-520	Astronomy & Astrophysics Electronics I	105	45	6
IBS-521	Methods of Experimental Physics	70	30	4
IBS-522	Electrodynamics	35	15	2
IBS-523	Physics Lab IV	35	15	2
IBS-524	Lab Course	105	45	6
Total Credits				24

6th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	Sessional	
IBS-601	Plant Biology I	105	45	6
IBS-602	Immunology I	105	45	6
IBS-603	Advanced Biochemistry I	70	30	4
IBS-604	Epigenetics	35	15	2
IBS-605	Developmental Biology	35	15	2
IBS-606	Lab Course	105	45	6
IBS-607	Quantum Chemistry	105	45	6
IBS-608	Physical Chemistry of Solutions	105	45	6
IBS-609	Fundamentals of Molecular Spectroscopy	70	30	4
IBS-610	Transition Metal Chemistry	35	15	2
IBS-611	Organic Synthesis – I	35	15	2
IBS-612	Lab Course	105	45	6
IBS-613	Vector Spaces, Rings and Modules	105	45	6
IBS-614	Measure Theory and Integration Point Set Topology	105	45	6
IBS-615	Graph Theory	70	30	4
IBS-616	Ordinary Differential Equations	35	15	2
IBS-617	Topics in Algebra	35	15	2
IBS-618	Topics in Geometry & Topology	105	45	6
IBS-619	Quantum Mechanics I	105	45	6
IBS-620	Statistical Mechanics I	105	45	6
IBS-621	Nonlinear Dynamics	70	30	4

IBS-622	Electronics II	35	15	2
IBS-623	Group Theory in physics	35	15	2
IBS-624	Lab Course	105	45	6
Total Credits				24

7th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	Sessional	
IBS-701	Biology and Disease	105	45	6
IBS-702	Plant Biology II	105	45	6
IBS-703	Structural Biology	70	30	4
IBS-704	Animal Physiology II	35	15	2
IBS-705	Immunology II	35	15	2
IBS-706	Lab Course	105	45	6
IBS-707	Advanced Molecular Spectroscopy Organic Synthesis – II	105	45	6
IBS-708	Bioinorganic Chemistry	105	45	6
IBS-709	Molecular Modelling and Simulation	70	30	4
IBS-710	Advanced Physical Chemistry	35	15	2
IBS-711	Solid State Chemistry	35	15	2
IBS-712	Lab Course	105	45	6
IBS-713	Galois Theory	105	45	6
IBS-714	Functional Analysis	105	45	6
IBS-715	Differential Geometry	70	30	4
IBS-716	Algorithms	35	15	2
IBS-717	Topics in Algebra	35	15	2
IBS-718	Topics in Geometry & Topology	105	45	6
IBS-719	Quantum Mechanics II	105	45	6
IBS-720	Statistical Mechanics II	105	45	6
IBS-721	Computational Physics	70	30	4
IBS-722	Quantum Information	35	15	2
IBS-723	Condensed Matter Physics I	35	15	2
IBS-724	Lab Course	105	45	6
Total Credits				24

8th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	Sessional	
IBS-801	Microbiology	105	45	6
IBS-802	Advanced Biochemistry II	105	45	6
IBS-803	Bioinformatics & Computational Biology	70	30	4
IBS-804	Genome Biology	35	15	2
IBS-805	Mathematical Biology	35	15	2
IBS-806	Lab Course	105	45	6
IBS-807	Structural Methods and Analysis	105	45	6
IBS-808	Statistical Thermodynamics	105	45	6
IBS-809	Medicinal Chemistry	70	30	4
IBS-810	Advanced Materials Science	35	15	2
IBS-811	Organometallic Chemistry: Principles and Applications	35	15	2
IBS-812	Lab Course	105	45	6

IBS-813	Algebraic Number Theory	105	45	6
IBS-814	Complex Analysis	105	45	6
IBS-815	Topics in Geometry & Topology	70	30	4
IBS-816	Topics in Discrete Mathematics	35	15	2
IBS-817	Topics in Algebra	35	15	2
IBS-818	Topics in Applicable Mathematics	105	45	6
IBS-819	Classical and Quantum Optics	105	45	6
IBS-820	Nuclear and Particle Physics	105	45	6
IBS-821	Advanced Materials Science	70	30	4
IBS-822	Condensed Matter Physics II	35	15	2
IBS-823	Gravitation and Cosmology	35	15	2
IBS-824	Lab Course	105	45	6
Total Credits				24

9th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	Sessional	
IBS-901	Research project and thesis	150	-	6
IBS-902	Research Methodology	105	45	6
IBS-903	Biostatic and Bioinformatics	105	45	6
IBS-904	Introduction to Computing	105	45	6
Total Credits				24

10th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	Sessional	
IBS-1001	Research project and thesis continued	150	-	6
IBS-1002	Study tour	105	-	6
IBS-1003	Viva-voce	105	-	6
IBS-1004	Field/ Industrial attachment	105	-	6
Total Credits				24

Total credits: 240 + 4

LEARNING OUTCOMES
COURSE STRUCTURE FOR B.Sc./M.Sc. BASIC SCIENCES

1st Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-101	**World of Biology I: Introduction Biology**	70	30	4
	Learning Outcome: The content of this paper is so designed that will provide basic and good knowledge of diversity, evolution, taxonomy, unicellular, multicellular organisms and also students will be able to learn about foundation of physics and chemistry both.			
IBS-101a*	**Biomolecules**	35	15	2
	Learning Outcome: This paper will help in understanding the basic knowledge of carbohydrates,lipids,proteins and nucleic acid which help in techniques used in biochemistry and research.			
IBS-101b*	**Microbial Genetics**	35	15	2
	Learning Outcome: The students will attain knowledge about the basic gene constitution of various microbes and also bacterial transduction, conjugation etc. and viral genetics too.			
IBS-102	**World of Chemistry I: General Chemistry**	70	30	4
	Learning Outcome: Students will gain an understanding of: • the fundamental properties of atoms, molecules, and the various states of matter • simple quantum mechanical treatments of atoms and molecules • the gases lawsand Kinetic Theory Stoichiometric calculations involving gas laws of chemical equations to determine the quantities of reactants and products and limiting reagent problems • concepts in thermodynamics, different thermodynamic quantities such as heat and work and how they are measured, related or transformed from one to the other • states of matter and how they depend on temperature and pressure as well as how they co-exist in phase equilibrium			
IBS-102a*	**Bioorganic Chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of:			

	• metabolism of carbohydrates, lipids, and proteins in humans. They will be able to describe in structures and words the metabolism of sugars through the pathways of glycolysis. • different bio synthesis of molecules.			
IBS-102b*	**Chemoinformatics**	35	15	2
	Learning Outcome: Students will gain an understanding of: Role of Chemoinformatics in pharmaceutical/chemical research, Molecular Descriptors (1D, 2D and 3D), Chemical Databases – Design, Storage and Retrieval methods, Quantitative Structure Activity/Property/Toxicity Relationship Studies, In-silico ADMET Studies, Docking Studies.			
IBS-103	**World of Mathematics I: Basic Mathematics**	70	30	4
	Learning Outcome: a student will be able to compute limits derivatives and definite and indefinite integrals of algebraic, logarithmic and exponential functions and Solve problems by using differentiation and integration.			
IBS-103a*	**Differentiation, integration and their applications**	35	15	2
	Learning Outcome Student will learn about Differentiation integration and their applications in real life problems such as to find the equation of motion of a accelerating body we sue differentiation.			
IBS-103b*	**Vector analysis (fundamental)**	35	15	2
	Learning Outcome Student will learn about fundamental concepts of vectors.			
IBS-104	**World of Physics I:Mechanics**	70	30	4
	Students will be able to articulate and describe: • Relative motion. Inertial and non-inertial reference frames. • Parameters defining the motion of mechanical systems • Study of the interaction of forces between solids in mechanical systems. • Centre of mass of mechanical systems. • Laws of motion and conservation principles			
IBS-104a*	**Mathematical Physics-I**	35	15	2
	• Various techniques to solve differential equations • How to use vector calculus in various physics problems.			

IBS-104b*	**Classical Mechanics**	35	15	2
	Learning outcome: Student will learn Euler-Lagrange equation from variational principle, constraints andLagrange multipliers, integrals of motion, symmetries and conservations laws. Hamiltonian formalism: Hamilton equations.			
MPDC-105	**Remedial Language**	15		1
Total Credits				24+1

2nd Semester

Course Code	**Course Title**	**Maximum Marks**		**Credits**
		End Semester	**Sessional**	
IBS-201	**World of Biology II : Introduction of Cell Biology and Biochemistry**	70	30	4
	Learning outcome: This paper will help students to attain knowledge about basic cell biology including different cell organelles like Endoplasmic reticulum, Golgi complex etc., hydrogen bonding and most important molecular biology including DNA replication, transcription etc.			
IBS-201a*	**Cellular Basis of Structure and Function in Biology**	35	15	2
	Learning Outcome: This paper contains the knowledge about the transport of molecules in cell, signal transduction and cell division help to the student about learning and research purpose.			
IBS-201b*	**Biophysics I**	35	15	2
	Learning Outcome: Students will be able to learn about physics involved in biology including thermodynamics of macromolecules and emphasis of light in biology.			
IBS-202	**World of Chemistry II: Physical Chemistry**	70	30	4
	Learning Outcome: Students will gain an understanding of: • concepts in thermodynamics, different thermodynamic quantities such as heat and work and how they are measured, related or transformed from one to the other			

	• states of matter and how they depend on temperature and pressure as well as how they co-exist in phase equilibria • the transport of ions and thermodynamic functions with applications to electron transfer in biological systems. chemical kinetics; how reaction rates are measured and represented in rate laws, and applications of chemical kinetics in studying enzyme mechanisms.			
IBS-202a*	**Statistical Thermodynamics**	35	15	2
	Learning Outcome: Student will gain the stastistical approach of thermodynamics.			
IBS-202b*	**Quantum Chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of: account for the basic principles and concepts of **quantum mechanics**. solve the Schrödinger equation for model systems of relevance within **chemistry** and physics. describe many-electron atoms with the independent particle model.			
IBS-203	**World of Mathematics II: Multi Variable Calculus**	70	30	4
	Learning Outcome: Students will be able to: • Represent vectors analytically and geometrically. • Evaluate double and triple integrals for area and volume. Differentiate vector fields. • Determine gradient vector fields and find potential functions • Evaluate the problems related to three dimensional geometry. • Evaluate line integrals directly by the fundamental theorems			
IBS-203a*	**Ordinary differential equations**	35	15	2
	Learning Outcome student will be able to Analyze basic concept of differential equations , first order differential equations and linear system of differential equations.			
IBS-203b*	**Vector calculus**	35	15	2
	Learning Outcome student will able to compute line integrals green's theorem surface integrals which is useful in physics and chemistry.			
IBS-204	**World of Physics II: Waves and Matter**	70	30	4
	Students will be able to: • Understand the role of the wave equation and appreciate the universal nature of wave motion. • Understand superposition of harmonic waves.			
IBS-204a*	**Mathematical Physics-I**	35	15	2
	Students will be able to:			

	• Use, advanced mathematical methods and theories on various mathematical and physical problems. • Understand the Fourier theorem and its applications. • Understand partial differential equations.			
IBS-204b*	**Fluid Dynamics**	35	15	2
	Learning outcome: Basic conservation equations of fluid dynamics, compressible and in compressible flows, dimensionless numbers in fluid dynamics.			
MPDC-205	**Moral Studies**	15		1
Total Credits				24+1

3rdSemester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-301	**World of Biology III: Evolution and Ecology**	70	30	4
	Learning Outcome: The students will be able to learn more about population genetics aspects such as Hardy Weinberg law including random mating, panmictic population. In ecology they will get knowledge of food chain, food web biodiversity.			
IBS-301a*	**Biophysics II**	35	15	2
	Learning Outcome: Students will be aware about dynamics of macromolecules, mechano-biology of cells including muscle, nerve and stem cells.			
IBS-301b*	**Neurobiology I**	35	15	2
	Learning Outcome: This paper include the Knowledge about nervous system, Action potential and transmission of nerve impulse which help to understand the neuroscience and disease related to nervous system.			
IBS-302	**World of Chemistry III: Inorganic Chemistry**	70	30	4
	Learning Outcome: Students will gain an understanding of: a. bonding fundamentals for both ionic and covalent compounds, including electronegativities, bond distances and bond energies using MO diagrams and thermodynamic data b. predicting geometries of simple molecules c. the fundamentals of the chemistry of the main group elements, and important real world applications of many of these species			
IBS-302a*	**Heterocyclic chemistry**	35	15	2
	Learning Outcome: Students will learn the importance of heterocycles in biological systems and in pharmaceuticals. Students will be able to draw mechanisms for reactions involving heterocycles as startingmaterials, intermediates and products, and be able to propose syntheses of heterocycles from the major classes. Students will be able to relate significant chemical properties to structure.			
IBS-302b*	**Environmental and Green chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of Synthesize and apply concepts from multiple sub-disciplines in environmental chemistry and toxicology.Use technical and analytical skills to quantify the level and effects of xenobiotics in			

	environmental compartments			
IBS-303	**World of Mathematics III: Linear Algebra**	70	30	4
	Learning Outcome: Student will be able to : • Solve system of linear equations • Analyze vectors in ring geometrically and algebraically. • Recognize the concept of the terms span, linear independence , basis and dimension and apply these concepts to various vector spaces and sub-spaces. • Use matrix algebra and related matrices to linear transformation which is useful in programming of many languages in computer.			
IBS-303a*	**Laplace transform**	35	15	2
	Learning Outcome Student will learn Laplace transform and inverse Laplace transform which useful in finding the behaviour of different biological fluids using equation motion related to fluids in the form of Differential equations.			
IBS-303b*	**Numerical analysis**	35	15	2
	Learning Outcome: Student will be able to derive numerical methods for approximation of continuous mathematics and analyze the errors in any such numerical approximation. This is useful in finding erros in different Lab experiments..			
IBS-304	**World of Physics III: Electricity & Magnetism**	70	30	4
	Learning Outcome: Students will be able to: • Understand the relationship between electrical charge, electrical field, electrical potential, and magnetism. • Solve numerical problems involving topics covered. • Understand various network theorems. • Define the magnetic field and magnetic flux, solve technical problems. • Calculate the magnitude and direction of the magnetic field for symmetric current distributions using the Law of Biot-Savart and Ampere's Law			
IBS-304a*	**Quantum Physics**	35	15	2
	Learning Outcome: Completion of this course will enable the students to: • Understanding of: Importance of quantum mechanics compared to classical mechanics at microscopic level. • Understand various tools to calculate Eigen values and total angular momentum of particles.			

IBS-304b*	**Nanotechnology**	35	15	2
	Learning Outcome: The goal is to generate new interest in nanoscience and nanotechnology among stud ents and prepare them with the knowledge and skills • Apply principles of basic science concepts in understanding, analysis and prediction of matter at Nano scale • To develop human resource with specialization in theoretical and experimental techniques required for career in academia and Nano technology driven industry			
MPDC-305	**Community Service**	15		1
Total Credits				24+1

4th Semester

Course Code	**Course Title**	**Maximum Marks**		**Credits**
		End Semester	**Sessional**	
IBS-401	**World of Biology IV: Biology of Systems**	70	30	4
	Learning outcome: The students after studying this particular paper will easily be able to understand and explain about detailed embryogenesis such as different stages morula, blastula, gastrula and organogenesis too. Students will also attain knowledge about regeneration of stem cell and also basic immunology included in this course.			
IBS-401a*	**Vaccines**	35	15	2
	Learning Outcome: The students will be able to learn about types of vaccines which are prepared from killed and attenuated system and also the mechanism of action and drug resistance.			
IBS-401b*	**Neurobiology II**	35	15	2
	Learning Outcome: Students will be able to know about the knowledge ofdifferent brain imaging function like MRI,PET Scan, emotions, learning and memory help to understand the different diseases in daily life.			
IBS-402	**World of Chemistry IV: Organic Chemistry**	70	30	4
	Learning Outcome: Students will gain an understanding of:			

	• the hybridization and geometry of atoms and the three-dimensional structure of organic molecules. • the reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry. • an understanding of nucleophiles, electrophiles, electronegativity, and resonance. • the prediction of mechanisms for organic reactions. how to use their understanding of organic mechanisms to predict the outcome of reactions.			
IBS-402a*	**Polymer chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of: a. isolate the key design features of a product which relate directly to the material(s) used in its construction b. indicate how the properties of polymeric materials can be exploited by a product designer			
IBS-402b*	**Physical Organic Chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of: concepts of acidity, basicity, and pKa; Equilibria, kinetics andmechanisms; Rearrangements; Radical Reactions; Mechanisms in Biological Chemistry; Advanced Molecular Orbital Theory; Sterochemistry and conformational analysis; Thermal pericyclic reactions; Sigmatropic and electrocyclic reactions; Synthesis and Reactions of carbenes.			
IBS-403	**World of Mathematics IV: Probability and Statistics**	70	30	4
	Learning Outcome: students will be able to : • Organize, present and interpret statistical data both numerically and graphically. • Use various methods to compute the probabilities of events. • Analyze and interpret statistical data using appropriate probability distribution. • Construct and interpret confidence intervals to estimates means, standard deviations and proportion for populations. • Perform a correlation and regression Analysis .			
IBS-403a*	**Dynamics of rigid bodies**	35	15	2
	Learning Outcome Student will be able to learn terms position, velocity acceleration , straight line motion, absolute motion, relative motion relative acceleration and motion relative to rotating axes.			
IBS-403b*	**Moment of inertia &Conservation of energy**	35	15	2
	Learning Outcome: Student will be able to analyze centre of mass, motion of inertia, kinetic energy of a rigid body in a plane and conservation of energy.			

IBS-404	**World of Physics IV: Quantum Physics**	70	30	4
	Learning Outcome: Completion of this course will enable the student to • Understand the discrete spectra and wave particle duality. • Student will know basic information on uncertainty principal. • Understand Schrodinger's equation, complete solution of hydrogen atom • Students got an idea of Pauli spin matrices which are very important in nuclear and particle physics as well as atomic and molecular physics			
IBS-404a*	**Atomic and Molecular Physics**	35	15	2
	Learning Outcome: After the completion of the course, Students will be able to • Student will be able to select molecular spectroscopy methods suitable for solving given scientific problem. • Student will know basic information on molecular methods (THz) • Student will be able to analyze results of measurements using molecular spectroscopy methods. • Understand the concept of continuous absorption and emission spectra.			
IBS-404b*	**Electromagnetism**	35	15	2
	Learning outcome: Student will be able to learnSources and effects of electromagnetic fields – Vector fields – Different co-ordinate systems- vector calculus – Gradient, Divergence and Curl - Divergence theorem – Stoke's theorem. Coulomb's Law – Electric field intensity			
MPDC-405	**Ambedkar Studies**	15		1
Total Credits				24+1

5th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	Sessional	
IBS-501	**Animal Physiology I**	105	45	6
	Learning Outcome: Students will be required with detailed knowledge of physiology of various systems, about the pumping of heart and its circulation of blood digestion, various nerve and conduction of impulse. Students will be able to understand more about processes E.C.G., Ultrasound.			
IBS-502	**Advanced Molecular Biology**	105	45	6
	Learning Outcome: Student will be equipped with the knowledge to handle techniques about DNA fingerprinting, Cloning methods, DNA sequencing, making genomic libraries help to handle various problem in life and criminal cases.			
IBS-503	**Advanced Cell Biology**	70	30	4
	Learning Outcome: Students will be provided with great knowledge of plasma membrane and transport mechanism, cell cycle, cell division along with cytoskeleton.			
IBS-504	**Biostatistics**	35	15	2
	Learning Outcome: This paper will provide students knowledge about various basic statistics variables. Mean, median, mode and types of various tests as t-test etc.			
IBS-505	**Animal Behaviour**	35	15	2
	Learning Outcome: The students will attain knowledge of various behavior of animals such as proximate, ultimate, sexual foraging types of behavior and parental care.			
IBS-506	**Lab Course**	105	45	6
	Learning Outcome: Students have to choose dissertation topic related with the subject and also some experiments such as blood test, parasitic slide preparation etc.			
IBS-507	**Advanced Organic Chemistry Laboratory**	105	45	6
	Learning outcomes: Student will gain the lab techniques of Separation of ternary quantitative analysis of organic compounds.Electrophilic aromatic substitution reactions			
IBS-508	**Symmetry and Group Theory**	105	45	6
	Learning Outcome: Students will gain an understanding of: By the end of the module the student should be able to: Recognize symmetry elements in a molecule; State the point group a molecule belongs to; Understand degenerate and non-degenerate representations; Combine matrices and set up matrix for			

	transformations; Carry out linear combinations of orbitals to form molecular orbitals; Apply this to polyatomic systems (e.g. square planar, octahedral)Be familiar with Morse potential energy curves, P/R branches in rotational spectroscopy; Find symmetry species of normal modes of vibrations; Deduce which modes are IR/Raman active; Have a firm grasp ???*, n??* transitions, Jablonski diagrams; Understand the role of symmetry in electronic spectroscopy, selection rules; Apply orbital symmetry to chemical reactions. This module will develop skills in numeracy and problem solving. The students should develop the ability to apply their knowledge to problems related to those covered in the lectures. The subject specific skill is the acquisition of a theoretical framework which underlies much of spectroscopy.			
IBS-509	**Self-assembly in Chemistry**	70	30	4
	Learning Outcome: Students will gain an understanding of the principles of main-group chemistry.			
IBS-510	**Main Group Chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of: self-assembly and supramolecular chemistry, types ofnon-covalent interactions, importance of pre-organization, determination of association, problem solving, metal ion-macro-ligand supramolecular structures and metallo-supramolecular polymers. Single & self-complementary system, two, three and four and multiple arm hydrogen bonding systems, switching of recognition functions, hydrogen bonded supramolecular polymers, etc. Guest-host approaches in cyclodextrins, Calixarenes, Molecular rings & Nots, Rotaxanes and Dendrimers with examples. Anionic, cationic and neutral Micelles, critical micelle concentration (CMC) determination, bolaamphiphilies and application of micelles in drug delivery, etc. Origin of liquid crystals, mesogens self-organization, Types: nematic, smectic and cholestric liquid crystals and characterization of LC-materials. Self-assembly in DNA, protein and peptides.			
IBS-511	**Separation Principles and Techniques**	35	15	2
	Learning Outcome: Students will gain an understanding of: Thermodynamics, diffusion rates, mass transfer etc. Solvent extraction, distillations, liquid-liquid extraction and other methods of separation. Types of Chromatography: GC, HPLC, hyphenated techniques. Electrophoresis, centrifugation DNA/Protein separations / purifications. Green Separation process separation using zeolite and polymer membranes. Chiral separations, molecular recognition, molecule imprinting and polymer separations.			
IBS-512	**Lab Course**	105	45	6
	Learning Outcome: Students will gain an understanding of: a. the use of an analytical balance for mass measurement b. the use of graduated cylinders, graduated pipettes, and volumetric pipettes for volumetric measurement c. the use of thermometers and temperature probes			

	d. titrations e. the calibration and use simple spectrophotometers, pH meters, centrifuges, and vortexers f. The analysis of data using a spreadsheet program such as Excel g. how to design and perform experiments to determine the rate, order, and activation energy of chemical reactions by varying concentrations and/or temperature h. methods to measure equilibrium concentrations and equilibrium constants for acid-base, solubility, and complexation reactions given initial concentrations of reactant i. the preparation of buffer solutions at a required pH, given a choice of solutions of acid/conjugate base pairs j. the identification of the absence or presence of a number of cations or anions in solution, using tests based on acid-base, solubility, and complexation equilibria. k. the acquisition of solubility vs. temperature data and the calculation of ΔH, ΔS, and ΔG for dissolving a salt at a given temperature. l. how to set up and use an electrolysis cell to determine the equivalent mass of an unknown metal m. the determination of the molar mass of an unknown nonelectrolyte and an unknown electrolyte from a freezing point depression experiment n. ligand strengths by the stability of the complexes and precipitates formed by the ligands with a given metal ion			
IBS-513	**Group Theory**	105	45	6
	Learning Outcome: theory Students will be able to- • Assess the properties of implied by the definition of group. • Use various canonical types of groups. • Analyze and demonstrate the examples of subgroups, normal subgroups and quotient groups • Use the concepts of isomorphism and homomorphism for groups.			
IBS-514	**Elementary Geometry**	105	45	6
	Learning Outcome student will able to Compare and contrast the geometries of Euclidean and non- Euclidean and will use transformational and axiomatic techniques to prove the theorem. And demonstrate the knowledge of the historical development of Euclidean and non-Euclidean geometries.			
IBS-515	**Analysis**	70	30	4
	Learning Outcome: Student will be able to : • Determine the Riemann integrability and the Riemann-Stieljes Integrability of a bounded function. • Recognize the difference between point-wise and uniform convergence of a sequence of function.			

	• Illustrate the convergence properties of power series.			
IBS-516	**Topics in Algebra**	35	15	2
	Learning Outcome: Students will be able to- • Assess the properties of implied by the definition of group. • Use various canonical types of groups. • Analyze and demonstrate the examples of subgroups, normal subgroups and quotient groups • Use the concepts of isomorphism and homomorphism for groups. Solve system of linear equations.			
IBS-517	**Topics in Geometry & Topology**	35	15	2
	Learning Outcome: Students will be able to: • Define and Illustrate the concept of topological spaces and continuous functions • Define and illustrate the concept of product topology and quotient topology. This theory is helpful in visualising the model of universe.			
IBS-518	**Topics in Discrete Mathematics**	105	45	6
	Learning Outcome: Students will be able to: • Write and interpret the mathematical notations and mathematical definition. Formulate and interpret statements presented in Boolean logic. • Apply truth tables and the rules of propositional and predicate calculus.Formulate short proofs using the following methods: Direct proofs, Indirect proofs and proof by Contradiction			
IBS-519	**Mathematical Methods in Physics**	105	45	6
	Learning Outcome: Upon successful completion of this course it is intended that a student will be able to: • Students will demonstrate competence with the basic ideas of Ordinary differential equation and partial differential equation. • Use the method of special function (Legender, Hermit, Laguerre, and Green Function) to solve problems • Solve a complex analysis and tensor.			
IBS-520	**Astronomy and Astrophysics Electronics I**	105	45	6
	Students who have completed this course will: • be able to perform basic experiments in astronomy, • be able perform a statistical analysis of observed data, • understand the formation, evolution, death and classification of stars,			

	• understand the physics of stars, including nuclear and neutrino processes, the emission, absorption and transport of radiation, and stellar atmospheres, • have an ability to interpret observations of stars including spectra and binary phenomena.			
IBS-521	**Methods of Experimental Physics**	70	30	4
	• This paper deals with the study of various phenomenons of Nano science and Nano technology. • First unit describes the free electron theory which can describe various phenomenons. • The last unit describes various synthesis techniques like cluster beam deposition, ion beam deposition, chemical bath deposition techniques etc. • The understanding of the subject leads the students in their research work.			
IBS-522	**Electrodynamics**	35	15	2
	• After taking this course, students are able to appreciate the need and necessity of four Maxwell equations. • They have applied it for electromagnetic field tensor which is one of the major aspects of theoretical physics. • They have understood the covariance formulation of Maxwell equation. • One of the major advantages of this course is that it is very much related to the real life where the ionosphere is playing very important part. • Students now know the basics of scattering and absorption and relate them to real life phenomena. • They have learnt about wave guides and transmission lines and propagation of waves through them. • Understand the relationship between electrical charge, electrical field, electrical potential, and magnetism			
IBS-523	**Physics Lab IV**	35	15	2
	Learning Outcome: Student will learn lab techniques of Skin depth measurement, Generation and transmission ofelectromagnetic waves (Lecher Wire). Magnetic susceptibility measurement			
IBS-524	**Lab Course**	105	45	6
	Learning Outcome: The student will has to identify, talk to and mutually agree on a researchproject before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.			
Total Credits				24

6th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	Sessional	
IBS-601	**Plant Biology I**	105	45	6
	Learning Outcome: This paper include the knowledge about the Introduction of plants,Physiology growth hormone and mineral nutrition which help to the student to understand the breeding techniques,crop improvement and research and socio economic development			
IBS-602	**Immunology I**	105	45	6
	Learning outcome: This paper of immunology will provide detailed knowledge to the students about the natural and acquired immunity including macrophages dendritic cells, B-and T-cell immunity. The students will also be able to learn more about complement system and major histocompatibility complex.			
IBS-603	**Advanced Biochemistry I**	70	30	4
	Learning outcome: The Paper will help the students to know the role of water and biomolecules in life. The paper also focuses on the structure and functions of biomolecules including protein, Carbohydrates, Nucleic etc. Some other topics such as Thermodynamic principles, Enzyme biochemistry are included which helps in providing the advanced knowledge of Biochemistry. Some biochemistry techniques are also covered which helps the students to know about Lab techniques and Instrumentation part for further research.			
IBS-604	**Epigenetics**	35	15	2
	Learning outcome: This study will provide students to know how the expression of DNA can be changed without changing the structure of DNA itself and will be able to understand what causes disease and is not only essential to create treatments but also precautions.			
IBS-605	**Developmental Biology**	35	15	2
	Learning outcome: The students will attain knowledge of evolution of body plans, stem cell biology and tissue repair, Regeneration and nervous system development. The students will also learn embryogenesis in plants and genes controlling embryogenesis.			
IBS-606	**Lab Course**	105	45	6
	Learning outcome: The student has to identify, talk to and mutually agree on a research project before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.			
IBS-607	**Quantum Chemistry**	105	45	6
	Learning Outcome: Students will gain an understanding of: quantum mechanics, wave equation and Schrodingerequation, postulates of quantum			

	mechanics, particle in a box, harmonic oscillator, rigid rotor, hydrogen atom, variational principle, perturbation theory, introduction to many electron systems, electron spin, antisymmetry, Slater determinants, 2-e system, Valence Bond theory, Molecular Orbital theory, Huckel theory, Hartree-Fock theory, post Hartree-Fock methods.			
IBS-608	**Physical Chemistry of Solutions**	105	45	6
	Learning Outcome: Students will gain an understanding of: Thermodynamic Description of mixtures, Partial Molar Quantities,Ideal Solutions, Nonideal solutions, Gibbs-Duhem Relation, Equilibrium constant for solutes, vapour-pressure lowering, Application to biology and polymer science, Electrolytes in Solution, Ionic Liquids, Ionic Mobilities, Dielectric Effect, Ionic Strength, Dissociation of Weak Electrolytes, Debye-Huckel Theory, Activities in more Concentrated Solutions, Polymer and Gel electrolyte, Thermodynamic description of Electrochemical Cells, Nernst equation, Activity Coefficients from EMF's, Equilibrium Constant from EMF's, Chemical Sensors, Fuel Cells, Impact on Biochemistry, Phase Equilibria, Pressure-Temperature Phase Diagrams, Phase Rule, Immiscible Liquids, Eutectic Formation, Solid-Compound Formation, Three-Component, Solid-Liquid Systems, Liquid-vapor, Pressure-Composition Diagrams, Boiling-Point Diagrams, Distillation, Adsorption of Gases, Supercritical fluids, Impact on Materials Science..			
IBS-609	**Fundamentals of Molecular Spectroscopy**	70	30	4
	Learning Outcome: Students will gain an understanding of the use of nuclear magnetic resonance spectroscopy, mass spectrometry and infrared spectroscopy, ESR spectroscopy for organic structure elucidation			
IBS-610	**Transition Metal Chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of: Identify the principles, structure and reactivity of selected coordination complexes Interpret their electronic spectra and magnetic properties.			
IBS-611	**Organic Synthesis – I**	35	15	2
	Learning Outcome: Students will gain an understanding of: • concept of protecting of different functional groups so that can use in the synthesis of desired medicinal molecules. • Formation of sigma and pi bonds and related reactions.			
IBS-612	**Lab Course**	105	45	6
	Learning Outcome: Students will gain an understanding of: • apply basic techniques used in the organic laboratory for preparation, purification and identification of organic compounds. • employ the major techniques used in organic chemistry laboratory for analyses such as melting point determination, extraction, chromatography, infrared spectroscopy,distillation and chemical characterization tests.			

	• synthesize at least one organic compound will be synthesized and identify the corresponding alteration in the functional groups. • correctly calculate reaction yield for relevant lab experiments. • analyze the given procedure of an experiment and suggest or recommend improvements. • apply safety rules in the practice of laboratory investigations.develop better understanding of the organic chemistry behind everyday observations such as the action of soap, or application of color dyes on variety of fabrics.			
IBS-613	**Vector Spaces, Rings and Modules**	105	45	6
	Learning Outcome: Students will be able to- • Analyze vectors in ring geometrically and algebraically. • Recognize the concept of the terms span, linear independence , basis and dimension and apply these concepts to various vector spaces and sub-spaces. Use of matrix algebra and related matrices to linear transformation which is useful in programming of many languages in computer.			
IBS-614	**Measure Theory and Integration** **Point Set Topology**	105	45	6
	Learning Outcome student will be able to define lebesgue measure Algebra and sigma Algebra of a set . and will also Learn about Canter's set Cantor's ternary function , integrability, etc. Determine convex function , General measure integration of measurable functions			
IBS-615	**Graph Theory**	70	30	4
	Learning Outcome: a student will be able learn about different types of graphs and their applications in real life situations.			
IBS-616	**Ordinary Differential Equations**	35	15	2
	Learning Outcome: Students will be able to Solve problems in ordinary differential equations, dynamical systems, stability theory, and a number of applications to scientific and engineering problems.			
IBS-617	**Topics in Algebra**	35	15	2
	Learning Outcome: Students will be able to use matrix algebra and related matrices to linear transformation which is useful in programming of many languages in computer.			
IBS-618	**Topics in Geometry & Topology**	105	45	6
	Learning Outcome: Students will be able to: • Define and Illustrate the concept of topological spaces and continuous functions • Define and illustrate the concept of product topology and quotient topology. • Define and illustrate the axioms of separation axioms. Define Connectedness and compactness.			

IBS-619	**Quantum Mechanics I**	105	45	6
	• After taking this course students will be able to appreciate the beauty of quantum mechanics. They will know all types of representations of operators and ways to apply them in different problems. • The most important thing students learned from this course was how to solve the hydrogen atom problem by using quantum mechanics. • Students learned about time independent degenerate and non degenerate perturbations and to apply them in harmonic oscillator.			
IBS-620	**Statistical Mechanics I**	105	45	6
	On completion of this course a student should be able to: • Define and discuss the concepts of microstate and macrostate of a model system • Define and discuss the concepts and roles of entropy and free energy from the view point of statistical mechanics • Apply the machinery of statistical mechanics to the calculation of macroscopic properties resulting from microscopic models of magnetic and crystalline systems • Define the Fermi-Dirac and Bose-Einstein distributions; state where they are applicable; understand how they differ and show when they reduce to the Boltzmann distribution • Apply the Fermi-Dirac distribution to the calculation of thermal properties of electrons in metals			
IBS-621	**Nonlinear Dynamics**	70	30	4
	Learning Outcome: Student will be able to determine Nonlinear dynamical systems: classification, chaos, features of chaos,continuous and discrete dynamical systems; 1-d flows: fixed points and stability, linear stability analysis, bifurcations, flows on a circle, population dynamics; 2-d flows: classification of fixed points, stability analysis, limit cycles, bifurcations, predator-prey systems; higher-dimensional systems: stability, attractors, bifurcations, chaos, Lorenz system, Rossler system, pendulum.			
IBS-622	**Electronics II**	35	15	2
	After the completion of the course, Students will be able to • Understand the fundamentals of converting from one number system to another. • Represent signed decimal numbers in 2's complement form, and vice versa. • Explain the basic logic operations of NOT, AND, OR, NAND, NOR, and XOR. • Apply the laws of Boolean algebra and Boolean algebra expressions.			

	• Understand the basic electronics of logic circuits, counters, registers and be able to use integrated circuit packages.			
IBS-623	**Group Theory in physics**	35	15	2
	Learning Outcome: This covers Introduction to discrete groups, Lie groups and Lie algebras, Liealgebras in particle physics, discrete and continuous symmetries in nature, symmetries and conserved quantities, gauge symmetries and fundamental forces.			
IBS-624	**Lab Course**	105	45	6
	Learning Outcome: The student will has to identify, talk to and mutually agree on a researchproject before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.			
Total Credits				24

7th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-701	**Biology and Disease**	105	45	6
	Learning Outcome: Students will be more aware and get more knowledge about various dreadful and important diseases like cancer, AIDS and various fungal, bacterial and parasitic diseases. The students will also know more about precautions and preventive measures.			
IBS-702	**Plant Biology II**	105	45	6
	Learning Outcome: This paper will help in understanding the knowledge about the tissue culture, crop improvement tool, breeding techniques and secondary metabolites help in socio economic development.			
IBS-703	**Structural Biology**	70	30	4
	Learning Outcome: Students will be equipped with various experimental techniques such as X-ray crystallography, electron microscopy, recombinant technology and purification tools to isolate biomolecules.			
IBS-704	**Animal Physiology II**	35	15	2
	Learning Outcome: This paper will provide more information about the physiology of sub-mammalian vertebrates to the students. Nervous and sensory systems across various invertebrate groups and respiration, digestion, moulting, sensory, nervous and			

	neuroendocrine systems and reproduction in insects will also provide knowledge about the lower groups of animals.			
IBS-705	**Immunology II**	35	15	2
	Learning Outcome: After studying this paper the students will be able to learn and explain molecular interactions between the T cell receptor and MHC molecules; immune synapse, polyspecificity of T cell receptor recognition, molecular mimicry and epitope spreading; T cell memory; Peripheral tolerance and regulatory lymphocytes; Interactions between the immune and the nervous systems.			
IBS-706	**Lab Course**	105	45	6
	Learning Outcome: The student has to identify, talk to and mutually agree on a research project before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.			
IBS-707	**Advanced Molecular Spectroscopy**	105	45	6
	Learning Outcome: Students will gain an understanding of: The course will provide and introduction to modern optical spectroscopic and imaging techniques and their applications to biology and chemistry. First part of the course will be an introduction to fundamental concepts of light-matter interaction, lasers and laser systems, detectors and other relevant aspects of instrumentation necessary for spectroscopy and imaging. In the second part of the course we will discuss various modern spectroscopic techniques. Discussion of each technique will be followed by examples from classic and contemporary literature.			
IBS 708(O)/712(N)	**Organic Synthesis – II**			
	Learning Outcome: Students will gain an understanding of: Formation of carbon-carbon single bonds, Organometallic reagents, synthesis of carbocyclic systems, sketches of synthesis, tactics in organic synthon approach, disconnection approach for multiple step syntheses, functional group interconversions, synthesis of heterocycles: ring-closing reactions; asymmetric synthesis, chiral pool synthesis, chiral auxillary, organocatalysis, Desymmetrisation, total synthesis of natural products.			
IBS-708	**Bioinorganic Chemistry**	105	45	6
	Learning Outcome: Students will gain an understanding of: Interpret their electronic spectra and magnetic properties. Utilize the principles of transition metal coordination complexes in understanding functions of biological systems.			
IBS-709	**Molecular Modelling and Simulation**	70	30	4
	Learning Outcome: Students will gain an understanding of: a. formulate the basis for and the most important approximations in key molecular computational models. b. chose computational model in various chemical problems. c. apply modern molecular-level software on presented problems. d. assess computational results critically.			

IBS-710	**Advanced Physical Chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of: Building of molecules using Gaussview: Calculation of energy,structure and vibrational frequencies using Gaussian software,Visualization of geometry, orbitals, vibrations and spectra using Gaussian software, Contact angle measurement on hydrophobic and hydrophilic surface, Synthesis and spectroscopic characterization of metallic nanostructures, Raman spectroscopic studies of CCl4, Lithographic patterning, Study of an oscillatory reaction by Emf, or (and) absorbance measurement, To study the fluorescence quenching of Anthracene by CCl4 in n-hexane or (and) ethanol.			
IBS-711	**Solid State Chemistry**	35	15	2
	Learning Outcome: Students will gain an understanding of the subject for further study			
IBS-712	**Lab Course**	105	45	6
	Learning Outcome: Students will gain an understanding of: a. the use of an analytical balance for mass measurement b. the use of graduated cylinders, graduated pipettes, and volumetric pipettes for volumetric measurement c. the use of thermometers and temperature probes d. titrations e. the calibration and use simple spectrophotometers, pH meters, centrifuges, and vortexers f. The analysis of data using a spreadsheet program such as Excel g. how to design and perform experiments to determine the rate, order, and activation energy of chemical reactions by varying concentrations and/or temperature h. methods to measure equilibrium concentrations and equilibrium constants for acid-base, solubility, and complexation reactions given initial concentrations of reactant i. the preparation of buffer solutions at a required pH, given a choice of solutions of acid/conjugate base pairs j. the identification of the absence or presence of a number of cations or anions in solution, using tests based on acid-base, solubility, and complexation equilibria k. the acquisition of solubility vs. temperature data and the calculation of ΔH, ΔS, and ΔG for dissolving a salt at a given temperature. l. how to set up and use an electrolysis cell to determine the equivalent mass of an unknown metal m. the determination of the molar mass of an unknown nonelectrolyte and an unknown electrolyte from a freezing point depression experiment n. ligand strengths by the stability of the complexes and precipitates formed by the ligands with a given metal ion			
IBS-713	**Galois Theory**	105	45	6
	Learning Outcome: Students will learn about Field, extension field, Galois Group and its application . This theory is applicable in various programming language.			
IBS-714	**Functional Analysis**	105	45	6
	Learning Outcome student will learn about linear spaces which is nothing but vector space			

	but approach is different, l-p spaces , normed linear spaces, and other important spaces which are the extension of topological spaces.			
IBS-715	**Differential Geometry**	70	30	4
	Learning Outcome: Student will be able to: • Compare and contrast the geometries of Euclidean and non- Euclidean • Learn the geometrical aspects like curvature, torsion with help of differentiation techniques.			
IBS-716	**Algorithms**	35	15	2
	Learning Outcome: Student will learn about different types of algorithms which are useful in different programming languages and data analysis and experimental techniques.			
IBS-717	**Topics in Algebra**	35	15	2
	Learning Outcome: Students will be able to Compute with the characteristic polynomial, eigenvectors, eigenvalues and eigen spaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result,			
IBS-718	**Topics in Geometry & Topology**	105	45	6
	Learning Outcome: Students will be able to: • Define and illustrate the concept of topological spaces and continuous functions, • Define and illustrate the concept of product topology and quotient topology, • Prove a selection of theorems concerning topological spaces, continuous functions, product topologies, and quotient topologies, • Define and illustrate the concepts of the separation axioms, • Define connectedness and compactness, and prove a selection of related theorems, and Describe different examples distinguishing general, geometric, and algebraic topology.			
IBS-719	**Quantum Mechanics II**	105	45	6
	• After studying this course, students can calculate the ground state and excited state energies of various real life systems by using Principle, WKB method and perturbation methods. • Students will be knowing about the Einstein's coefficients and relating them to lasers. • They know about scattering in two different frames and can easily calculate scattering amplitude and scattering cross section. • Students can write total energy and wave function as slater determinant for system of identical fermion.			
IBS-720	**Statistical Mechanics II**	105	45	6
	• Understand the kinetic theory of gases: Maxwell –Boltzmann distribution law, Brownian motion etc.			

	• Understand the behaviour of real gases.			
IBS-721	**Computational Physics**	70	30	4
	After the completion of the course, Students will be able to • Understand the theoretical and practical aspects of the use of numerical analysis. • Proficient in implementing numerical methods for a variety of multidisciplinary applications. • Establish the limitations, advantages, and disadvantages of numerical analysis. • Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations			
IBS-722	**Quantum Information**	35	15	2
	Learning Outcome: Student will be able to leranFundamental Concepts-Qubits and their measurements, superdense coding, ensembles, Schmidt decomposition, Bell inequality.			
IBS-723	**Condensed Matter Physics I**	35	15	2
	After the completion of the course, Students will be able to • Understand the physics behind structural properties of the solids. • The properties of solids with proper understanding. • Pursue the research work in the field of material science and nanotechnology			
IBS-724	**Lab Course**	105	45	6
	Learning Outcome: The student will has to identify, talk to and mutually agree on a researchproject before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.			
Total Credits				24

8th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-801	**Microbiology**	105	45	6
	Learning outcome: This paper provides the knowledge of basic concepts of microbiology include microbial diversity, taxonomy and classification. Students also study the role and importance of micro-organisms in human life, about Biodegradation and Bioreactor. Such topics are helpful to move further in various Industrial, Pharmaceutical other research sectors.			

IBS-802	**Advanced Biochemistry II**	105	45	6
	Learning outcome: Students will be able to learn more about carbohydrate, protein and fat metabolism. This paper will also improve knowledge of students about different metabolism pathways and different processes such as glycolysis, gluconeogenesis pathway, amino acid biosynthesis and urea cycle.			
IBS-803	**Bioinformatics & Computational Biology**	70	30	4
	Learning outcome: The students will be equipped with the knowledge to prepare sequences analysis (pair wise alignment, multiple sequence alignment,motif discovery, gene annotation), inferring phylogenetic trees (UPGMA, neighbor-joining, maximum parsimony, maximum likelihood), analysis of next generation sequencing data.			
IBS-804	**Genome Biology**	35	15	2
	Learning outcome: The students will attain knowledge of nucleic acid, protein structure and chemistry. FISH methods, chromosome painting studies and molecular cytogenetics, copy number variations (CNV), array-comparative genomic hybridization (a-CGH), Chromosome conformation capture, 3C, 4C and Hi-C; microarrays, next generation DNA and RNA Sequencing.			
IBS-805	**Mathematical Biology**	35	15	2
	Learning outcome: This paper will provide information about the relationship of mathematics and biology, such as modeling in neuroscience (the classification of spiking activity based on different bifurcation scenarios), enzyme kinetics and Michaelis Menten equations.			
IBS-806	**Lab Course**	105	45	6
	Learning Outcome: The student has to identify, talk to and mutually agree on a research project before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.			
IBS-807	**Structural Methods and Analysis**	105	45	6
	Learning outcome: The paper focuses the Instrumentation part and the Structural Methods and Analysis techniques that may help the students to learn the biological techniques which would be beneficial for their further research work. The course will also play an important role in understanding the biological macromolecules with their functions with the help of advanced techniques.			
IBS-808	**Statistical Thermodynamics**	105	45	6
	• **Learning Outcome:** Students will gain an understanding of: • To apply distribution function to quantum and classical systems • To evaluate thermal properties of solids using statistical approach • To classify magnetic and superconducting behaviour of solids			

IBS-809	**Medicinal Chemistry**	70	30	4
	Learning Outcome: Students will gain an understanding of: • enzyme structure, inhibitors, types of inhibitors and their use in drug designing. • concept of designing the drugs			
IBS-810	**Advanced Materials Science**	35	15	2
	Learning Outcome: Students will gain an understanding of: Ability to apply knowledge of mathematics, science, and engineering to solve problems related to materials science and engineering. Ability to design and conduct experiments, as well as to analyze and interpret data using statistical, computational, or mathematical methods. Ability to collaborate effectively on multidisciplinary teams. Ability to communicate effectively in written and oral formats. Broad education necessary to understand the impact of engineering and scientific solutions in a global, economic, environmental, and societal context.			
IBS-811	**Organometallic Chemistry: Principles and Applications**	35	15	2
	Learning Outcome: Students will gain an understanding of: Organometallic compounds have been widely used in industry. Major industrial processes include hydrogenation, hydrosilylation, hydrocyanation, olefin metathesis, alkene polymerization, alkene oligomerization, hydrocarboxylation, methanol carbonylation, and hydroformylation. Organometallic complexes are also used in small-scale fine chemical synthesis as well, especially in cross-coupling reactions that form carbon-carbon bonds, e.g. Suzuki-Miyaura coupling,and Sonogashira coupling.			
IBS-812	**Lab Course**	105	45	6
	Learning Outcome: Students will gain an understanding of: • the planning and implementation of advanced organic reactions, purification of molecules, FTIR, uv-vis, laser methods etc.. • reporting of experimental results (including error analysis) in a publication-style (journal paper) • an appreciation for modern problems and scientific controversies in physical chemistry			
IBS-813	**Algebraic Number Theory**	105	4 5	6
	• **Learning Outcome:**Student will be able to Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime, and prime-factorization, • Apply the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues, • Formulate and prove conjectures about numeric patterns, and			

	• Produce rigorous arguments (proofs) centered on the material of number theory, most notably in the use of Mathematical Induction and/or the Well Ordering Principal in the proof of theorems.			
IBS-814	**Complex Analysis**	105	4 5	6
	Learning Outcome student will be able to • Analyze sequences and series of analytic functions and types of convergence, • Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, and • Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.			
IBS-815	**Topics in Geometry & Topology**	70	3 0	4
	Learning Outcome: Student will be able to: • Define and illustrate the concept of topological spaces and continuous functions, • Define and illustrate the concept of product topology and quotient topology, • Prove a selection of theorems concerning topological spaces, continuous functions, product topologies, and quotient topologies, • Define and illustrate the concepts of the separation axioms, • Define connectedness and compactness, and prove a selection of related theorems, and • Describe different examples distinguishing general, geometric, and algebraic topology.			
IBS-816	**Topics in Discrete Mathematics**	35	1 5	2
	Learning Outcome: Student will be able to: • Write and interpret the mathematical notations and mathematical definition. • Formulate and interpret statements presented in Boolean logic. • Apply truth tables and the rules of propositional and predicate calculus. • Formulate short proofs using the following methods: Direct proofs, Indirect proofs and proof by Contradiction. • Demonstrate the working knowledge of Set notation and Elementary Set operations and logics.			
IBS-817	**Topics in Algebra**	35	1 5	2
	Learning Outcome: Student will be able to: • Analyze finite and infinite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces,			

	• Use the definition and properties of linear transformations and matrices of linear transformations and change of basis, including kernel, range and isomorphism, • Compute with the characteristic polynomial, eigenvectors, eigenvalues and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result, • Compute inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization, and • Identify self-adjoint transformations and apply the spectral theorem and orthogonal decomposition of inner product spaces, the Jordan canonical form to solving systems of ordinary differential equations.			
IBS-818	**Topics in Applicable Mathematics**	105	4 5	6
	Learning Outcome: student will learn different mathematical techniques in different field of mathematical modelling , Science and technology.			
IBS-819	**Classical and Quantum Optics**	105	4 5	6
	• Understand interference and diffraction (Fraunhofer and Fresnel diffraction) • Understand optical phenomena such as polarization. • Through the lab course, understand the principles of measurement and error analysis and develop skills in experimental design.			
IBS-820	**Nuclear and Particle Physics**	105	4 5	6
	After the completion of the course, Students will be able to • Students shall learn about the knowledge of particles. • Significance of various decays tells the students about the nuclear process. • It will teach the students about the spin parity concept &magic no. Related to shell. • About the scattering process how it will occur.			
IBS-821	**Advanced Materials Science**	70	3 0	4
	After the completion of the course, Students will be able to • Understand the Metals, Alloys, Insulators, Polymers, Semiconductors, Composites, Liquid Crystals, Quasi Crystals. • Defects in Solids – Point, Line and Volume or Bulk Defects. • Study of Mechanical, Thermal, Optical and Magnetic.			
IBS-822	**Condensed Matter Physics II**	35	1	2

			5	
	• The objective of the paper is to aware the students about the field of Condensed matter physics. • This paper enable the students to understand about the crystal structure, interaction with X-ray, lattice vibrations, defects, electronic properties and the magnetic properties etc. • It also helps the students to understand various properties about crystals. • This paper deals with the study of structural properties of solids			
IBS-823	**Gravitation and Cosmology**	35	1 5	2
	Learning outcome: Introduction to four-vectors, Principle of equivalence, Einstein'sequation from action principle and its basic properties, Schwarzschild solution and classical tests of relativity; basic ideas of black hole physics, introduction to gravitational waves.Basic introduction to contents and scales in the universe, Friedmann metric, dynamics of the FRW universe and elements of cosmology**.**			
IBS-824	**Lab Course**	105	4 5	6
	Learning Outcome: The student will has to identify, talk to and mutually agree on a researchproject before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.			
Total Credits				24

9th Semester

Course Code	Course Title	Maximum Marks		Credits
		End Semester	**Sessional**	
IBS-901	**Research project and thesis**	150	-	6
	Learning Outcome: In this topic students willsupposed to carryout field/ laboratory training cum experimental works and prepare a corresponding report along with a research proposal for future career. The area should include from basics to latest developments and discoveries which will impart a broad training in various discipline of life sciences and biotechnology, these students will be able to pursue careers in pharmaceutical industries, research laboratories, clinical research organizations, school colleges and Universities as researcher or academicians..			
IBS-902	**Research Methodology**	105	45	6

	Learning Outcome Student will learn about General research, Computer applications , GLP and Bio safety, IPRE and Bioethics, and laboratory courses.			
IBS-903	**Biostatistics and Bioinformatics**	105	45	6
	Learning Outcome:student will learn about general statistics and probability , population and sampling theory, experimental design and bioinformatics tools.			
IBS-904	**Introduction to Computing**	105	45	6
	Learning Outcome: student will learn about different programming languages which are useful in various research fields.			
Total Credits				24

10th Semester

Course Code	**Course Title**	**Maximum Marks**		**Credits**
		End Semester	**Sessional**	
IBS-1001	**Research project and thesis continued**	150	-	6
	Learning Outcome: Students will supposed to be carry forward their field/ laboratory training cum experimental works which they have done in IX semester.			
IBS-1002	**Study tour**	105	-	6
	Learning Outcome Students are required to visit research institute for real exposure in subject and qualitative interactions.			
IBS-1003	**Viva-voce**	105	-	6
	Learning Outcome:Students Will learn communication and expression ability			
IBS-1004	**Field/ Industrial attachment**	105	-	6
	Students are encouraged to undertake research on their area of interest , it acquaints students with identification of a research topic, research planning and its execution. Besides this student learn the morality and ethics in publication.			
Total Credits				24

Total credits: 240 + 4

SEMESTER I

IBS-101: World of Biology I: Introduction Biology

Content:

Unit 1: Introduction: What is biology: Salient features of life; Importance of biology on the frontiers of science and technology; Brief history of biology; How plants, animals and microorganisms shaped human history.

The logical structure of biology: Foundations of physics and chemistry, concepts of complexity, emergent properties, adaptation, optimality, diversity, chance and necessity, structure-function relationship, theme and variations, individual variability and plasticity; Nature of experimentation in biology and statistical inference.

Unit 2: Diversity and comparative organization of life forms: Introduction to natural history, art and methodology of making and recording observations. Shapes and sizes of life forms: Size range, properties and constraints associated with size. Scaling rules in biology. Adaptability and optimality of shapes. Expanse of the living world.

Concept of species. Principles of taxonomy, outline classification. Hierarchical organization: cell, tissue, organ, systems, individual, kin, group, society, community, ecosystem. Organizational themes in plants and animals.

Unit 3: Evolution: Brief history of evolutionary thought. Nature of evidence in evolution. Mechanisms of Darwinian evolution. Concept of adaptive versus neutral evolution. Concept of evolutionary relationships and phylogeny.

***Unit4*:** Biological information: Nature of biological information. Mechanisms of transmission of information: genetic, epigenetic, cultural and other mechanisms of inheritance. Signaling and its role in different levels of interactions.

Laboratory Course

Content: This practical course will cover basic concepts in biology, cell biologyand cell culturing techniques with an emphasis on 3D's in biology – draw, describe and differentiate.

Practical include: Basics of microscopy; Field trip; Microscopy of samples; Micrometry of different cells; Staining of bacteria, fungi, Plant cells, Blood cells and Bone marrow; Osmosis; Mitosis; Crude cultures – Bacteria and Protozoa; Pure culture techniques; Sterilization and media preparation; Streaking of bacteria; Enumeration of bacteria.

Recommended Readings:

1. Principles of Biology: Interactive textbook from NatureEducation
2. Biology: N. Campbell and J. Reece (2005) 7th edition, Pearson, Benjamin,Cumming
3. Evolutionary Analysis: S. Freeman and J.C. Herron (2007) PrenticeHall
4. Evolution: D.J. Futuyma (1997) Sinauer Associates
5. Evolution: N.H. Barton, D.E.G. Briggs, J.A. Eisen, D.B. Goldstein and N.H. Patel (2007) Cold Spring Harbor LaboratoryPress

IBS-101 a:Biomolecules

Classification and physico-chemical properties of amino acids and proteins. Classification & properties of mono-, di-, oligo and poly- saccharides. Structural features and compositional analysis of polysaccharides. Biological importance of glucose, fructose, maltose, sucrose, lactose, starch, glycogen. Classification, structure, properties and functions of lipids. Structure, properties and functions of nucleic acids.

Recommended Readings:

1. Christopher K. Mathews, K.E. van Holde and Kevlin G. Ahern, *Biochemistry*, Pearson Education (Singapore) Pte. Ltd. Indian Branch, 482 F.I.E. Patparganj, Delhi.
2. Lubert Stryer, *Biochemistry*, W.H. Freeman and Company, New York.
3. D.L. Nelson, M.M. Cox, *Lehninger's Principles of Biochemistry*, Macmillan Worth Pub. Inc. NewYork
4. Geoffery Zubey, Biochemistry, Macmillon Publishing Company, NewYork
5. Donald Voet and Judith Voet, *Biochemistry*, John Wiley & Sons, NewYork.

IBS-101 b: Microbial Genetics

Basic concepts of microbial genetics; bacterial genomes and basic functions; Microbial replication, transcription and translation; microbial gene organization and Operon; Plasmid; Transduction; Transposition; Transformation; Conjugation; DNA Mutation and DNA Repair; Viral Genetics.

Recommended Readings:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D., 1989, Molecular Biology of The Cell, 2nd ed., Garland Publishing, Inc., NewYork.
2. Darnell, J., Lodish, H., Baltimore, D., 1990, Molecular Cell Biology, Scientific American Books, New York.
3. Freifelder, D., Malacinski, G.M., 1987, Essentials of Molecular Biology, John and BartlettPublishers,London.
4. Watson, Baker, Bell, Gann, Levine, Losick. 2004. Molecular biology of the gene . 5th ed. Pears.pdf

IBS-102: World of Chemistry I: General Chemistry

Contents: Chemistry in the Modern World, Measure of Matter, Introduction toThermodynamics, Chemical Equilibrium, Chemical Kinetics, Behaviour of Gases, Properties of Solutions, Solubility, Understanding Acid-Base Buffers, Solid State-Crystal versus Amorphous Solids, Symmetry and Organisation Principles for Crystalline Solids, Unit Cell, Periodic trends in properties of the Elements, Types of Bonds, Introduction to Organic Chemistry, Chirality, Functional groups and structural diversity, conformational analysis, Hetero atoms and Metals in Chemistry and Biology,

Organic Materials, Asymmetric Synthesis, Chemistry of Life- Peptides, Nucleic acids, Carbohydrates, Lipids.

Recommended Readings:

1. Chemistry: Principles, Patterns and Applications: B.A. Averill and P. Eldredge (2007) 1st edition, PrenticeHall
2. Chemical Principles: S.S. Zumdahl (2009) 6th edition, Houghton-MifflinCompany
3. The Biological Chemistry of the Elements: J.J.R.F. da Silva, R.J.P. Williams (2001) 2nd edition, Oxford UniversityPress

IBS-102a: Bioorganic Chemistry

Contents: Overview of basic structure of carbohydrates, nucleic acids, proteins and lipids, secondary metabolism, bioenergetics, biological and organic reaction mechanisms, coenzymes and cofactors, amino acids: biosynthesis of amino acids promoted by pyridoxal phosphate, Shikimic acid pathway to aromatic amino acids, peptides, depsipeptides antibiotics and their biological activities, biosynthesis of nucleosides.beta-oxidation of fatty acids, biosynthesis of fatty acids, various lipids, polyketides, prostanoids, leucotrienes and other secondary metabolites, metabolites of mixed biosynthetic origin, from acetate, mevalonate and shikimate pathway, isoprenoids: isoprene unit, monoterpenes, diterpenes, sesquiterpenes and triterpenes, and biological activities, steroids: steroidogenesis, biosynthesis and biologicalimplications.

Recommended Readings:

1. Lehninger Principles of Biochemistry: D.L. Nelson and M.M. Cox (2008) 5th edition, W.H. Freeman
2. Biochemistry: D. Voet and J.G. Voet (2004) 3rd edition,Wiley

IBS-102b: Chemoinformatics

Introduction to Chemoinformatics: aims, scope. Role of Chemoinformatics in pharmaceutical/chemical research, Molecular Descriptors (1D, 2D and 3D), Chemical Databases – Design, Storage and Retrieval methods, Quantitative Structure Activity/Property/Toxicity Relationship Studies, In-silico ADMET Studies, Docking Studies.

1. Bunin Barry A. Siesel Brian,Morales Guillermo,Bajorath Jürgen. Chemoinformatics: Theory, Practice, & Products Publisher:New York, Springer. 2006. ISBN:1402050003.
2. Gasteiger Johann, Engel Thomas. Chemoinformatics: A Textbook. Publisher: Wiley- VCH; 1st edition. 2003. ISBN:3527306811.
3. Leach Andrew R., Valerie J. Gillet. An introduction to chemoinformatics. Publisher: Kluwer academic , 2003. ISBN:1402013477.
4. Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge (4 Volumes), 2003. Publisher: Wiley-VCH.ISBN:3527306803.

IBS-103: World of Mathematics I: Basic Mathematics

Contents: Mathematical grammar, elementary logic, truth tables, quantifiers,proof techniques as mentioned in the introduction, theory building, sets, relations, ordering, one-to-one and onto functions, inverse functions, strong and weak induction, inductive definitions, natural numbers via Peano arithmetic, divisibility and primes, infinite sets and cardinality.

Real numbers and properties, sequences and series, concept of a limit,continuous functions and their properties, differentiability, examples of (non-)differentiable functions, higher order derivatives, chain rule, mean value theorem, Taylor's expansion, applications of Differential Calculus, integration, fundamental theorem of Calculus, techniques of integration, change of variables, applications of Integral Calculus.

Recommended Readings:

1. How to Solve It: G. Polya (2004) Princeton UniversityPress
2. How to Read and Do Proofs: D. Solow (2009)Wiley
3. How to Prove It: A Structured Approach: D.J. Velleman (2006) Cambridge UniversityPress
4. Proof in Mathematics: An Introduction: J. Franklin & A. Daoud (2011) Kewbooks
5. What is Mathematics: R. Courant and H. Robbins (1996) Oxford UniversityPress
6. Calculus Vol. 1 and 2: T.M. Apostol (2007)Wiley
7. Calculus: M. Spivak (2006) Cambridge UniversityPress
8. A Course in Calculus and Real Analysis: S.R. Ghorpade and B.V. Limaye (2006)Springer
9. Introduction to Calculus and Analysis, Vol. 1, 2 and 3: R. Courant and F. John (1989) Springer
10. Calculus: J. Stewart (2007) CengageLearning

IBS-103a: Differentiation, Integration and their applications

First Order Differential Equations: Linear Equations, Nonlinear Equations, Separable Equations, Exact Equations, Integrating Factors.
Second Order Linear Differential Equations: Fundamental Solutions for the Homogeneous Equation, Linear Independence, Reduction of Order, Homogeneous Equations with Constant Coefficients. Numerical integration, Integration by Substitution.

IBS-103b: Vector analysis (fundamental)

Gradients and directional derivatives, Line Integrals, Gradient Vector Fields, FTC for gradient vector fields, finding a potential, radial vector fields, Surface Integrals, Surfaces, Integral, Kissing problem Divergence of Vector Fields, Flux across a surface, divergence Gauss's Divergence Theorem, Integration by parts, Green's Theorem and Curls in R2, Stokes's Theorem, Complex Derivatives.

IBS-104: World of Physics I:Mechanics

Contents:

Section 1: Place of mechanics in physics, Range of validity of classical mechanics. Kinematics and mathematical tools, Newton's laws, Examples of one, two and three dimensional motion under forces.
Section 2: Central force motion and application to planetary motion, Rotational motion of a rigid body, Potential energy, multiparticle systems and conservation laws.
Section 3: Frames of reference, Galilean relativity, non-inertial frames, basic special relativity, Least action principle, Hamiltonian and phase space.

Laboratory Course

Contents: Torsional pendulum, physical pendulum, Young's modulus, coefficientof friction, Euler's relation, Faraday's and Lenz's law of electromagnetic induction, Biot-Savart's law, Stoke's law,

numerical experiments.

Recommended Readings:

1. Mechanics: C. Kittel, W.D. Knight, M.A. Ruderman, C.A. Helmholz and B.J. Moyer (2008) Berkeley Physics Vol 1, Tata McGraw-HillLtd
2. Classical Mechanics: R.D. Gregory (2008) Cambridge UniversityPress
3. Introduction to Classical Mechanics: D. Borin (2009) Cambridge UniversityPress
4. Classical Mechanics: J.R. Taylor (2005) University ScienceBooks
5. Mechanics: L.D. Landau and I.M. Lifshitz (2007) 3rd edition,Butterworth-Heinemann

IBS-104a: Mathematical Physics-I

Linear vector spaces, Schmidt orthogonalisation, linear operators, dual space, ket and branotation, Hilbert space, Metric space, Function spaces, Riesz –Fisher theorem (no proof),basis, orthogonal expansion of separable Hilbert spaces, Bessel inequality, Parsevals formula, Orthogonal curvilinear coordinates-gradient, divergence, Curl and Laplacian. Definition of tensors, Metric tensor, One- form, metric tensor as a Mapping of vectors into one form. Covariant, Contravariant, and mixed tensors. Differentiable manifolds and tensors. Frobenius method for solving second order ordinary differential equations with variable coefficients. Bessel ,Legendre, Hermite equations. Recurrence relations, generating functions and Rodrigues formulae for the Bessel, Legendre and Hermite functions. Dirac delta functions-properties and representations, Definitions and physicalsignificance of Greens functions, Translational invariance, eigen function expansion of Greens function, Greens function for ordinary differential operators, first order linear differential operators. Greens functions for partial differentialoperators.

Recommended Readings:

1. Mathematical methods in classical and quantum physics- T. Das and S.K. Sharma, University Press(1998)
2. Theory and problems of vector analysis- M. Spiegel, Schaum Out line series, McGraw Hill Book company.
3. A first course in general relativity- B.F.Schutz, Cambridge universitypress(1985)
4. Mathematical methods for physicists- G.B. Arfken and ,H.T.Weber General, thorough A. Sommerfeld: *Thermodynamics and Statistical Mechanics*, Academic press,New York, 1956. Good for traditional thermodynamics

IBS-104b: Classical Mechanics

Contents: Euler-Lagrange equation from variational principle, constraints andLagrange multipliers, integrals of motion, symmetries and conservations laws. Hamiltonian formalism: Hamilton equations, Poisson brackets, symplectic formulation, canonical transformations, Hamilton-Jacobi theory, action-angle variables.Central force motion: integrals, Kepler problem, classical scattering. Small oscillations, normal modes. Continuous systems: wave equation, classical fields, classical perturbation theory. Nonlinear oscillators, hamiltonianchaos.

Recommended Readings:

1. Classical Mechanics: H. Goldstein, C. Poole and J. Safko (2002) 3rd edition,Pearson
2. ClassicalDynamicsofParticlesandSystems:ThorntonandMarion(2003)Thomson

Learning EMEA Ltd
3. Classical Mechanics: R.D. Gregory (2008) Cambridge UniversityPress
4. Mechanics: L.D. Landau and E.M. Lifshitz(2007)3rd edition,Butterworth-Heinemann
5. Classical Mechanics A Contemporary Approach: J.V. Jose and E.J. Saletan (2006) Cambridge UniversityPress

SEMESTER II

IBS-201: World of Biology II: Introduction of Cell Biology and Biochemistry

Content:

Unit 1:Elemental Composition of Biomolecules; Properties of Water, hydrogen bonding and its biochemical properties; Concept of pH, pKa and buffers; Basic structure and function of Biological Macromolecules: Amino acids, Nucleotides and Monosaccharides, fatty acids (building blocks) Proteins, Nucleic Acids, Carbohydrates and Lipids (polymers)

Unit 2: Cellular organization, Cell theory, cell types: prokaryotes vs. eukaryotes, single cell to multi-cellular organism. Cell structures, beginning with the cell envelope of bacteria, plant and animal cells, cell membranes and their properties and structure of the cellmembrane.

Unit 3: Cytoskeletal components: actin, microtubules and microfilaments and motor proteins. Cell organelles, Cell nucleus and chromatin structure.

Unit 4: Fundamental processes: DNA replication, mitosis and meiosis, RNA, transcription and translation.

Laboratory Course

Content: This practical course will cover biochemical, genetic and molecular basis of life. Practicals include: Glucose estimation; Lipid estimation; Amino acid Paper chromatography; Protein estimation; Enzyme assay and Kinetics; Human genetic traits and blood grouping; DNA isolation; DNA estimation; Transformation; Plasmid isolation; Agarose gel electrophoresis; Restriction digestion and Ligation; PCR demonstration; ATC PTC demonstration; Animal handling, inoculation, dissection.

Recommended Readings:

1. Biochemistry: D. Voet, and J.G. Voet (2010), 4th edition,Wiley
2. Harper's Illustrated Biochemistry: R. Murray, V. Rodwell, D. Bender, K.M. Botham, P.A. Weil and P.J. Kennelly (2009) 28th edition, McGrawHill-Medical
3. Biology: N. Campbell and J. Reece (2005) 7th edition, Pearson, Benjamin,Cummings
4. Biology: P.H. Raven, G.B. Johnson, J.B. Losos and S.R. Singer (2005) 7th edition, McGraw Hill
5. Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2007) 5th edition, GarlandScience.

IBS-201a: Cellular Basis of Structure and Function inBiology

Transport –simple diffusion, facilitated diffusion, active transport, exocytosis and endocytosis, nuclear transport, osmosis and imbibition in plants. Cytoskeleton and motility and extracellular matrix in plants and

animals. Signal transduction- electrical signals, messengers and receptors. Plants forms and functions. Mitosis, meiosis in plants and animals. Basics genetics of animals and plants.

Recommended Readings:

1. The world cell by Wayne M. BeckerAuthor.
2. Molecular cell biology by Harvey LodishAuthor
3. Human molecular genetics by Tom StrachanAuthor
4. Essential cell biology second edition by Bruce AlbertsAuthor
5. Essential Developmental Biology Second Edition by J M WSlack

IBS-201b: Biophysics I

Content: Order of magnitude physics applied to biology, molecular biophysics,cellular biophysics, physics in development, and biophysical techniques with special emphasis on light in biology. Laboratories will be conducted for measuring molecular thermodynamics of biological macromolecules, quantifying cellular dynamics and measuring diffusion.

Recommended Readings:

1. Biological Physics: Energy, Information, Life: P. Nelson (2003) W.H.Freeman
2. Physical Biology of the Cell: R. Philips, J. Kondev and J. Theriot (2008) GarlandSciences
3. Biological Physics of the Developing Embryo: G. Forgacs (2005) Cambridge UniversityPress

IBS-202: World of Chemistry II: Physical Chemistry

Contents:

*Chemical kinetics:*Basic laws of kinetics, Experimental determinationof reaction order and rate, Study of fast reactions, Simultaneous reactions, Temperature dependence of reaction rate, Mechanism of chemicalreactions

Kinetic Theory of Gases: Maxwell's distribution of molecular velocities, collisionin a gas, mean free-path, heat capacity of gases, Equi-partition of energy, viscosity, thermal conductivity Impact on environmental science and astrophysics;

Thermodynamics: State and path functions, Internal Energy, Heat and Work, Lawsof thermodynamics, Heat Capacity, Enthalpy, Entropy, Gibbs Free energy, Gibbs Helmholtz Equation, Chemical Potential, Colligative properties; *Chemical Bonding & Spectroscopy:* Historical development, Schrödinger equation andPostulates of Quantum Mechanics, Operators in Quantum Mechanics, Particle in a 1 D Box to 3 Dimensional Box, Harmonic Oscillator, Hydrogen atom, Molecular Orbital Theory and Valence Bond Theory, Applications in Spectroscopy.

Laboratory Course

Contents: Acid Base Titration using pH meter, Acid Base Titration usingconductivity method, Potentiometric titrations, Heat of Neutralization, Kinetic Study of Ester hydrolysis, Activation Parameter calculations, Colligative properties of Solutions, Optical Activity by Polarimetry, UV-VIS

Spectrophotometry

Recommended Readings:

1. Physical Chemistry: G.M. Barrow (2007) 5th edition, Tata McGrawHill
2. Physical Chemistry: I.N. Levine (2002) 5th edition, Tata McGrawHill
3. Physical Chemistry: P.W. Atkins (2006) 8th edition, Oxford UniversityPress
4. Quantum Chemistry: D.A. McQuarrie (2003), VivaBooks
5. Quantum Chemistry: I.N. Levine (2007) 5th edition, Pearson Education
6. Chemical Kinetics: K.J. Laidler (1987) 3rd edition, PearsonEducation
7. Experiments in Physical Chemistry: C.W. Garland, J.W. Nibler and D.P. Shoemaker (2008) 8thedition, McGraw-Hill Science/Engineering/Math
8. Physical Chemistry: P. Atkins and J. de Paula (2006) 8th edition, W.H.Freeman

IBS-202a: Statistical Thermodynamics

Contents: Thermodynamics postulates, Conditions of equilibrium, ReversibleProcesses and Maximum Work Postulate, Extremum Principle, Maxwell Relation, Review of Probability Theory, Ensembles and Postulates, Canonical Ensemble, Grand Canonical Ensemble, Microcanonical Ensemble, Other Ensembles, Equivalence of Ensembles.

Recommended Readings:

1. Thermodynamics and Introduction to Thermostatistics: H.B. Callen (1985) 2nd edition, Wiley, [First sixchapters]
2. Statistical Mechanics: D.A. McQuarrie, University Science Books, California, USA, Viva Books Private Limited, New Delhi (Indian Edn) [First 7 chapters and some otherchapters]
3. An Introduction to Statistical Thermodynamics: T.L. Hill (1987) Dover Publications, Inc, NewYork

IBS-202b: Quantum Chemistry

Contents: Introduction to quantum mechanics, wave equation and Schrodingerequation, postulates of quantum mechanics, particle in a box, harmonic oscillator, rigid rotor, hydrogen atom, variational principle, perturbation theory, introduction to many electron systems, electron spin, antisymmetry, Slater determinants, 2-e system, Valence Bond theory, Molecular Orbital theory, Huckel theory, Hartree-Fock theory, post Hartree-Fockmethods.

Recommended Readings:

1. Quantum Chemistry: D.A. McQuarrie (2007) 2nd edition, University ScienceBooks
2. Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory: A. Szabo and N. Ostlund (1996) New edition, DoverPublications
3. Quantum Chemistry: I.N. Levine (2008) 6th edition, PrenticeHall

IBS-203: World of Mathematics II: Multi Variable Calculus

Contents: Functions of several variables,equations of lines, planes and quadricsurfaces, partial

differentiation, directional derivatives, total derivative, level surfaces, tangent planes, applications of derivatives, Inverse function theorem, Lagrange multipliers, multiple integrals, line and surface integrals, change of variables, applications of integrals, Stokes' Theorem, Green's Theorem.

Recommended Readings:

1. Calculus Vol. II: Multi variable calculus and linear algebra with applications to differential equations and probability: T.M. Apostol (1969)Wiley
2. Calculus and Analytic Geometry: G.B. Thomas and R.L. Finney (1984) 6th/9th edition, Narosa or Addison-Wesley orPearson
3. Calculus – Concepts and Contexts: J. Stewart (2004) 4th edition, BrookesCole
4. Principles of Mathematical Analysis: W. Rudin (1976) McGraw-Hill BookCompany
5. Functions of Several Real Variables: M. Moskowitz and F. Paliogiannis (2011) WorldScientific

IBS-203 a: Ordinary differential equations

Contents: First order equations: Separable equations, linear equations, initial-value problems, explicit and implicit solutions, exact equations and integrating factors, autonomous equations and equilibrium points, stability. Higher order equations and systems: Higher-order equations and n-by-n systems, linear equations, Wronskians and Liouville's theorem, higher-order linear equations and systems with constant coefficients, phase portraits, stable, unstable and center subspaces, multiple roots, inhomogeneous systems, method of undetermined coefficients, variation of constants, stability, asymptotic stability.

Recommended Readings:

1. Differential Equations, Dynamical Systems and an Introduction to Chaos: M.W. Hirsch, S. Smale and R.L. Devaney (2012) AcademicPress
2. Differential Equations and Dynamical Systems: L. Perko (2001)Springer
3. Theory of Ordinary Differential Equations: E.A. Coddington and N. Levinson (1955) McGraw Hill
4. Ordinary Differential Equations: V.I. Arnold (2006)Springer
5. Elementary Differential Equations: W.E. Boyce & R.C. DiPrima (2008)Wiley
6. Differential Equations: P. Blanchard, R.L. Devaney and G.R. Hall (2008) CengageLearning
7. Ordinary Differential Equations: P. Hartman (1987) Cambridge UniversityPress
8. An Introduction to Dynamical Systems: D.K. Arrowsmith and C.M. Place (1990) Cambridge UniversityPress
9. Dynamical Systems: G.D. Birkhoff (1999) Colloquium PublicationsAMS
10. Ordinary Differential Equations: G. Birkhoff and G. Rota (1989)Wiley

IBS-203 b: Vector calculus

Vector Calculus

Line Integrals, Path Independence of Line Integrals, Green`s Theorem in the plane, Surface Integrals, Divergence Theorem of Gauss, Stokes`s Theorem.

Recommended Readings:

1. Introduction to Linear Algebra with Application, Jim Defranza, Daniel Gagliardi, Tata McGraw-Hill
2. Elementary Linear Algebra, Applications version, Anton and Rorres, Wiley IndiaEdition.
3. Advanced Engineering Mathematics, Erwin Kreysig, WileyPublication.
4. Elementary Linear Algebra, Ron Larson, CengageLearning
5. Calculus, Volumes 2, T. M. Apostol, WileyEastern.
6. Linear Algebra and its Applications, David C. Lay, PearsonEducation

IBS-204: World of Physics II: Waves and Matter

Contents

Section 1 – Properties of deformable media: stress and strain, Hooke's law, energy of a bent plate, torsion of rods, bending of rods, small deflections of rods, stability of elastic systems, compressible and incompressible fluids, viscous fluids.

Section 2 – Oscillations and waves: free oscillations of simple systems: linearity and the superposition principle, free oscillations of systems with many degrees of freedom, beats, transverse modes of a continuous string, general motion of a continuous string and Fourier analysis, forced oscillations, damped driven one-dimensional harmonic oscillator, resonances in a system with two degrees of freedom, forced oscillations of a closed system with many degrees of freedom.

Section 3 – Traveling waves: harmonic traveling waves in one dimension and phase velocity,index of refraction and dispersion, reflection and transmission, modulations, pulses and wave packets, group velocity, Fourier analysis of pulses and of traveling wave packets, waves in two and three dimensions, harmonic plane waves and the propagation vector, elastic waves in an isotropic medium, vibration of rods and plates, water waves, electromagnetic waves, polarization, interference and diffraction, Huygens' principle, de Brogliewaves.

Recommended Readings:

1. Waves: F.S. Crawford Jr (2008) Berkeley Physics volume 3, Tata McGraw-HillLtd
2. Physics of Waves: H. Georgi (2007) BenjaminCummings
3. Classical Mechanics: N. Rana and P. Joag (2001) Tata McGraw-HillEducation
4. Classical Mechanics: J.R. Taylor (2005) University ScienceBooks
5. Mechanics of Materials: F.P. Beer, E.R. Johnston and J.T. DeWolf (2011) 6^{th} edition, McGraw Hill, NewYork

6. Theory of Elasticity: L.D. Landau and I.M. Lifschitz (2007) 3rd edition, Butterworth-Heinemann

IBS-204a: Mathematical Physics-II

Functions of a complex variable – The derivative and Cauchy Reimann differential equations – Line integrals of complex functions – Cauchy's integral theorem - Cauchy's integral formula – Taylor's series – Laurent's series – Residues – Cauchy's residue theorem – Singular points of an analytic function – The point at infinity – Evaluation of residues – Evaluation of definite integrals by contour integration - Method of steepest descent (Sterlings formula)- summation of series using residue theorem. Definition of groups (eg.)– matrix groups- transformation groups- cosets- congugacy classes- Lagrange theorem – invariant subgroup- factor group- homomorphismhomomorphism theorem- isomorphism- direct product of groups. Fourier series – Dirichlet's conditions – Fourier series of even and odd functions –Complex form of Fourier series – Fourier integral and it's complex form – Fourier transforms – Fourier sine and cosine transforms – Convolution theorem and Parseval's identity. Laplace transform of elementary functions – Inverse Laplace transforms – Methods of finding Inverse Laplace transforms – Heaviside expansion formula –Solutions of simple differentialequations.

Principle of equivalence (weak and strong) - Einstein – Hilbert action- Einstein equations from the action- Newtonian limit of Einstein's equations. Centrally symmetric gravitational fields.

Recommended Readings:

1. Mathematical methods in classical and quantum physics, T Dass & S KSharma
2. Mathematical methods for physicists- G F Arfkan &Weber
3. A first course in general relativity- B FSchutz
4. Classical theory of fields- L D Landau & E MLifshitz

IBS-204b: Fluid Dynamics

Contents: Basic conservation equations of fluid dynamics, compressible andincompressible flows, dimensionless numbers in fluid dynamics, applications: astrophysics, aerodynamics, geophysics, fluid instabilities andturbulence.

Recommended Readings:

1. Prandtl's Essentials of Fluid Mechanics: Ed. Herbert Oertel (2009) 3rd edition,Springer
2. Jean Eilek's lecture notes:http://www.physics.nmt.edu/~jeilek/fluids.html
3. Fluid Mechanics: L.D. Landau and E.M. Lifshitz (2007) 2nd edition, PergamonPress

SEMESTER III

IBS-301: World of Biology III: Evolution and Ecology

Content:

Unit 1: Introduction: An overview of biological processes; Why study ecologyand evolution?

Unit 2: Population ecology: Survivorship curves, Life-tables, Simple population dynamics models and their behavior, Spatial ecology.

Unit 3: Life history evolution: Basic concepts; Community ecology/ Species interaction: Competition; Predation; Ecosystem dynamics: Food webs; biodiversity; conservation biology.

Unit 4: Classical Genetics: Mendel's laws, linkage; Population genetics: Hardy-Weinberg equilibrium; mutation; selection; genetic drift; inbreeding. Macroevolution and diversity of life: Macroevolutionary concepts: reproductive isolation, speciation.

Laboratory Course

Content: This practical course will cover basic concepts in ecology and evolution.Practicals include: Evolution of Ethnocentrism; Isolation of organisms; Global Population Dynamics Database; Plant Biodiversity field work; Growth curve (Factorial design 3 pH × 2 temperatures); Effect of nutritional selection on bacterial growth; Chemical ecology and its impact on diatom diversity; Behavioral Ecology.

Recommended Readings:

No single text book can be prescribed. The following books shall cover much of the proposed syllabus:

1. Ecology - From Individuals to Ecosystems: M. Begon, C.R. Townsend, and J.L. Harper (2005) BlackwellPublishing
2. Ecology Concepts and Applications: M.C. Molles (2009) McGrawHill
3. Evolutionary Analysis: S. Freeman, and J. Herron (2004) 4th edition, W. PrenticeHall

IBS-301a: Biophysics II

Content: Mathematics of water and crowding, dynamics of macromoleculesparticular molecular motors and the cytoskeleton, non-equilibrium approaches, mechano-biology of cells with a focus on muscles, nerves and stem cells, tissue dynamics and development (embryology), literature review, term paper, labs on macromolecular crowding and pattern formation.

Recommended Readings:

1. Mechanics of the Cell: D. Boal (2001) Cambridge UniversityPress
2. Physical Biology of the Cell: Philips, Kondev, Theriot & Orme (2009) Garland Science, Taylor and Francis Group LLC.3
3. Biological Physics of the Developing Embryo: G. Forgacs and S. Newman (2005) Cambridge UniversityPress
4. Biological Physics: P. Nelson (2007) W.H.Freeman
5. Biophysics: An Introduction: R. Glaser (2010, 2012)Springer
6. Life in Living Fluids: S. Vogel (1996) Princeton UniversityPress
7. Lehrbuch Der Biophysik: E. Sackmann and R. Merkel (2010) Wiley-VCH Verlag GmbH & Co KGaA

IBS-301b: Neurobiology I

Content: Evolution and organization of the nervous system; electrical properties of neurons; ionic basis of membrane potentials and the action potential; synaptic transmission and neurotransmitters; development of the nervous system; experience-dependent synaptic refining & plasticity; introduction to Hebb's postulate and learning andmemory.

Recommended Readings:

1. Principles of Neural Science: E. Kandel et al. (2000) 4th edition, McGraw-HillMedical
2. Neuroscience: M. Bear et al. (2006) 3rd edition, Lippincott Williams &Wilkins
3. Development of the Nervous System: D. Sanes et al. (2005) 3rd edition, AcademicPress
4. Foundations of Cellular Neurophysiology: D. Johnston and S. Wu (1994) 1st edition, MIT Press

IBS-302: World of Chemistry III: Inorganic Chemistry

Contents: Atomic Structure, electronic configuration, periodicity, sizes of atomsand ions, ionization energy, electron affinity, relativistic effects, chemical bonding, Lewis theory, valance bond and molecular orbital theories, solid state structures and properties, concepts of acids and bases, Brønsted and Lewis theory, hard and soft acids and bases, oxidation and reduction, electrode potentials, Nernst equation, representation of electrochemical data, importance of water splitting, batteries and fuel cells, coordination complexes, theories of bonding in transition metal compounds, some introduction to main group compounds.

Laboratory Course

Contents: Acid-base titrations relevant to the neutralizing power of antacids,conventional and photochemical synthesis of coordination compounds, complexametric and spectroscopic estimation of metal ion concentrations in coordination compounds, redox titration relevant to the iodine content in common salts, synthesis of disinfectants containing main group compounds such as Alum, soaps andmicelles.

Recommended Readings:

1. Inorganic Chemistry: Shriver and Atkins (2006) International Student Edition, 4th edition, Oxford UniversityPress
2. Concepts and Models of Inorganic Chemistry: B. Douglous, D. McDaniel and J. Alexander (2006) 3rd edition (student edition), Wiley-India
3. Inorganic Chemistry: J.E. Huheey, E.A. Keiter and R.L. Keiter (2007) 4thedition, Pearson Education
4. Concise Inorganic Chemistry: J.D. Lee (1999) 5th edition, BlackwellScience
5. A Collection of Interesting General Chemistry Experiments: A.J. Elias (2007) Revised edition Universities Press (India) Pvt. Ltd.

IBS-302a: Heterocyclic chemistry

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles. General Chemical Behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in 1H NMR- spectra. Preparation and properties of azirine, oxirane, azitidine, oxetene, oxatane and thietane. Preparationofdiazirineandoxaziridine.Preparationandpropertiesofpyrrole,furan,thiophene,

pyrazole and imidazole. Preparation ofphosphole, benzaluminol. Synthesis and reactions of pyridine, pyran, quinoline, isoquinoline, acridine and phenanthridine. Strain – bond angle and torsional strains and their consequences in small ring heterocycles.

Recommended Readings:

1. Bansal R K, HeterocyclicChemistry.
2. Acheson R H, An introduction to the chemistry of Heterocycliccompounds.
3. Trivedi J J, Chemistry of HeterocyclicCompounds.
4. Gupta R R, Kumar M amd Gupta V, Heterocyclic Chemistry,Springner.
5. Eicher T and Hauptmann S, The Chemistry ofHeterocycles.
6. Joule J A, Mills K and Smith G F, HeterocyclicChemistry.
7. Gilchrist T L, HeterocyclicChemistry.

IBS-302a: Environmental and Greenchemistry

The structure of the earth's atmosphere- chemistry of the lower and upper atmosphere. The chemistry of air pollution. The lithosphere- the chemical composition of earth- the structure and composition of inner earth- the mantle, and the crust. The hydrosphere : The fresh water chemistry – the structure and properties of liquid water – lakes, rivers, ponds and stream. The structure of the biosphere, Man's perturbation of the biosphere – Man as a chemical factory – material use and waste – energy use and thermal pollution – ecological disruption – chemical sensation, hormonal imbalance and mutagens- internal pollution. Hydrosphere - lithosphere interaction. Introduction, Principles & Concepts of Green Chemistry. Historical context: The Greening of Chemistry. Waste: Production, Problems, Prevention. Measuring and Controlling Environmental Performance.

Recommended Readings:

1. Chemistry of our environment R.A.Horne
2. Environmental chemistry A.K.De
3. Environmental chemical analysis Iain L, Marr and Malcom S.Cresser
4. Pollution control in process industries S.P.Mahajan. *Chem. Rev.* **2007**, *107*, 2167-2820 (special issue on GreenChemistry)
5. *Environmentally Benign Reactions*; Ahluwalia, V. K. *Green Chemistry:* CRC Press: Boca Raton, FL,2008.

IBS-303: World of Mathematics III: Linear Algebra

Contents: Definition and examples of fields, real and complex numbers, finitefields, vector spaces, matrices, solution of a system of linear equations using elementary row and column operations and related geometry, linear transformations, representations of linear transformations by matrices, linear functionals, similarity (conjugacy) of matrices, determinants, invertible matrices, eigenvalues and eigenvectors, characteristic and minimal polynomials, triangulation of matrices, diagonalization of matrices, Cayley-Hamilton theorem.

Recommended Readings:

1. Linear Algebra: K. Hoffman and R. Kunze (2009)Prentice-Hall

2. Basic linear algebra: T.S. Blith and E.F. Robertson (1998) UTMSpringer
3. Linear algebra problem book: P.R. Halmos (1995)MAA
4. Introduction to Linear Algebra: G. Strang (2009) Wellesley CambridgePress
5. Linear Algebra: G. Shilov (1977)Dover.

IBS-303a: Laplace transform

Review of Laplace transform, Laplace transform of periodic functions, Initial and Final value Theorems, Inverse Laplace transform.

Recommended Readings:

1. Review of Laplace transform, Laplace transform of periodic functions, Initial and Final value Theorems, Inverse Laplace transform.
2. David K.Cheng; "Analysis of Linear System", Addision Welsley PublishingCompany.
3. ME Van-Valkenberg; "Network Analysis", Prentice Hall of India
4. Donald E.Scott," An Introduction to circuit Analysis", Mc Graw Hill, InternationalEdition.
5. Choudhary, D.Roy, "Network & Systems", Wiley EasternLtd.,India.

IBS-303b: Numerical analysis

Introduction, State space representation of linear systems, transfer function and state variables.

Recommended Readings:

1. Review of Laplace transform, Laplace transform of periodic functions, Initial and Final value Theorems, Inverse Laplace transform.
2. David K.Cheng; "Analysis of Linear System", Addision Welsley PublishingCompany.
3. ME Van-Valkenberg; "Network Analysis", Prentice Hall of India
4. Donald E.Scott," An Introduction to circuit Analysis", Mc Graw Hill, InternationalEdition.
5. Choudhary, D.Roy, "Network & Systems", Wiley EasternLtd.,India.

IBS-304: World of Physics III: Electricity & Magnetism

Contents: Electrostatics, Coulomb's law, Gauss's law and its applications, methodof images, magnetostatics, electric fields in matter, dielectrics, polarisation, magnetic fields in matter, magnetic materials, Biot-Savart law, Ampere's law, Faraday's law, Lorentz force law, displacement current, Maxwell equations, plane electromagnetic waves, polarised light

Laboratory Course

Contents: Thermal expansion of solids, thermal conductivity by Lee's method,specific heat of solids, Stefan's law of radiation, temperature dependence of a thermistor, resolving power of a telescope, Newton's rings, Malus's Law.

Recommended Readings:

1. Electricity and Magnetism: E.M. Purcell (2008) Berkeley Physics Course, Vol 2, Tata McGraw-HillLtd

2. Feynman Lectures on Physics: R.P. Feynman, R.B. Leighton and M. Sands (2011) The Millenium edition, Vol 2, BasicBooks
3. Introduction to Electrodynamics: D.J. Griffths (2012) PearsonEducation

IBS-304a: Quantum Physics (Introductory)

Introduction to quan, photoelectric effect, Compton scattering, photons, Franck-Hertz experiment, the Bohr atom, electron diffraction, de Broglie waves, and the wave-particle duality of matter and light. Introduction to wave mechanics.

Recommended Readings:

1. Eisberg, Robert M., and Robert Resnick. *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*. Wiley, 1985. ISBN:9780471873730.
2. Liboff, Richard L. *Introductory Quantum Mechanics*. Addison Wesley, 2002. ISBN:9780805387148.
3. Gasiorowicz, Stephen. *Quantum Physics*. John Wiley & Sons, 2003. ISBN:9780471429456.

IBS-304b: Nanotechnology

Basic concepts of Nanoscience and Nanotechnology – Quantum wire – Quantum well – Quantum dot – fullerenes – Graphene – Carbon nanotubes – Material processing by chemical vapor deposition and physical vapor deposition –Principle of SEM, TEM, AFM, Scanning near-field optical microscopy (SNOM) –Scanning ion-conducting microscopy (SCIM) – Potential uses of nanomaterials in electronics, robotics, computers, sensors, sports equipment, mobile electronicdevices, vehicles and transportation – Medical applications ofnanomaterials.

Recommended Readings:

1. Cao G., "*Nanostructures and Nanomaterials: Synthesis, Properties and Applications*", Imperial College Press,2004.
2. T.Pradeep, "*A Text Book of Nanoscience and Nanotechnology*", Tata McGraw Hill, New Delhi,2012.

SEMESTER IV

IBS-401: World of Biology IV: Biology of Systems

Content: Introduction to complex systems; Emergent properties and evolution of biological complexity; Signal transduction; Gene regulation and gene regulatory networks; Network motifs; Fertilization and organismal development; Pattern formation; Reaction-diffusion; Evolution of body plans; Regeneration and stem cells; Physiology and models of the immune system; Physiology and models of the nervous system; Oscillation in biology.

Recommended Readings:

1. Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2002) 4th edition, GarlandScience
2. PrinciplesofDevelopment:L.Wolpert,J.Smith,T.Jessell,P.Lawrence,E.Robertsonand E. Meyerowitz (2006) 3rd edition, Oxford University Press
3. An Introduction to Systems Biology: Design Principles of Biological Circuits: U. Alon (2006) 1st edition, Chapman &Hall/CRC
4. Mathematical Biology: J.D. Murray (2007) Vol. I. 3rd edition,Springer

IBS-401a: Vaccine

Conventional vaccines -killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery and adjuvants, large scale manufacturing. Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals—mechanism of action and drug resistance.

Recommended Readings:

1. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: MarcelDekker.
2. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons,Incorporated.
3. Chimeric Virus -like Particles as Vacc ines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor). Latest edition / Pub. Date: November 1996 Publisher: Karger, S.Inc.
4. Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Latest edition / Pub. Date: September 2003. Publisher: Elsevier HealthSciences.

IBS-401b: Neurobiology II

Content: Autonomous nervous system; Sensory systems and sensory processing;Motor control and pattern generators; Brain imaging: electro-encephalography, positron emission tomography, functional magnetic resonance imaging; Sleep and circadian rhythms; Processing of emotion; Learning and memory; Neurobiology of perception and cognition; astrocyte and glial feedback; Current topics: mirror neurons, neurodegeneration.

Recommended Readings:

1. Principles of Neural Science: E. Kandel et al. (2000) 4th edition, McGraw-HillMedical
2. Neuroscience: M. Bear et al. (2006) 3rd edition, Lippincott Williams &Wilkins

3. Foundations of Cellular Neurophysiology: D. Johnston and S. Wu(1994)
4. 1st edition, MITPress
5. The Other Brain: D. Fields (2009) 1st edition, Simon andSchuster
6. Mathematical Physiology I: J. Keener and J. Sneyd (2008) 2nd edition,Springer
7. Neuroscience: D. Purves et al. (2011) 5th edition, SinauerAssociates

IBS-402: World of Chemistry IV: Organic Chemistry

Contents: Carbon compounds and chemical bonding, Reactive Intermediates;Carbocations and Carbanions chemistry, Free radicals and Carbenes, Acidity, basicity, and pKa, Acidity, The definition of pKa, Basicity, Factors that influence the acidity and basicity, HSAB Principle, Stereochemistry: R and S descriptors, Axis of Chirality; E and Z system; erythro, threo; Helical descriptors- M and P. cis, trans, Conformational analysis of ethane and cyclohexane,Addition Reactions: Nucleophilic addition reaction: Nucleophilic addition reation to carbonyl group: Molecular orbitals explain the reactivity of the carbonyl Group, angle of nucleophilic attack on aldehydes and ketones, Electrophilic addition reactions: Alkenes react with bromine, water; bromohydrin formation etc. Conjugate addition: Conjugation changes the reactivity of carbonyl group, Alkenes conjugated with carbonyl groups, Substitution Reactions: Nucleophilic substitution at saturated carbon: Nucleophilic substitution**,** Structure and stability of carbocations, The SN1 and SN2 mechanisms for nucleophilic substitution. Neighbouring group participation (NGP), Aromatic electrophilic and nucleophilic substitutions, Elimination Reactions: Types of elimination reactions and factors that affecting the elimination reactions. Rearrangements: Various types: Electrophilic and nucleophilic rearrangement and Migratory aptitudes, Free radical rearrangements and Pericyclic rearrangements.

Laboratory Course

Contents: Functional group analysis, classical name reactions and oxidation,reduction, cycloaddition, aromatic electrophilic substitution reactions, isolation of natural products and synthesis of fluorescent compounds, purification techniques such as recrystallization and column chromatography

Recommended Readings:

1. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers (2000) 1stedition, Oxford UniversityPress
2. Organic Chemistry: T.W.G. Solomons, 2nd or 3rd edition, John Wiley &Sons
3. March's Advanced Organic Chemistry: M. Smith and J. March, 5th or 6th edition, Wiley-Interscience

IBS-402a: Polymer chemistry

Contents: Basic concepts, Molecular weight distribution, Linear, Branched,Cross-linked, grafted-Polymers, Polymer Crystallization, Glass Transition, Solution and Melt viscosity, Polymer Rheology, Step-polymerization, Addition Polymers, Radical, Cationic, Anionic Living polymerization, Block copolymers, Liquid crystalline polymers, Ring opening polymerization, Physical and Reactive blends, Nano-composites and synthetic-natural fiber composites, Concepts of conducting polymers and their applications in opto-electronics and sensors, one and 3D dimensional polymericmaterials.Demdrims,hyperbranchedpolymers,randombranchedpolymers,branching

density, influence of branching on the melt, viscosity, rheological and thermal properties of polymers

Recommended Readings:

1. Principles of Polymerization: G. Odian (2004) 4th edition,Wiley
2. Text Book of Polymer Science: F.W. Billmeyer Jr. (1984) 3rd edition, John Wiley &Sons
3. Polymers: Chemistry and Physics of Modern Materials: J.M.G. Cowie (2007) 3rd edition, CRCPress
4. Review and research articles, communications and notes published in international journals (will beprovided)

IBS-402a: Physical Organic Chemistry

Contents: Basic concepts of acidity, basicity, and pKa; Equilibria, kinetics andmechanisms; Rearrangements; Radical Reactions; Mechanisms in Biological Chemistry; Advanced Molecular Orbital Theory; Sterochemistry and conformational analysis; Thermal pericyclic reactions; Sigmatropic and electrocyclic reactions; Synthesis and Reactions of carbenes.

Recommended Readings:

1. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers (2000) 1stedition, Oxford UniversityPress
2. Modern Physical Organic Chemistry: E. Anslyn and D.A. Dougherty (2006) 1st edition, University ScienceBooks
3. Advanced Organic Chemistry: Part A: Structure and Mechanism: R.J. Sundberg and F.A. Carey (2000) 4th edition, Kluwer/Plenum Press
4. Physical Organic Chemistry: N. Isaacs (1995) 2nd edition,Addison-Wesley-Longman

IBS-403: World of Mathematics IV: Probability and Statistics

Contents: Organization of Data, Measures of central tendency and dispersion,Graphs and Charts, Histogram, Box plot, Axiomatic definition of Probability, Conditional Probability and Independence, Bayes' theorem, Random Variables, Cumulative Distribution Function, probability mass function, probability density function, Some standard discrete and continuous random variables, Mathematical expectation, moments, moment generating function, Chebychev's and Markov's inequality, Functions of random variables and their distributions, Random vectors, Joint, marginal and conditional distributions, Independence of random variables, Law of large numbers, Central limit theorem, Sampling distributions.

Recommended Readings:

1. An Introduction to Probability and Statistics: V.K. Rohatgi, A.K.Md.E. Saleh (2000) Wiley-Interscience
2. A First Course in Statistics: S. Ross, PrenticeHall
3. Introduction to Probability Theory and Its Applications, Vol 1: W. Feller (1968)Wiley
4. Statistical Inference: G. Casella and R.L. Berger (2001)Duxbury
5. Parametric Inference: B.K. Kale (1999)Narosa

IBS-403a: Dynamics of rigid bodies

Position, velocity, acceleration, straight line motion, Acceleration as a function of time, position, or velocity. Introduction, Rotation, Absolute Motion, Relative Velocity, Instantaneous Center of Zero Velocity, Relative Acceleration, Motion Relative to Rotating Axes.

Recommended Readings:

1. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II Dynamics, 9th Ed, Tata McGraw Hill,2011.
2. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I Statics, Vol IIDynamics, 6th Ed, John Wiley, 2008.
3. R. C. Hibbeler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press,2006.
4. I.H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed,PHI,2002.

IBS-403b: Moment of inertia &Conservation of energy

Centre of mass, moments of inertia, kinetic energy of a rigid body in a plane motion, conservation of energy for conservative systems. Inertia forces in plane mechanisms. Inertia stress and bending.

IBS-404: World of Physics IV: Quantum Physics(Advanced)

Contents: Historical background, discrete spectra, wave-particle duality, wave packets, uncertainty principle, postulates of quantum mechanics, Schroedinger equation, expectation values, particle in a box, potential well and barrier in one dimension, Hydrogenatom

Laboratory Course

Contents: Photo-electric effect, Cornu's method to determine Young's modulus,e/m by Thomson's method Rydberg's Constant, Millikan's oil drop Methods, G-M Counter Characteristics, Constant Deviation spectrometer, Michelson interferometer.

Recommended Readings:

1. Quantum Physics: S. Gasiorowicz (2003) 3rd edition, Wiley IndiaEdition
2. Quantum Physics: E.H. Wichman (2008) Berkeley Physics Course, Vol 4, Tata McGraw-Hill Ltd
3. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles: R. Eisberg and R. Resnick, 2nd edition, John Wiley andSons
4. Quantum Mechanics: C. Cohen-Tannoudji, B. Diu and F. Laloe (1977) Vol 1, Wiley-Interscience
5. Advanced Practical Physics: B.L. Worsnop and H.T. Flint, Asia PublishingHouse
6. Analytical Experimental Physics: Michael Ference Jr., Harvey B. Lemon, Reginald J. Stephenson (1970) University of ChicagoPress
7. The Art of Experimental Physics: D.W. Preston and E.R. Dietz (1991) JohnWiley

IBS-404a: Atomic and Molecular Physics

Contents: Electronic structure of atoms, models of many-electron atoms, spin-orbit interaction-

coupling schemes, emission and absorption of electromagnetic radiation by atoms, transition probabilities and selection rules, induced and spontaneous emission, Einstein coefficients, broadening of spectral lines, continuous absorption and emission spectra, rotation and vibration spectra of molecules, experimental techniques, optical cooling and trapping of atoms, atom interferometer, quantum measurement and decoherence, THzspectroscopy.

Recommended Readings:

1. Physics of Atoms and Quanta: H. Haken and H.C. Wolf (2005)Springer
2. Physics of Atoms and Molecules: B.H. Bransden and C.J. Joachain (2003) Pearson Education India
3. Atoms, Molecules and Photons: W. Demtroder (2010)Springer

IBS-404b: Electromagnetism

Sources and effects of electromagnetic fields – Vector fields – Different co-ordinate systems- vector calculus – Gradient, Divergence and Curl - Divergence theorem – Stoke's theorem. Coulomb's Law – Electric field intensity – Field due to point and continuous charges – Gauss's law and application – Electric potential – Electric field and equipotential plots – Electric field in free space, conductors, dielectric -Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson's and Laplace's equations – Capacitance- Energy density. Lorentz Law of force, magnetic field intensity – Biot–savart Law - Ampere's Law – Magnetic field due to straight conductors, circular loop, infinite sheet of current – Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization – Magnetic field in multiple media – Boundary conditions – Scalar and vector potential – Magnetic force – Torque – Inductance – Energy density – Magnetic circuits. Faraday's laws, induced emf – Transformer and motional EMF – Forces and Energy in quasistationary Electromagnetic Fields - Maxwell's equations (differential and integral forms) – Displacementcurrent.

Recommended Readings:

1. Joseph. A.Edminister, 'Theory and Problems of Electromagnetics', Second edition, Schaum Series, Tata McGraw Hill,1993.
2. William .H.Hayt, 'Engineering Electromagnetics', Tata McGraw Hill edition,2001.
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, FifthEdition,1999.

SEMESTER V

IBS-501: Animal Physiology I

Content: Skeletal and smooth muscle systems, human cardio-vascular system and blood, excretion and regulation of the body fluids, gaseous exchange, transport and tissue respiration, physiology of digestion and gastrointestinal hormones, endocrines and reproduction.

Recommended Readings:

1. Textbook of Medical Physiology: A.C. Guyton, J.C. Hall (2008)Elsevier-Saunders
2. Williams Textbook of Endocrinology: H.M. Kronenberg et al. (2008)Saunders
3. Eckert Animal Physiology: D.J. Randall et al. (2002) W.H.Freeman
4. Comparative Animal Physiology: P.C. Withers et al. (2001) BrooksCole
5. Animal Physiology: R.W. Hill, G.A. Wyse and M. Anderson (2008) SinauerAssociates

IBS-502: Advanced Molecular Biology

Content: This course covers a detailed analysis of the molecular mechanisms thatcontrol the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. The topics covered in lectures and readings of relevant literature include maintenance and expression of the genome including DNA replication, mutability and repair of DNA, genetic recombination, gene regulation, transcription, RNA splicing and translation. In particular, the logic of experimental design and data analysis is emphasized in particular molecular cloning methods and tools for studying gene and gene activity.

Recommended Readings:

1. Molecular Biology of the Gene: J.D. Watson, T.A. Baker, S.P. Bell, A.A.F. Gann, M. Levine and R.M. Losick (2007) 7th edition, BenjaminCummings
2. Molecular Biology: Weaver (2011) 5th edition, McGraw-HillScience
3. Principles of Gene Manipulation: S.B. Primrose, R. Twyman and R.W. Old (2002) 6th edition,Wiley-Blackwell
4. Molecular Biology and Genomics: C. Mulhardt (2006) 1st edition, AcademicPress

IBS-503: Advanced Cell Biology

Content: This course covers a wide range of advanced cell biology topicsdiscussing in some detail membrane structure, transport, intracellular compartments, protein sorting and vesicular traffic. It will also discuss the cell cycle and cell division. Finally we will be looking at mechanisms of cell communications, cell junctions and adhesion to the extracellular matrix, looking at the role and regulation of the cytoskeleton and motor proteins and also see how many of these process work together to drive cell migration. This course will also provide an introduction to the types and role of mechanical forces incells.

Recommended Readings:

1. Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2007) 5th edition, GarlandScience
2. Molecular Biology of the Gene: James Watson et al., (2007) 6th edition, BenjaminCummings
3. Molecular Cell Biology: H. Lodish, A. Berk, C.A. Kaiser et al (2007) 6thedition, W.H. Freeman Reviews recommended on the coursewebsite.

IBS-504: Biostatistics

Content: Scales and variables; Descriptive statistics: population and sample,frequency distributions, probability distributions, binomial, poisson and Gaussian distributions; Distribution of sample means, standards errors, confidence intervals; Concept of hypothesis testing, null hypothesis, statistical significance, type 1 type 2 errors; T tests, Anova, factorial design, Regression and correlation, Non-parametric statistics; Introduction to multivariate tools; Sampling design; Case studies.

Recommended Readings:

1. Biometry: The Principles and Practice of Statistics for Biological Research: R.R. Sokal and H.A. Rohlf (1995) 3rd edition, W.H.Freeman
2. Biostatistical Analysis: J.H. Zar (1998) 4th edition, PrenticeHall

IBS-505: Animal Behaviour

Content: Research methodologies. Proximate and ultimate causes of behaviour.Evolution of behaviour, adaptationism, genetic and cultural inheritance. Individual and social learning, cognition. Behavioural ecology of foraging, group living, sociality, movement, mating, parental care, aggression, interspecific interactions: theories and empirical tests. Evolution of cooperation and communication.

Recommended Readings:

1. Principles of Animal Behaviour: L.A. Dugatkin (2004) W.W. Norton &Co
2. An Introduction to Behavioural Ecology: J.R. Krebs and N.B. Davies (1993) Blackwell Publishing
3. Animal Behaviour: J. Alcock (2009) SinauerAssociates

IBS-506: Lab Training / Theory Project –I

The larger objective of this course is to encourage students to participate in ongoing research at BBAU. This may be in the form of a reading/literature review/theoretical and computational project/lab based research project.

The student has to identify, talk to and mutually agree on a research project with a faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.

Contents: The student has to identify, talk to and mutually agree on a research project with the faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria (also see below) for the course are decided by the project supervisor.

Recommended Reading: As per suggestions of the project supervisor.

IBS-507: Advanced Organic Chemistry Laboratory

Contents: Separation of ternary quantitative analysis of organic compounds.Electrophilic aromatic substitution reactions: Synthesis of methyl orange (organic dye); Name reactions and rearrangements: Wittig reaction, Beckmann rearrangement: Acetanilide from Acetophenone Oxime; Multi step synthesis: Synthesis of substituted Flavones and characterization of the diketo intermediates and flavones derivatives; Photochemical reaction: Photochemical reaction: Synthesis of benzopinacol from benzophenone using sunlight; Thermal pericyclic reactions: Diels alder reaction: anthracene and maleic anhydride; Cupper(I) mediated cycloaddition reaction: Click reaction: Azide and alkyne coupling reaction; Organometallic reactions: Palladium catalyzed cross- coupling reaction: Stereochemistry: Addition of Bromine to trans-cinnamicacid.

Recommended Readings:

1. Experimental procedures will be provided from currentliterature
2. A Collection of Interesting General Chemistry Experiments: A.J. Elias (2007) Revised Edition, UniversitiesPress
3. Comprehensive Practical Organic Chemistry: V.K. Ahluwalia and R. Aggarwal (2001) Illustrated edition, UniversitiesPress
4. Vogel's Textbook of Practical Organic Chemistry: 5th edition, PrenticeHall

IBS-508: Symmetry and Group Theory

Contents: Symmetry elements and operations, *Schönflies notation*of point group,prediction of dipole moment and optical activity from the viewpoint of symmetry, definition of group, subgroup and class, matrix representation of a point group, reducible and irreducible representations, great orthogonality theorem and its corollaries, construction of character tables and meaning of all the terms in a character table, Mulliken symbols for irreducible representations, direct product of irreducible representations, application of symmetry to quantum mechanics, application of symmetry to spectroscopy – electronic, IR and Raman selection rules, projection operator and its application to symmetry adapted linear combinations, construction of molecular orbital correlation diagram of simple and complex molecules, Hückel π molecular orbital of a conjugatedsystem.

Recommended Readings:

1. Chemical Applications of Group Theory: F.A. Cotton (1963) 1st edition, WileyInterscience
2. Molecular Symmetry and Group Theory: R.L. Carter (1997) John Wiley &Sons
3. Symmetry and Spectroscopy: D.C. Harris and M.D. Bertolucci (1989) DoverPublications
4. Group Theory and Quantum Mechanics: M. Tinkham (2003) DoverPublications

IBS-509: Main Group Chemistry

Contents: Theories of bonding, acids and bases, thermodynamic acidityparameters; hydrogen and classical hydrogen bond, water, hydrates, hydrogen ions, metal hydrides, activation of hydrogen complexes; alkali metals in liquid ammonia; boron, boranes, carboranes, borazines and borates; allotropy of carbon; silane and polysilanes, silicone Polymers, silicates; compounds of nitrogen, activation of nitrogen, nitrogen fixation, hydrogen, halogen, oxygen and nitrogen compounds of phosphorous; oxygen and singlet oxygen, ozone, complexes of molecular oxygen; N-S compounds; sulphides, oxides and oxoacids of sulphur, chalcogenides and polychalcogenides; halogens,

polyhalides, interhalogen compounds, charge-transfer complexes of Halogens; Compounds of Xenon and other noble gases; Zintl compounds and homometallic clusters; elemental and compound semiconductors; energy, polarity, and reactivity of M-C bond; organometallic chemistry of the main group elements.

Recommended Readings:

1. Advanced Inorganic Chemistry: F.A. Cotton, G. Wilkinson,C.A.
2. Murillo and M. Bochmann (1999) 6th edition,Wiley-Interscience
3. Chemistry of the Elements: A. Earnshaw and N. Greenwood (1997) 2nd edition, Butterworth-Heinemann
4. Inorganic Chemistry: D. Shriver and P. Atkins (2006) International Student Edition, 4th edition, Oxford UniversityPress
5. Inorganic Chemistry: J.E. Huheey, E.A. Keiter, and R.L. Keiter; Modified by O.K. Medhi (2007) 4th edition, Pearson EducationInc.

IBS-510: Self-assembly in Chemistry

Contents: Introduction to self-assembly and supramolecular chemistry, types ofnon-covalent interactions, importance of pre-organization, determination of association, problem solving, metal ion-macro-ligand supramolecular structures and metallo-supramolecular polymers. Single & self-complementary system, two, three and four and multiple arm hydrogen bonding systems, switching of recognition functions, hydrogen bonded supramolecular polymers, etc. Guest-host approaches in cyclodextrins, Calixarenes, Molecular rings & Nots, Rotaxanes and Dendrimers with examples. Anionic, cationic and neutral Micelles, critical micelle concentration (CMC) determination, bolaamphiphilies and application of micelles in drug delivery, etc. Origin of liquid crystals, mesogens self-organization, Types: nematic, smectic and cholestric liquid crystals and characterization of LC-materials. Self-assembly in DNA, protein andpeptides.

Recommended Readings:

1. Selected Topics covered in Comprehensive Supramolecular Chemistry, Volume8
2. Core concepts in Supramolecular chemistry and Nano-chemistry: Authors; J.W.Steed
3. Supramolecular Chemistry: Fundamentals and Applications: Advanced Text book: Authors: KatsuhikoAriga
4. Introduction to Soft mater: Synthetic and Biological Self-Assembling Materials: Authors: Ian W. Hamley
5. Review and research articles, communications and notes published in international journals (will beprovided)

IBS-511: Separation Principles and Techniques

Contents: Thermodynamics, diffusion rates, mass transfer etc. Solvent extraction,distillations, liquid-liquid extraction and other methods of separation. Types of Chromatography: GC, HPLC, hyphenated techniques. Electrophoresis, centrifugation DNA/Protein separations / purifications. Green Separation process separation using zeolite and polymer membranes. Chiral separations, molecular recognition, molecule imprinting and polymer separations.

Recommended Readings:

1. An Introduction to Separation Science: B.L. Karger, L.R. Snyder and C. Horvath (1973) 2nd edition, John Wiley &Sons
2. Handbook of Separation Process Technology: R.W. Rousseau (1987) 1st edition, John Wiley &Sons
3. Separation Process Principles: J.D. Seader and E.J. Henley (2005) 2nd Edition, John Wiley & Sons

IBS-512: Lab Training / Theory Project –I

The larger objective of this course is to encourage students to participate in ongoing research at BBAU. This may be in the form of a reading/literature review/theoretical and computational project/lab based research project.

The student has to identify, talk to and mutually agree on a research project with a faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.

IBS-513: Group Theory

Contents: Definition of groups, homomorphisms, subgroups, normal subgroupsand quotient groups, Lagrange's theorem, examples: cyclic groups, symmetric groups, alternating groups, general linear groups and other matrix groups, simple groups, group actions, Cayley's theorem, class equation, Sylow theorems, direct and semi-direct products, structure theorem for finite Abelian groups, solvable and nilpotent Groups.

Recommended Readings:

1. Abstract Algebra: D.S. Dummit and R.M. Foote (1999)Wiley
2. Topics in Algebra: I.N. Herstein (1975) Wiley
3. Algebra: M. Artin (1991) PrenticeHall
4. Problems in Group Theory: J. Dixon (2007)Dover
5. Group Theory Selected Problems: B. Sury (2004) UniversitiesPress
6. Groups and Symmetry: Armstrong (1987) UTMSpringer
7. An Introduction to the Theory of Groups: J.J. Rotman (1994)Springer
8. Symmetries: D.L. Johnson (2004) SUMSSpringer

IBS-514: Elementary Geometry

Contents: Euclidean Geometry: constructions using straightedge and compass,constructible numbers and some classical problems in geometry: trisection of an angle, doubling a cube and squaring a circle, complex numbers, symmetries in 2 and 3 dimension: translations, rotations, reflections and glide reflections, the orthogonal groups O(2) and O(3), quaternions and 3-dimensional geometry. Projective Geometry: the projective line and the projective plane. Spherical Geometry, area of a triangle, Euler's formula for planar graph. Hyperbolic Geometry: the upper half-plane model, triangles, non-Euclidean geometry, Mobius transformations, area of a hyperbolic triangle.Geometry

Lab: Symmetries of regular polygon and platonic solids, tiling, Origami and classical problems in geometry, perspective drawings (1 and 2 point perspectives) and projective geometry, Computer graphics and quaternions.

Recommended Readings:

1. Geometry: R. Fenn (2000) SUMSSpringer
2. The Poincare Half Plane: A Gateway to Modern Geometry: S. Stahl (1993) Jones &Bartlett
3. Hyperbolic Geometry: J.W. Anderson (2007) SUMSSpringer
4. Geometry: M. Audin (2003) UniversitextSpringer
5. Curved Spaces: P.M.H. Wilson (2008) Cambridge UniversityPress
6. Geometry Euclid and beyond: R. Hartshorne (2010)Springer
7. The Four Pillars of Geometry: J. Stillwell (2005)Springer
8. Introduction to Geometry: H.S.M. Coxeter (1989)Wiley
9. Course in Modern Geometries: J.N. Cederberg (2001)Springer
10. Geometry of Surfaces: J. Stillwell (2007) UniversitextSpringer

IBS-515: Analysis

Contents: Construction of Real numbers: Cauchy sequences, construction, leastupper bound property. Limits of sequences: convergence, suprema and infima, limsup, liminf, limit points, subsequences. Series: infinite series, rearrangement of series, tests for convergence. Infinite sets: countability, uncountable sets, axiom of choice. Functions on R: continuous functions, left and right limits, maximum principle, intermediate value theorem, uniform continuity. Differentiation: definitions, local maxima and minima, L'Hopital rule. Riemann integration: basic properties, Riemann integrability of continuous functions, non-Riemann integrable functions, Riemann-Stieltjes integral, fundamental theorems of Calculus. Uniform convergence: point-wise and uniform convergence, uniform convergence and continuity, Weierstrass M-test, uniform convergence and integration, uniform convergence and derivation. Introduction to Power series and Fourier series.

Recommended Readings:

1. Analysis I & II: T. Tao, TRIM series (2006) Hindustan BookAgency
2. Principles of Mathematical Analysis: W. Rudin (1976) Tata McGrawHill
3. A Course of Pure Mathematics Centenary edition: G.H. Hardy and T.W. Korner (2008) Cambridge MathematicalLibrary
4. Mathematical Analysis: T.M. Apostol (1974)Addison-Wesley
5. A first course in Real Analysis: S.K. Berberian (1994) UTMSpringer
6. Metric Spaces: M. Searcoid (2006) UTMSpringer
7. Metric Spaces: E.T. Copson (1968) Cambridge UniversityPress

IBS-516:Topics in Algebra

Simple groups and solvable groups, nilpotent groups, simplicity of alternating groups, composition series, Jordan-Holder Theorem. Semidirect products. Free groups, free abelian groups. Rings, Examples (including polynomial rings, formal power series rings, matrix rings and group rings), ideals, prime and maximal ideals, rings of fractions, Chinese Remainder Theorem for pairwise comaximal ideals. Euclidean Domains, Principal Ideal Domains and Unique Factorizations Domains. Poly-nomial rings over UFD's. Fields, Characteristic and prime subfields, Field extensions, Finite, algebraic and finitely generated field extensions, Classical ruler and compass constructions, Splitting fields and normal extensions, algebraic closures. Finite fields, Cyclotomic fields, Separable and inseparable extensions.Galois groups, Fundamental Theorem of Galois Theory, Composite extensions, Examples (including cyclotomic extensions and extensions of finite fields).

Recommended Readings:

1. M. Artin, Algebra, Prentice Hall of India,1994.
2. D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley,2002.
3. J.A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa,1999.
4. N. Jacobson, Basic Algebra I, 2nd Ed., Hindustan Publishing Co., 1984, W.H. Freeman, 1985.

IBS-517: Topics in Geometry & Topology

Basic properties of a topology, open sets, closed sets, covers, continuous maps. Connectedness, Hausdorff property, local compactness, compactness, paracompactness

Fundamentals of smooth manifolds, immersions, embeddings, submersions, submanifolds, manifolds with boundary, smooth maps, diffeomorphisms, partition of unity.

Recommended Readings:

1. J.R. Munkres,Topology
2. T.W. Gamelin and R.E. Greene, Introduction toTopology
3. M.A. Armstrong, BasicTopology
4. J.M. Lee, Introduction to TopologicalManifolds
5. Th. Br¨ocker and K. J¨anich, Introduction to DifferentialTopology

IBS-518: Topics in Discrete Mathematics

Set theory - Operations - union, intersection, complement, difference, DeMorgan's Laws Subsets, power sets, Venn diagrams, Equal vs. equivalent sets, Countability, Sets of numbers (integers, reals, etc.) Cartesian products, Proof by Contadiction, History - Cantor, Mandelbrot, Descartes,Venn.
Relations and functions-Symmetry, transitivity, reflexivity, Equivalence classes, Congruence, partitions, domain, range, co-domain, One-to-one, onto, inverse, Modular numbers, History Pythagorean relationship, Descartes

Recommended Readings:

1. Scheinerman, Edward, Mathematics: A Discrete Introduction, 2006,Cengage.
2. Roman, Steven. An Introduction to Discrete Mathematics, 2nd edition, Saunders,NY.
3. Rosen, Kenneth h. Discrete Mathematics and Its Applications, 2 ed,McGraw/Hill
4. Barnett, Steven. Discrete Mathematics, Addison Wesley, Reading, MA (Accessory resource for numberbases)
5. Dossey, John A. et al, Discrete Mathematics, 3rd edition, Addison-Wesley, Reading,MA.
6. Johnsonbaugh, Richard, *Essential Discrete Mathematics*, MacMillan Publishing Co., NY. 2005

IBS-519: Mathematical Methods in Physics

Contents: Complex analysis; Ordinary differential equations; Sturm-Liouvilletheory,Special functions: Hermite, Legendre, Laguerre, Bessel and Green's functions; partial differential equations, complex analysis and an introduction to tensors.

Recommended Readings:

1. Mathematical Methods for Physicists: G. Arfken and H. Weber (2012) 7th edition, Academic Press
2. Fundamentals of Complex Analysis**:** E.B. Staff and A.D. Snider (2008) Dorling Kinderley (India)Ltd
3. Ordinary Differential Equations: G. Birkhoff and G.C. Rota (1989) 4th edition, WileyIndia
4. Differential Equations with Applications and Historical Notes: G. Simmons (2003) Tata McGraw Hill
5. Linear Partial Differential Equations for Scientists and Engineers: Tyn Myint-U and Lokenath Debnath (2006) 4th edition,Birkhauser

IBS-520: Astronomy & Astrophysics

Contents: Electromagnetic processes, thermal and synchrotron emission, spectrallines; stellar physics: structure, composition, evolution; active galactic nuclei, radio galaxies, quasars, galaxies and galaxy clusters, galaxy structure and composition; X-ray clusters, cluster radio sources; dark matter, gravitational lensing, rotation curves; cosmology, big bang model, cosmic microwave background, reionisation. Other topics (time permitting): pulsars, extra solar planets,telescopes.

Recommended Readings:

1. Galaxies in the Universe: An Introduction: L.S. Sparke and J.S. Gallagher III (2000) Cambridge UniversityPress
2. Galactic and Extragalactic Radio Astronomy: G.L. Verschuur and K.I. Kellermann (1988) Springer-Verlag
3. The Physics of Stars (Manchester Physics Series): A.C. Phillips (1999) John Wiley &Sons.

IBS-521: Methods of Experimental Physics

Contents: Error analysis and the value of "zero" in experimental physics,measurement of noise and analysis of noise, electrical measurements and precautions: I-V, C-V, resistivity.Magnetic

measurements and precautions: vibrating sample magnetometer, SQUID;Vacuum techniques: units, gauges, pumps, materials;Techniques of temperature measurements: very low, medium and very high - temperaturethermometers, thermocouples, thermistors, pyrometer, spectroscopy etc; Thin film deposition methods: physical, e-beam, sputter, chemical vapor deposition, molecular beam epitaxy, spin coatings, dip coating, electroplating, electroless plating etc; Techniques of optical spectroscopy and optoelectronic devices: UV-Vis absorption, photoluminescence, electroluminescence, light-emitting diodes, solar cells; Advanced experimental techniques: AFM, atomic and molecular traps, superconductivity, astronomy, NMR, nano-materials and devices, time-resolved measurementsetc.

Recommended Readings:

1. Practical Physics: G.L. Squires (2001) 4th edition, Cambridge UniversityPress
2. Astronomical Optics: D.J. Schroeder (1999) 2nd edition, AcademicPress
3. Experimental Physics: R.A. Dunlap (1988) 1st edition, Oxford University ,press
4. Characterization of Materials: J.B. Wachtman and Z.H. Kalman (1992) Butterworth-Heinemann

IBS-522: Electrodynamics

Contents: Maxwell's equations, conservation laws, electromagnetic waves invacuum and in matter, absorption and dispersion, guided waves, dipole radiation, scalar and vector potentials, gauge transformations, relativistic electrodynamics, electromagnetic field tensor, covariant formulation of Maxwell's equations.

Recommended Readings:

1. Introduction to Electrodynamics: D.J. Griffths (2012) PearsonEducation
2. Modern Electrodynamics: A. Zangwill (2013) Cambridge UniversityPress
3. Feynman Lectures on Physics: R.P. Feynman, R.B. Leighton and M. Sands (2011) The Millenium edition, Vol 2, Basic Books
4. Electrodynamics of Continuous Media: L.D. Landau and E.M. Lifshitz (2007) 3rd edition, Butterworth-Heinemann

IBS-523: Physics Lab IV

Contents: Skin depth measurement, Generation and transmission ofelectromagnetic waves (Lecher Wire). Magnetic susceptibility measurement (Quincke's method), Magnetic Susceptibility measurement by Gouy's method , B-H hysteresis, Hall effect, Diode and Transistor characteristics, Field Effect Transistor, Operational amplifiers, Solar cell (IV characteristics), Faraday effect

Recommended Readings:

1. Advanced Practical Physics: B.L. Worsnop and H.T. Flint, Asia PublishingHouse
2. Analytical Experimental Physics: M. Ference Jr., H.B. Lemon and R.J. Stephenson (1970) University of ChicagoPress
3. The Art of Experimental Physics: D.W. Preston and E.R. Dietz (1991) JohnWiley
4. The Art of Electronics: P. Horowitz and W. Hill (1989) 2nd edition, Cambridge UniversityPress.

IBS-524: Lab Training / Theory Project

Contents: The student has to identify, talk to and mutually agree on a research project before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.

Recommended Reading: As suggested by the project supervisor

SEMESTER VI

IBS-601: Plant Biology I

Content: Introduction to land plants, evolutionary history of plants; plant cell andplasmodesmata, tissue organization; photosynthesis- light and dark reactions, molecular mechanisms, ecological considerations; respiration; lipid metabolism; water transport and mineral nutrition; translocation in the phloem, macromolecular (RNA/Protein) transport, transporter genes; plant hormones (biogenesis and mode of actions); plant growth and development, embryogenesis, pattern formation, stem cells & Shoot Apical Meristem (SAM) architecture; the control of flowering, ABC models, molecular mechanisms; photoreceptors and light control of plant development.

Recommended Readings:

1. Plant Physiology: L. Taiz and E. Zeiger (2010) 5th edition, Sinauer AssociatesInc
2. Biochemistry and Molecular Biology of Plants: B. Buchanon et. al. (2002) American Society of Plant Physiologists(ASPP)
3. Physiology and Behavior of Plants: P. Scott (2008) 1st edition, WileyPublishers
4. Plant Biochemistry: H.W. Heldt and B. Piechulla (2010) 4th edition, WileyPublishers

IBS-602: Immunology I

Content: Development of the immune system, innate immunity, immunoglobulinstructure and genetics, antigen-antibody reactions, the major histocompatibility complex and antigen presentation, T cell receptors (genetics, structure, selection), T cell activation and effector functions, adhesion molecules, immune responses to infections organisms and tumors, autoimmune diseases, allergies, immune deficiencies and AIDS. The major experiments that allowed the elucidation of various mechanistic features of the immune system will be featured to help you understand how immunologists think and work towards unraveling such complex interplay of molecules and cells.

Recommended Readings:

1. Janeway's Immunobiology: K.M. Murphy, P. Travers and M. Walport (2007) 7th edition, GarlandScience
2. Kuby Immunology: T.J. Kindt, B.A. Osborne and R.A. Goldsby (2006) 6thedition, W.H. Freeman

IBS-603: Advanced Biochemistry I

Content: Water and life; Biomolecules: Structural and functional aspects ofproteins, nucleic acids and carbohydrates; Nucleic acids: Structure and function, RNA world, ribozymes, DNA as the

genetic information carrier; Protein folding, dynamics and interaction: Thermodynamic principles, binding and protein folding reactions analyzed from the framework of enthalpy, entropy, free-energy and heat capacity. Enzyme biochemistry: Enzymes as biological catalysts, kinetics of unireactant systems, inhibition systems, enzyme activation, multisite and allosteric enzymes; Carbohydrates: Structure and function; Biochemical techniques: Protein and nucleic acid isolation, electrophoresis, chromatography, mass spectrometry, isothermal titration calorimetry and isotope exchange.

Recommended Readings:

1. Biochemistry: D. Voet and J.G. Voet (2010/2004), 4th/3rd edition,Wiley
2. Biochemistry:Thechemicalreactionsoflivingcells:D.E.Metzler(2003)VolumesI&II,2nd edition, Academic Press

IBS-604: Epigenetics

Content: In this course I will begin with the fundamentals of regulation of geneexpression and chromatin organization (6 lectures) and then discuss emerging concepts of how DNA sequence can dictate chromatin organization at the domain level (6 lectures), with specific emphasis on regulatory elements such as boundary elements and insulators (6 lectures). The implications of these in development, differentiation and disease will be discussed using specific examples (12 lectures).

Recommended Readings:

1. Histone variants – ancient wrap artists of the epigenome: Talbert, P.B. and Henikoff, S. *Nat. Rev. Mol. Cell Biol*., 2010doi:10.1038/nrm2861
2. Divide and (epigenetic) rule: Chromatin domains as functional and structural units of genomes. Mishra, R.K. and Galande, S. *Journal ofIndian Academy of Sciences*, Platinum Jubilee issue, 2009, pp211-224
3. Berstein et al. (2007). The mammalian epigenome. *Cell*, 128:669-681
4. Fuks, F. (2005). DNA methylation and histone modifications: teaming up to silence genes. *Curr Opin Genet Dev*.,15(5):490-495
5. Lunyak, V.V. (2008). Boundaries. Boundaries...Boundaries???. *CurrOpin Cell Biol*., 20(3):281-287

IBS-605: Developmental Biology

Content: History of developmental Biology, evolutionary developmental biology,an overview of early development, from Egg to Embryo. Commonly used Experimental methods in developmental biology; Introduction to positional information, axes, coordinates and morphogen gradients; Generation and Interpretation of gradient information and Pattern formation; Modes of cell-cell interactions during tissue organization: Self-organization, lateral inhibition, induction, and recruitment; Growth, differentiation and cancer; Evolution of body plan; Stem cell biology and tissue repair; Regeneration; Nervous system development; Embryogenesis in plants. Genes controlling embryogenesis; The control of flowering and molecular signaling. Specification of the floral organ identity; New twists on old model and Quartet theory for floral organ specification.In addition to the lectures, the course will include paper reading, group discussions,some demonstrations, debates and assignments.

Recommended Readings:

1. Developmental Biology: S.F. Gilbert (2006) 8th edition, SinauerAssociates
2. Principles of Development: L. Wolpert, R. Beddington, T. Jessell, P. Lawrence, E. Meyerowitz and J. Smith (2008) Oxford UniversityPress
3. Plant Physiology: L. Taiz and E. Zeiger (2006) 4th edition, SinauerAssociates

IBS-606: Lab Training / Theory Project –II

Contents: The student has to identify, talk to and mutually agree on a research project with the faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria (also see below) for the course are decided by the project supervisor.

Recommended Reading: As per suggestions of the project supervisor.

IBS-607: Quantum Chemistry

Contents: Introduction to quantum mechanics, wave equation and Schrodingerequation, postulates of quantum mechanics, particle in a box, harmonic oscillator, rigid rotor, hydrogen atom, variational principle, perturbation theory, introduction to many electron systems, electron spin, antisymmetry, Slater determinants, 2-e system, Valence Bond theory, Molecular Orbital theory, Huckel theory, Hartree-Fock theory, post Hartree-Fockmethods.

Recommended Readings:

1. Quantum Chemistry: D.A. McQuarrie (2007) 2nd edition, University ScienceBooks
2. Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory: A. Szabo and N. Ostlund (1996) New edition, DoverPublications
3. Quantum Chemistry: I.N. Levine (2008) 6th edition, Prentice Hall

IBS-608: Physical Chemistry of Solutions

Contents: Thermodynamic Description of mixtures, Partial Molar Quantities,Ideal Solutions, Nonideal solutions, Gibbs-Duhem Relation, Equilibrium constant for solutes, vapour-pressure lowering, Application to biology and polymer science, Electrolytes in Solution, Ionic Liquids, Ionic Mobilities, Dielectric Effect, Ionic Strength, Dissociation of Weak Electrolytes, Debye-Huckel Theory, Activities in more Concentrated Solutions, Polymer and Gel electrolyte, Thermodynamic description of Electrochemical Cells, Nernst equation, Activity Coefficients from EMF's, Equilibrium Constant from EMF's, Chemical Sensors, Fuel Cells, Impact on Biochemistry, Phase Equilibria, Pressure-Temperature Phase Diagrams, Phase Rule, Immiscible Liquids, Eutectic Formation, Solid-Compound Formation, Three-Component, Solid-Liquid Systems, Liquid-vapor, Pressure-Composition Diagrams, Boiling-Point Diagrams, Distillation, Adsorption of Gases, Supercritical fluids, Impact on MaterialsScience.

Recommended Readings:

1. Physical Chemistry: P.W. Atkins and J.de Paula (2010) 8th edition, Oxford UniversityPress
2. Physical Chemistry: G.M. Barrow (2007) 5th edition, Tata McGraw HillsPublishing

3. Physical Chemistry: I.N. Levine (2010) 5th edition, Tata McGraw Hills Publishing Modern Electrochemistry: Bockris and Reddy (1998) 2nd edition,Springer

IBS-609: Fundamentals of Molecular Spectroscopy

Contents: Introduction to radiation-matter interaction, Rotational Spectroscopy,Infrared Spectroscopy, Raman Spectroscopy, Electronic Spectroscopy, Nuclear Magnetic Resonance (NMR) Spectroscopy, Electron Spin Resonance (ESR) Spectroscopy.

Recommended Readings:

1. Introduction to Molecular Spectroscopy: G.M. Barrow (1988)McGraw-Hill
2. Fundamentals of Molecular Spectroscopy: C.N. Banwell and E.M. McCash (1994) 4thedition, Tata McGrawHill
3. Modern Spectroscopy: J.M. Hollas (2004) 4th edition, Wiley, NewYork
4. Spectra of Atoms and Molecules: P.F. Bernath (2005) 2nd edition, Oxford University Press, New York
5. Physical Chemistry - A Molecular Approach: D.A. Mc Quarrie and J.D. Simon (1997) 1st edition, Viva Books PrivateLimited
6. Physical Chemistry: P.W. Atkins (2010) 9th edition, W.H.Freeman

IBS-610: Transition Metal Chemistry

Contents: Crystal and ligand field theories, crystal field stabilization energies,Irving-Williams series, 10Dq and pairing energies, molecular orbital diagrams for coordination complexes, magnetic susceptibilities and Jahn-Teller effects. Spectroscopic terms, LS-coupling scheme, ligand field transitions, charge transfer bands, selection rules, Orgel diagrams, Tanabe-Sugano diagrams and circular dichroism. Thermodynamic and kinetic factors, labile and inert complexes, ligand substitutions in octahedral and square planar complexes, stereo chemical effects. Oxidation/reduction potentials, Nernst equation and redox stability in water, complementary and non-complementary redox reactions, Inner and outer sphere electron transfer and Marcus theory, electron transfer in metalloprotiens. Basic terminologies, kinetic factors affecting quantum yield, photochemistry of Co, Rh, Cr andRu.

Recommended Readings:

1. Inorganic Chemistry: D. Shriver and P. Atkins (2006) 4th edition, Oxford University Press, International StudentEdition
2. Inorganic Chemistry: J.E. Huheey, E.A. Keiter and R.L. Keiter (2007) 4th edition, Pearson Education
3. Reaction Mechanisms of Inorganic & Organometallic Systems: R.B. Jordan (2007) 3rd edition, Oxford UniversityPress

IBS-611: Organic Synthesis – I

Contents: The concept of protecting functional groups, oxidations and reductionsin functional group transformations, enantioselective reduction and oxidation, diastereofacial selectivity in acyclic

systems, The chemistry of carbon-carbon sigma and pi bonds and related reactions: Reactions of Carbon-Carbon Double and triple bonds, formation of carbon-carbon single, double and triple bonds and rings, chemistry of enolates, Organometallic Reagents in organic syntheses.

Recommended Readings:

1. Advanced Organic Chemistry: Part B: F.A. Carey and R.J. Sundberg (2007) 5th edition,Springer
2. March's Advanced Organic Chemistry: M. Smith and J. March (2001) 5thedition, Wiley-Interscience
3. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers (2000) 1stedition, Oxford UniversityPress
4. ModernOrganicSynthesisAnIntroduction:G.S.ZweifelandM.H.Nantz(2006)1stedition, W.H. Freeman

IBS-612: Lab Training/Theory Project – II

Contents: The student has to identify, talk to and mutually agree on a research project with the faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria (also see below) for the course are decided by the project supervisor.

Recommended Reading: As per suggestions of the project supervisor.

IBS-613:Vector Spaces, Rings and Modules

Contents: Vector Spaces: Matrices and linear transformations, trace, determinant,characteristic and minimal Polynomials, diagonalisation and upper triangulation, conjugacy/similarity classes. Inner product spaces, unitary transformations, spectral theorems. Rings, homomorphisms, ideals and quotient rings, prime and maximal ideals, integral domains, Chinese remainder theorem, field of fractions of an integral domain, irreducible and prime elements; Euclidean domains, principal ideal domains (PID), unique factorization domains (UFD). Modules: submodules, quotient modules, homomorphisms, torsion, direct product and sum, free modules, Structure theory of finitely generated modules over PID, Conjugacy Classes: Jordan and rational canonical forms of matrices, Linear groups.

Recommended Readings:

1. University Algebra: N.S. Gopalkrishnan (1986) New AgeInternational
2. Abstract Algebra: D.S. Dummit and R.M. Foote (2003) WileyIndia
3. Algebra: M. Artin (1991) PHI Learning PrivateLimited
4. Algebra: T.W. Hungerford (1974) GTMSpringer
5. Further Linear Algebra: T.S. Blyth and E.F. Robertson (2000) SUMSSpringer
6. Advanced Linear Algebra: S. Roman (2008) GTMSpringer
7. Finitely Generated Abelian Groups and Similarity of Matrices over a Field: C. Norman (2012) SUMSSpringer

IBS-614: Measure Theory and Integration

Contents: Lebesgue Integration: Algebra and σ-algebra of sets, Lebesguemeasure, measurable

functions of a real variable, existence of a non-measurable sets, nowhere dense sets with positive measure, Cantor sets, Cantor ternary function, integrability, Littlewood's three principles, Lebesgue convergence theorem; functions of bounded variations, change of variable, Jensen's inequality for convex functions. General Measure & Integration Theory: Definition and examples of general measure, integration of measurable functions, absolute continuity of measures, Radon-Nikodym theorem, outer measure, the extension theorem, product measures and Fubini's theorem.

Recommended Readings:

1. Real Analysis: H.L. Royden (1997)Prentice-Hall
2. Measure Theory: V.I. Bogachev (2006)Springer
3. Measure Theory: K.B. Athreya and S.N. Lahiri (2006) TRIM Hindustan BookAgency
4. Real Analysis: Measure Theory, Integration and Hilbert Spaces: E.M. Stein and R. Shakarchi (2005) Princeton UniversityPress
5. Measure Theory and Integration: G. Debarra (1981) New Age InternationalPublishers

IBS-615: Graph Theory

Contents: The Basics: graphs, paths and cycles, connectivity, trees and forests,bipartite graphs, contraction and minors, Euler tours, Hamilton Cycle. Matching and Covers: Maximum bipartite matching algorithms, matching in general graphs, Tutte's 1-factor theorem. Cuts and Connectivity: 2-connected Graphs, Menger's theorem. Network Flow: Max-flow Min-cut and the Ford-Fulkerson algorithm. Planar Graphs: drawing, Euler's formula, Kuratowski's theorem, plane duality. Coloring: coloring maps and planar graphs, coloring vertices, coloring edges.

Recommended Readings:

1. Introduction to Graph Theory: D.B. West (1996) PrenticeHall
2. Graph Theory: F. Harary (1969)Addison-Wesley
3. Modern Graph Theory: B. Bollobas (2008)Springer
4. Graph Theory: R. Diestel (2006)Springer
5. Graphs: C. Berge (1989)North-Holland
6. Graph Theory and its Applications: J.L. Gross and J. Yellen (2006) CRCPress
7. Introduction to Graph Theory: R.J. Wilson (1993) Addison WesleyLongman

IBS-616: Ordinary Differential Equations

Calculus of variations: Functionals and their extrema, Euler's equations, extrema with side conditions, geodesics. Phase space analysis of higher-order systems: Autonomous systems, phase space, equilibrium points, limit cycles, linearization, Lyapounov stability, asymptoticstability. Theory of planar systems: Poincare-Bendixson theorem, Bendixson criterion. Existence and uniqueness: Gronwall's Inequality, Contraction mappings, Picard approximations, Lipschitz condition, local existence and uniqueness, Peano's Theorem, Maximum interval ofsolution

Recommended Readings:

1. Differential Equations, Dynamical Systems and an Introduction to Chaos: M.W. Hirsch, S. Smale and R.L. Devaney (2012) AcademicPress

2. Differential Equations and Dynamical Systems: L. Perko (2001)Springer
3. Theory of Ordinary Differential Equations: E.A. Coddington and N. Levinson (1955) McGraw Hill
4. Ordinary Differential Equations: V.I. Arnold (2006)Springer
5. Elementary Differential Equations: W.E. Boyce & R.C. DiPrima (2008)Wiley
6. Differential Equations: P. Blanchard, R.L. Devaney and G.R. Hall (2008) CengageLearning
7. Ordinary Differential Equations: P. Hartman (1987) Cambridge UniversityPress
8. An Introduction to Dynamical Systems: D.K. Arrowsmith and C.M. Place (1990) Cambridge UniversityPress
9. Dynamical Systems: G.D. Birkhoff (1999) Colloquium PublicationsAMS
10. Ordinary Differential Equations: G. Birkhoff and G. Rota (1989)Wiley

IBS-618: Topics in Geometry & Topology

Products, quotient topology and spaces, identification topology and spaces, metric spaces, homeomorphisms. Basic properties of vector bundles, the tangent and cotangent bundles. Vector fields and flows of vectors fields, integral curves, singular points.

Recommended Readings:

1. J.R. Munkres,Topology
2. T.W. Gamelin and R.E. Greene, Introduction toTopology
3. M.A. Armstrong, BasicTopology
4. J.M. Lee, Introduction to TopologicalManifolds
5. Th. Br¨ocker and K. J¨anich, Introduction to DifferentialTopology

IBS-619: Quantum Mechanics I

Contents: Vector spaces, linear operators, eigenvalue problems; postulates ofquantum mechanics, Heisenberg uncertainty relations; time evolution; Schroedinger equation; harmonic oscillator; creation and annihilation operators; orbital angular momentum; ladder operators; Hydrogen atom; spin angular momentum; identical particles.

Recommended Readings:

1. Modern Quantum Mechanics: J.J. Sakurai (1999) Revised Edition,Addison-Wesley
2. Quantum Mechanics: C. Cohen-Tannoudji, B. Diu and F. Laloe (1977) Vol 1 and 2, Wiley-Interscience
3. Principles of Quantum Mechanics: R. Shankar (2010) 2nd edition,Springer
4. Introduction to Quantum Mechanics: D.J. Griffiths (2004) 2nd edition,Addison-Wesley

IBS 620: Statistical Mechanics I

Contents: Ergodic hypothesis, postulate of equal*apriori*probability, phase space,Liouville's theorem, microcanical ensemble, canonical ensemble, grand canonical ensemble, Boltzmann entropy, partition function, microscopic definition of temperature and calculation of other thermodynamic quantities, fluctuations of energy/particles in canonical/grand canonical ensembles, classical spins: paramagnetism, ferromagnetism, Curie's law.

Bose and Fermi statistics, quantum ideal gas, Bose-Einstein condensation, black body radiation spectrum, Einstein and Debye model of specific heat, interacting gases, van der Waals equation for non-ideal gas, first-order and second-order phase transitions, Boltzmann equation.

Recommended Readings:

1. Statistical Mechanics: K. Huang (1987) 2nd edition,Wiley
2. Fundamental of Statistical and Thermal Physics: F. Reif (2008) Waveland PrInc
3. Statistical Physics of Particles: Mehran Kardar (2007) Cambridge UniversityPress
4. Statistical Mechanics: R.K. Pathria (1996) 2nd edition,Butterworth-Heinemann

IBS 621: Nonlinear Dynamics

Contents: Nonlinear dynamical systems: classification, chaos, features of chaos,continuous and discrete dynamical systems; 1-d flows: fixed points and stability, linear stability analysis, bifurcations, flows on a circle, population dynamics; 2-d flows: classification of fixed points, stability analysis, limit cycles, bifurcations, predator-prey systems; higher-dimensional systems: stability, attractors, bifurcations, chaos, Lorenz system, Rossler system,pendulum.

Discrete dynamical systems, 1-d systems: logistic map, bifurcations, period doubling, chaos, Lyapunov exponent, circle map; 2-d systems: Henon map, quasiperiodicity, Arnold tongue; measures of chaos, Poincare map, basin boundary, FFT, Lyapunov exponents; Fractals: dimensions, multi- fractals, f-alpha spectrum.

Special topics: control of chaos, stochastic resonance, synchronization, spatio-temporal chaos, time series analysis, complex networks.

Recommended Readings:

1. Nonlinear Dynamics and Chaos: Steven Strogatz (2001) WestviewPress
2. Chaos and Nonlinear Dynamics: Hilborn (2009) Oxford UniversityPress
3. Chaos: An Introduction to Dynamical Systems: K.T. Alligood, T.D. Sauer and J.A. Yorke (1996) Springer Chaos in Dynamical Systems: E. Ott (2003) Cambridge UniversityPress
4. Nonlinear Dynamics: M. Lakshmanan and S. Rajasekar (2003)Springer

IBS 622: Electronics II

Contents: Advanced electronic devices: photo diodes, light emitting diodes, solarcells, Schottky diodes, tunnel diodes, Gunn diodes, IMPATT diodes; Electronic switches: BJT, FET and MOSfet switches, high power switching; Circuit design: voltage and power regulation, BJT and FET amplifier circuits, audio and high-frequency amplifier circuits, modulators and demodulators; Filters and oscillators: low pass, high pass and notch filters, active filters, oscillators; Signal measurement and signal processing: noise in electronic circuits, noise sources, interference and shielding, phase sensitive detection and phase-locked loops, Fourier transform and fast Fourier transform, noise- reduction techniques; Communications systems: modulation techniques, heterodyne and super heterodyne receivers, fundamentals of audio and video transmission, fiber optic and satellite base telecommunications,globalpositioningsystems;Digitalelectronics:introductiontovariousdigital

signal standards, interfacing of signals between various logic level signals, analog to digital conversion, digital to analog conversion, microcontrollers and microprocessor, fundamentals of digital signal processing, introduction to field programmable gate arrays and their applications.

Recommended Readings:

1. The Art of Electronics: Paul Horowitz & Winfield Hill (2011) Cambridge UniversityPress
2. Digital Principles and Their Applications: Donal P. Leach, Albert Paul Malvino and Gautam Saha (2006) Tata McGrawHill
3. Solid State Electronic Devices: B.G. Streetman & S.K. Banerjee(2005) 6th edition,Prentice
4. Electronic Devices and Circuits: Robert L. Boylestad & Louis Nashelsky (2009)Pearson

IBS 623: Group Theory inphysics

Contents: Introduction to discrete groups, Lie groups and Lie algebras, Liealgebras in particle physics, discrete and continuous symmetries in nature, symmetries and conserved quantities, gauge symmetries and fundamentalforces.

Recommended Reading:

1. Group Theory: A Physicist's Survey: P. Ramond (2010) 1st edition, Cambridge UniversityPress
2. Lie Algebras in Particle Physics: H. Georgi (1999) Westview Press, 2ndedition

IBS 624: Lab training/ Theory Project

Contents: The student has to identify, talk to and mutually agree on a researchproject before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.

Recommended Reading: As suggested by the project supervisor

SEMESTER VII

IBS-701: Biology and Disease

Content: What is Cancer and profile of a cancer cell; causes of cancer and how itspreads; molecular biology of cancer; What is neurodegeneration and biology of the disease; molecular basis of neurodegenerative disorders; Major types of heart diseases and their causes; review some of the methods for detecting and investigating heart disease; How genetic traits are inherited; effects of single gene mutations; types of chromosomal mutations; ways in which single gene mutations are treated; Types and symptoms of some common infectious diseases; outline preventive measures; general effects of antibiotics on infectious organisms, discuss some general aspects of the management and treatment of specific infectious diseases.

Recommended Readings:

1. Biology of Disease: N. Ahmed, M. Dawson, C. Smith and E. Wood (2006) 1st edition, Taylor &Francis
2. One Renegade Cell: The Quest For The Origin Of Cancer (Science Masters): R.A. Weinberg (1999) 1st edition, Basic Books
3. The Biology of Cancer: R. Weinberg (2006) 1st edition, GarlandScience
4. The Biology Of Disease: Murray, Jonathan and Kirk (2001) 2nd edition,Wiley-Blackwell

IBS-702: Plant Biology II

Content: Plant cell, tissue and organ culture (micropropagation, somaticembryogenesis, organogenesis, protoplasts and somatic hybridization); plant genetic transformation and transgenic and transplastomicplants; plant metabolites and engineering of plant metabolic pathways; production of phyto-chemicals by cell, tissue and hairy root cultures; molecular farming;phyto-remediation; crop improvement tools: molecular markers and marker mediated applications in plant breeding techniques, quantitative genetics, breeding strategies, biotechnology in crop improvement (biotic and abiotic stress, nutritional quality, defense responses); seed technology, molecular tests for seed analysis; visits to plant biotech companies.

Recommended Readings:

1. Introduction to Plant Tissue Culture: M.K. Rajdan (2003) 2nd edition, SciencePublishers
2. Plant Biotechnology-the genetic manipulation of plants: A. Slater (2008) 2nd edition, Oxford UniversityPress
3. Genetically Modified Crops (2011) 2nd edition, Imperial College Press, Worlds Scientific Publishers

IBS-703: Structural Biology

Content: Introduction to structures of biomolecules: proteins and nucleic acids;Recombinant technology and purification techniques to isolate biomolecules; Determination of atomic structure using X-ray crystallography; Studying macromolecular assembly using electron microscopy; Biophysical and spectroscopic techniques to understand structures; Graphics tools to visualize and analyze atomic structure of biomolecules; Understanding biological phenomenon with structures.

Recommended Readings:

1. Introduction to Protein Structure: C. Branden and J. Tooze (1999) 2nd edition, Garland Science
2. Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology: B. Rupp (2009) 1st edition, Garland Science Understanding DNA: C. Calladine, H. Drew, B. Luisi and A. Travers (2004) Elsevier AcademicPress
3. Textbook of Structural Biology: A. Liljas, L. Liljas, J. Piskur, G. Lindblom, P. Nissen and M. Kjeldgaard (2009) 1st edition, World ScientificPublishing

IBS-704: Animal Physiology II

Content: Physiology of circulation, respiration, excretion, ionic balance in sub-mammalian

vertebrates, physiology of reproduction, thermoregulation in ectothermic and endothermic animals. Nervous and sensory systems across various invertebrate groups. Circulation, ionic balance and excretion, respiration, digestion, moulting, sensory, nervous and neuroendocrine systems and reproduction in insects.

Recommended Readings:

1. Eckert Animal Physiology: D.J. Randall et al. (2002) W.H.Freeman
2. Comparative Animal Physiology: P.C. Withers et al. (2001) BrooksCole
3. Animal Physiology: R.W. Hill, G.A. Wyse and M. Anderson (2008) SinauerAssociates

IBS-705: Immunology II

Content: Toll-like receptors; Regulation of NK cell activity; Host-pathogeninteractions; Subversion of the host immune responses by intracellular parasites; Ontogeny and function of dendritic cells; Autoantibodies in health and disease; Molecular interactions between the T cell receptor and MHC molecules; Immune synapse; Polyspecificity of T cell receptor recognition; Molecular mimicry and epitope spreading; T cell memory; Peripheral tolerance and regulatory lymphocytes; Animal models of immune dysregulation; Interactions between the immune and the nervous systems.

Recommended Readings:

1. Kuby Immunology: T.J. Kindt, B.A. Osborne and R.A. Goldsby (2006) 6th edition W.H.Freeman
2. In addition, reading assignments for this course will be from recently published papers from the primaryliterature

IBS-706: Lab Training/Theory Project – III

Contents: The student has to identify, talk to and mutually agree on a researchproject with the faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria (also see below) for the course are decided by the projectsupervisor.

Recommended Reading: As per suggestions of the project supervisor.

IBS-707: Advanced Molecular Spectroscopy

Contents: Introduction to interaction of radiation with matter, Fundamentals oflasers and laser systems, Advanced spectroscopic techniques and applications, e.g., Raman spectroscopy, Electronic spectroscopy, Fluorescence techniques, Cavity ringdown absorption spectroscopy, Supersonic jet spectroscopy**,** Laser induced fluorescence, Stimulated emission pumping, Multiphoton ionization spectroscopy, Photoelectron spectroscopy, Ultrafast spectroscopy.

Recommended Readings:

1. Modern Spectroscopy: J.M. Hollas (2004) 4th edition, Wiley, NewYork
2. High Resolution Spectroscopy: J.M. Hollas (1998) 2nd edition,Wiley
3. Laser Fundamentals: W.T. Silfvast (2008) 2nd edition, Cambridge University Press,Cambridge
4. Laser Chemistry: Spectroscopy, Dynamics and Applications: H.H. Telle, A.G. Urena, R.J. Donovan, (2007) 1st edition, Wiley
5. PhysicalChemistry-AMolecularApproach:D.A.McQuarrieandJ.D.Simon(1998)1stSouth

Asian edition, Viva Books Private Limited

6. Spectra of Atoms and Molecules: P.F. Bernath (2005) 2nd edition, Oxford University Press, New York

IBS-708: Organic Synthesis – II

Contents: Formation of carbon-carbon single bonds, Organometallic reagents,synthesis of carbocyclic systems, sketches of synthesis, tactics in organic synthon approach, disconnection approach for multiple step syntheses, functional group interconversions, synthesis of heterocycles: ring-closing reactions; asymmetric synthesis, chiral pool synthesis, chiral auxillary, organocatalysis, Desymmetrisation, total synthesis of natural products.

Recommended Readings:

1. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers (2000) 1st edition, Oxford UniversityPress
2. Organic Synthesis: The Disconnection Approach: S.G. Warren (2008) 2nd edition,Wiley
3. The Logic of Chemical Synthesis: E.J. Corey and Xue-Min Cheng (1995) 1st edition, Wiley, New York
4. Classics in Total Synthesis: K.C. Nicolaou and E.J. Sorensen (1996) 1st edition,Wiley-VCH
5. AdvancedOrganicChemistry,PartsAandB:F.A.CareyandR.J.Sundberg,Springer(2007)5th edition, Springer
6. Other course material given time to time fromliterature

IBS-709: Bioinorganic Chemistry

Contents: General aspects of chemistry of dioxygen, Fe, Cu and Co. Nature of M-O2 linkage, heme proteins, molecular mechanism of oxygenases, catalase and peroxidase, Cu-Znsuperoxide dismutase. Electron transferases, Respiration, Photosynthesis, Nitrogen fixation and Vitamin B12. Fe-S proteins, redox behaviour. Metals for diagnosis and chemotherapy, Pt anti-cancer drugs as a case study. ESR and Mossbauerspectroscopy.

Recommended Readings:

1. Bioinorganic Chemistry: I. Bertini, H.B. Gray, J.S. Valentine and J. Lippard (2007) South Asian Edition, Viva Books PrivateLtd
2. Biological Inorganic Chemistry: Eds: H.B. Gray, E.I. Stiefel, J.S. Valentine and I. Bertini (2006) University ScienceBooks
3. The Biological Chemistry of the Elements: J.J.R.F. da Silva and R.J.P. Williams (2001) 2nd edition, Oxford UniversityPress

IBS-710: Molecular Modelling and Simulation

Contents: Introduction to Molecular Dynamics: Atomic potentials and force-fields, periodic boundary conditions, equation of motion integrators, treatment of statistical mechanical ensembles,

time correlation functions, radial distribution functions, mean square displacement, diffusion coefficient. Perform simulation experiments using GROMACS Molecular Dynamics software. Learning Molecular Builder and Visualization Tools (Gaussview, MOLDEN and Visual Molecular Dynamics). Quantum Mechanics: Born Oppenheimer Approximation, Self Consistent Field Theory/Density Functional Theory Equations, Basis Sets, Electron Correlation, Use of Quantum Chemistry software (GAUSSIAN).

Recommended Readings:

1. Computer Simulations of Liquids: M.P. Allen and D.J. Tildesley (1987) Oxford Science Publications
2. Molecular Modelling: Principles and Applications: A.R. Leach (1997) Addison Wesley PublishingCompany
3. Introduction to Computational Chemistry: F. Jensen (2006) 2nd edition, John Wiley &Sons
4. Density Functional Theory of Atoms and Molecules: R.G. Parr and W. Yang, (1994) Oxford UniversityPress.

IBS-711: Advanced Physical Chemistry Laboratory

Contents: Building of molecules using Gaussview: Calculation of energy,structure and vibrational frequencies using Gaussian software,Visualization of geometry, orbitals, vibrations and spectra using Gaussian software, Contact angle measurement on hydrophobic and hydrophilic surface, Synthesis and spectroscopic characterization of metallic nanostructures, Raman spectroscopic studies of CCl_4, Lithographic patterning, Study of an oscillatory reaction by Emf, or (and) absorbance measurement, To study the fluorescence quenching of Anthracene by CCl_4 in n-hexane or (and) ethanol.

Recommended Readings:

1. Experimental Physical Chemistry: V.D. Athawale and P. Mathur (2007) New Age International Publisher
2. Relevant research paper in J. Chem.Educ.
3. Gaussian 03/09 Usermanual

IBS-712: Lab Training/Theory Project –III

Contents: The student has to identify, talk to and mutually agree on a researchproject with the faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria (also see below) for the course are decided by the projectsupervisor.

Recommended Reading: As per suggestions of the project supervisor.

IBS-713:Galois Theory

Contents: Polynomial Rings: basic properties, division algorithm, roots ofpolynomials, Gauss's Theorem (R UFD implies R[X] UFD), irreducibility criteria, symmetric polynomials, Newton's

theorem. Field Extensions: Finite, algebraic and transcendental extensions, adjunction of roots, degree of a finite extension, algebraically closed fields, existence and uniqueness of algebraic closure, splitting fields, normal extensions, separable extensions, Galois extensions, automorphism groups and fixed fields, fundamental theorem of Galois theory, examples: finite fields, cyclic extensions, cyclotomic extensions, solvability by radicals, ruler and compass constructions, constructibility of regularn-gon.

Recommended Readings:

1. Abstract Algebra: D.S. Dummit and R.M. Foote (2003) WileyIndia
2. Galois Theory: I. Stewart (2003) Chapman Hall/CRC Math.Series
3. Algebra: S. Lang (2002)Springer
4. Field and Galois Theory: P. Morandi (1996) GTMSpringer
5. Galois Theory (lectures delivered at the University of Notre Dame): E. Artin (1997) Dover Publications
6. Galois Theory: H.M. Edwards (1984)Springer
7. Field Theory: S. Roman (2006) Springer
8. Galois' Theory of Algebraic Equations: J.-P. Tignol (2001) WorldScientific
9. Lectures on the Algebraic Theory of Fields: K.G. Ramanathan, TIFR Lecture notes (available online)
10. Galois Theory: M.P. Murthy, K.G. Ramanathan, C.S. Seshadri, U. Shukla and R. Sridharan, TIFR Pamphlets (availableonline)

IBS-714: Functional Analysis

Contents: Normed linear spaces: Definition and examples, bounded linearoperators, Hahn-Banach theorem. Banach spaces: Definition and examples, uniform boundedness principle, open mapping theorem, closed graph theorem, quotient spaces, projections, dual spaces, weak and weak* convergence, reflexivity, compact operators, spectrum of compact operators. Hilbert spaces: Definition and examples, geometry of Hilbert spaces, orthonormal sets, orthogonal projections, Riesz representation theorem. Spectral theory: Adjoint of an operator, unitary operators, normal operators, self-adjoint operators on Hilbert spaces, spectral theorem for compact self-adjoint operators.

Recommended Readings:

1. Functional Analysis: B.V. Limaye (1996) New Age InternationalPublishers
2. Notes on Functional Analysis: R. Bhatia (2009) Hindustan BookAgency
3. Introduction to Topology and Modern Analysis: G.F. Simmons (2003) Krieger PublishingHouse
4. A Course in Functional Analysis: J. Conway (1990) Graduate Texts in Mathematics,Springer
5. Introductory Functional Analysis with Applications: E. Kreyszig (1989)Wiley
6. Essential results of Functional Analysis: R. Zimmer (1990) Chicago UniversityPress

IBS-715: Differential Geometry

Contents: Multi-variable Analysis: Differential calculus in several variables,vector fields on open subsets of Euclidean spaces, implicit and inverse function theorems. Differentiable manifolds:

Definition, differentiable functions between manifolds, immersions, submanifolds, groups acting on manifolds, covering manifolds. Lie groups: Definition, action of a lie group on a manifold and transformation groups. Vector fields and Lie algebras: Definition, integral curves, flows, Lie algebra of vector fields, Frobenius' theorem. Forms: Tensors, bilinear forms, Riemannian manifolds, wedge product. Integration on manifolds: Definition of Integration of forms, Stokes' theorem, applications. Curvature: Curvature on curves and surfaces, Theorema Egregium of Gauss.

Recommended Readings:

1. An Introduction to Differentiable Manifolds and Riemannian Geometry: W.M. Boothby (1975) AcademicPress
2. Introduction to Smooth Manifolds: J.M. Lee (2000) GTMSpringer
3. Notes of Differential Geometry: N.J. Hicks (1965) VonNostrand
4. Geometry from a Differentiable Viewpoint: J. McCleary (2012) Cambridge UniversityPress
5. Differential Geometry of Curves and Surfaces: M.P. Do Carmo (1976) PrenticeHall
6. Elementary Differential Geometry: B. O'Neill (2006) AcademicPress
7. A Course in Differential Geometry and Lie Groups: S. Kumaresan (2002) TRIM Hindustan Book Agency
8. Elementary Differential Geometry: A.N. Pressley (2010)Springer
9. Analysis and Algebra on Differentiable Manifolds: A Workbook for Students and Teachers: P.M. Gadea and J.M. Masque (2009)Springer

IBS-716: Algorithms

Contents: Asymptotic order of growth: big O notation and its relatives. Datastructures: Priority queues, heaps, queues, stacks, Union-Find. Basic Graph Algorithms: breadth first search, depth first search, DAGs (directed acyclic graphs) and topological ordering, strongly connected components. Greedy Algorithms: interval scheduling, Dijkstra's algorithm for finding shortest paths in a graph, minimum spanning trees, Huffman codes for data compression. Divide and Conquer and Recurrences: The master theorem, application to the complexity of recursive algorithms, example of an algorithm with running time O(n^{1.59}). Dynamic Programming: weighted interval scheduling, the notion of memoization over sub problems, subset sums and knapsacks. Network Flow: Max- Flow Min-Cut and the Ford-Fulkerson algorithm. NP and computational complexity: reducibility, definition of NP, sketch proof that 3-SAT is NP-complete, selected examples of NP-complete problems.

Recommended Readings:

1. Algorithm Design: J. Kleinberg and E. Tardos (2006) PearsonEducation
2. Introduction to Algorithms: H. Cormen, C.E. Leiserson and R.L. Rivest (2009) MITPress
3. Design and Analysis of Algorithms: A.V. Aho, J.E. Hopcroft and J.D. Ullman (1975) Addison-Wesley
4. Fundamentals of Computer Algorithms: E. Horowitz and S. Sahni (1999) GalgotiaPublishers
5. Algorithms and Data Structures: K. Mehlhorn and P. Sanders (2008)Springer
6. Combinatorial Optimization: Algorithms and Complexity: C.H. Papadimitriou and K. Steiglitz (1982) Prentice Hall

IBS-717:Topics in Algebra-II

Modules, submodules, quotient modules and module homomorphisms. Generation of modules, direct sums and free modules. Tensor products of modules. Exact sequences, projective modules. Tensor algebras, symmetric and exterior algebras. Finitely generated modules over principal ideal domains, invariant factors, elementary divisors, rational canonical forms. Applications to finitely generated abelian groups and linear trans-formations. Noetherian rings and modules, Hilbert basis theorem, Primary decomposition of ideals in noetherian rings.

Recommended Readings:

1. M.F. Atiyah and I. G. Macdonald, Introduction to Commutative Algebra, Addison Wesley, 1969.
2. D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley,2002.
3. N. Jacobson, Basic Algebra I and II, 2nd Ed., W. H. Freeman, 1985 and1989.
4. S. Lang, Algebra, 3rd Ed., Springer (India),2004.
5. O. Zariski and P. Samuel, Commutative Algebra, Vol. I, Springer,1975.

IBS-718:Topics in Geometry & Topology

Basic properties of a topological manifold, embeddings and immersions of topological manifolds. Elementary properties of Lie groups, group actions, quotient spaces, homogeneous spaces.

Recommended Readings:

1. J.R. Munkres,Topology
2. T.W. Gamelin and R.E. Greene, Introduction toTopology
3. M.A. Armstrong, BasicTopology
4. J.M. Lee, Introduction to TopologicalManifolds
5. Th. Br¨ocker and K. J¨anich, Introduction to DifferentialTopology

IBS-719: Quantum Mechanics II

Contents: General properties of Schroedinger equation; Approximation methods: time-independent and time dependent perturbation theory, variational and WKB approximation; angular momentum and Clebsch-Gordan coefficients; Landau levels; scattering theory; coherent states; relativistic quantum mechanics.

Recommended Readings:

1. Quantum Mechanics: Vol I and 2, C. Cohen-Tannoudji, B. Diu and R. Laloe (2005) John Wiley andSons
2. Modern Quantum Mechanics: J.J. Sakurai (2009) Revised edition, AddisonWesley

3. Principles of Quantum Mechanics: R. Shankar (2010) 2nd edition,Springer
4. Introduction to Quantum Mechanics: D.J. Griffiths (2004) 2nd edition,Addison-Wesley

IBS-720: Statistical Mechanics II

Contents:
Section 1: Introduction to non-ideal classical gas: second virial coefficient and van der Waals equation, introduction to modern theory of phase transitions and critical phenomena, concept of renormalization group.
Section 2: Introduction to non-equilibrium processes, diffusion, transport, Brownian motion, review of probability distributions, stochastic processes, Markov processes, master equation, Fokker-Planck equation, Langevin equation, normal and anomalous diffusion, Levy flights and fractional Brownian motion.

Recommended Readings:
1. Statistical Mechanics: K. Huang (2005) 2nd edition, John Wiley andSons
2. Statistical Mechanics of Phase Transitions: J. Yeomans (1992) Oxford UniversityPress
3. Introduction to Modern Statistical Mechanics: D. Chandler (1979) Oxford UniversityPress
4. Elements of Non-equilibrium Statistical Mechanics: V. Balakrishnan (2009) AneBooks
5. Stochastic processes in Physics and Chemistry: N.G. van Kampen (2007) 3rd edition, North Holland

IBS-721: Computational Physics

Contents: Solutions to ordinary and partial differential equations, solutions toeigenvalue problems, Monte-Carlo techniques, numerical integration, interpolation, density functional theory, molecular dynamics.

Recommended Readings:
1. Computational Physics: J. Thijssen (1997) Cambridge UniversityPress
2. An Introduction to Computational Physics: T. Pang (2006) Cambridge UniversityPress
3. Computational Physics: Problem Solving with Computers: R.H. Landu et al (2007) Wiley VCH
4. Electronic Structure: Basic theory and Practical Methods: R.M. Martin(2008) Cambridge UniversityPress
5. M.C. Payne et al. (1992). Iterative minimization techniques for ab-initio total energy calculations: molecular dynamics and conjugate gradients. *Rev. Mod. Phys*. 64:1046.

IBS-722: Quantum Information

Contents:
Section 1: Fundamental Concepts-Qubits and their measurements, superdense coding,ensembles,

Schmidt decomposition, Bell inequality.
Section 2: Quantum Computation-Circuits, quantum Fourier transform, search and factorization, physical implementations.
Section 3: Quantum Information-Noise, fidelity measures, error-correction, entropy and information.

Recommended Readings:

1. Quantum Computation and Quantum Information: M.A. Nielsen and I.L. Chuang(2011) Cambridge UniversityPress
2. Preskill's lecture notes on Quantum Information and Quantum Computation, http://www.theory.caltech.edu/people/preskill/ph229/
3. An Introduction to Quantum Computing: P. Kaye, R. Laflamme and M. Mosca (2007) Oxford UniversityPress

IBS-723: Condensed Matter Physics I

Contents: Crystal structure, diffraction, reciprocal lattice, chemical bonding,Bloch theory and band-structures, beyond band theory: Mott insulator, nearly free electron model, tight binding theory, Hall effect and magneto-resistance, conduction in metals, Hartree-Fock approximation, dynamic lattice model and harmonic approximations, phonon and specific heat, anharmonic effects, insulators and semiconductors, superconductivity, optical properties, magnetic properties.

Recommended Readings:

1. Solid State Physics: N.W. Ashcroft and N.D. Mermin (1976) College edition, Harcourt College Publishers
2. Introduction to Solid State Physics: C. Kittel (2004) 8th edition, John Wiley andSons
3. Advanced Solid State Physics: Philip Phillips (2012) Cambridge UniversityPress

IBS 724 : Lab training/ Theory Project

Contents: The student has to identify, talk to and mutually agree on a researchproject before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.

Recommended Reading: As suggested by the project supervisor

SEMESTER VIII

IBS-801: Microbiology

Content: Microbial diversity: Cultural and culture independent methods, taxonomy, functional

anatomy of prokaryotic and eukaryotic microbial cells. Microbial physiology: Unique pathways for fermentation, biodegradation and biosynthesis. Microbial growth kinetics. Development and differentiation in microorganisms: spores, cysts, biphasic growth, Dictyostelium development, myxobacterial development, Biofilms and signaling among microbial cells. Microbial genetics. Principles of disease and epidemiology: Mechanisms of pathogenicity, host parasite interactions, Antimicrobial drugs, disease
transmission dynamics, public health and prophylaxis. Microbial biotechnology and bioengineering: Types of bioreactors, design of bioreactor, operation, downstream processing, development of new products, scale up.

Recommended Readings:

1. Microbiology: An Introduction: G.J. Tortora, B.R. Funke and C.L. Case (2004) 8th edition, PearsonEducation
2. Bacterial and Bacteriophage Genetics: E.A. Birge (2006)Springer
3. Microbiology: J. Nicklin, N. Khan, and R. Killington (2006) 3rd edition, Taylor andFrancis
4. Fermentation Microbiology and Biotechnology: M.E. Mansi and C.F.A. Bryce (2007) 2ndedition, Taylor andFrancis

IBS-802: Advanced Biochemistry II

Content: Membrane Biochemistry: Lipid structure and dynamics, membrane protein insertion and folding, lipid and protein organization in membranes, Molecular recognition principles on membranes, Lipid and protein sorting, membrane fusion and fission, homeoviscous adaption, Membrane-mimetic systems, membrane protein purification and reconstitution, Metabolism: Amino acid, lipid, carbohydrate, nucleotide and glycogen metabolism, metabolic pathways such as glycolysis, citric acid cycle, electron transport and oxidative phosphorylation.

Recommended Readings:

1. Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2002) GarlandScience
2. Life - As a Matter of Fat: O. Mouritsen (2004)Springer
3. The Structure of Biological Membranes: P. Yeagle (2004) CRCPress
4. Biochemistry: The chemical reactions of living cells: D. Metzler (2001) AcademicPress
5. Primary research articles and reviews will be utilized to provide contemporary insights into the field

IBS-803: Bioinformatics & Computational Biology

Content: Sequences analysis (pair wise alignment, multiple sequence alignment,motif discovery, gene annotation), pattern recognition/discovery in large-scale expression data, hidden markov models for sequence analysis, inferring phylogenetic trees (UPGMA, neighbor-joining, maximum parsimony, maximum likelihood), analysis of next generation sequencing data (Alignment, ChIP- Seq, RNA-seq, Assembly), Bayesian networks.

Recommended Readings:

1. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids: R. Durbin, S. R. Eddy, A. Krogh, and G. Mitchison (1999) Cambridge University Press, ISBN 0521629713

2. Algorithms on Strings, Trees, and Sequences: Computer Science and ComputationalBiology: D. Gusfield (2007) Cambridge University Press, ISBN 0521585198

IBS-804: Genome Biology

Content: Nucleic acid chemistry, DNA, RNA, proteins, DNA-hydrogen bonding,base pairing, replication, sequencing, annealing, hybridization, RNA, transcription, Amino acids, proteins, protein synthesis. Biology of Genomes; Synthetic genomes; Biology of the nucleus – nuclear architecture (cell biology and cytogenetics meets genomics); Mechanobiology and the nucleus; Advanced Chromosome biology – karyotyping & Spectral Karyotyping (SKY), FISH methods, chromosome painting studies and molecular cytogenetics, Copy number variations (CNV), array-comparative genomic hybridization (a-CGH), Chromosome conformation capture, 3C, 4C and Hi-C; microarrays, Next generation DNA sequencing; RNA Sequencing; Chip-Seq, Functional Genomics, Bioinformatics & computational biology; Transcriptomics; Cancer Genomics, Epigenomics, Chemical Genomics; Metabolomics; Proteomics; Genomics & stem cells; Systems biology

Recommended Readings:

1. Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2007) 5th edition (Sections: 1-3, Chapters:1-8)
2. Gibson et al, *Science*, 2010:329,52–56
3. http://cshperspectives.cshlp.org/cgi/collection/the_nucleus
4. Shivashankar, G.V. (2010). Nuclear mechanics and genome regulation, *Methods Cell Biol*., 98:xiii
5. Vorsanova, S.G. et al (2010). Human interphase chromosomes: a review of available molecular cytogenetic technologies, *Mol Cytogenet*., Jan 11;3:1
6. Padilla-Nash, H.M. et al (2006). Spectral karyotyping analysis of human and mouse chromosomes. *Nat Protoc*., 1(6):3129-3142 Metzker, M.L. (2010) *Nature Reviews Genetics* 11:31-46

IBS-805: Mathematical Biology

Content: Classical examples will be drawn from the literature that best illustratethe seamless integration of mathematics and biology, such as modeling in neuroscience (the classification of spiking activity based on different bifurcation scenarios), enzyme kinetics (slow-fast analysis and the MichaelisMenten equations), cell cycle modeling, and others.

Recommended Readings:

1. Dynamic Models in Biology: S.P. Ellener and J. Guckenheimer (2006) Princeton University Press
2. Mathematical Physiology: J. Keener and J. Sneyd (2008) Springer
3. Theoretical Neuroscience: P. Dayan and L. Abbott (2005) MITPress
4. Mathematical Models in Biology: L. Edelstein-Keshet (2005) RandomHouse

IBS-806: Lab Training/Theory Project – IV

The larger objective of this course is to encourage students to participate in ongoing research at

BBAU. This may be in the form of a reading/literature review/theoretical and computational project/lab based research project.
The student has to identify, talk to and mutually agree on a research project with a faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.

IBS-807: Structural Methods and Analysis

Contents: Infrared Spectroscopy, Ultra-Violet Spectroscopy, Fluorescence, Spectroscopy, Elemental Analysis, Mass Spectrometry, Nuclear Magnetic Resonance and multiple problem solving sessions for structure elucidation of natural and synthetic molecules.

Recommended Readings:

1. Spectrometric Identification of Organic Compounds: R.M. Silverstein, F.X. Webster and D.J. Kiemle (2005) 7th edition,Wiley
2. Organic Spectroscopy: W. Kemp (1991) 3rd edition, W.H.Freeman
3. Introduction to Organic Spectroscopy: L.M. Harwood and T.D.W. Claridge (2000) 1st edition, Oxford UniversityPress
4. Principles of Fluorescence Spectroscopy: J.R. Lakowicz (2006) 3rd edition,Springer
5. Introduction to Mass Spectrometry: J.T. Watson and O.D. Sparkman (2007) 4th edition, Wiley
6. Mass Spectrometry a Textbook: J.H. Gross and P. Roepstorff (2011) 2nd edition,Springer

IBS-808: Statistical Thermodynamics

Thermodynamic Connection, Fluctuation, Boltzmann Statistics, Fermi-Dirac Statistics, Bose- Einstein Statistics, monatomic gas, monatomic crystals, Ideal Diatomic Gas, Classical Statistical Mechanics, Ideal Polyatomic Gas, Chemical Equilibrium, Distribution Functions in Classical Monoatomic Liquids.

Recommended Readings:

1. Thermodynamics and Introduction to Thermostatistics: H.B. Callen (1985) 2nd edition, Wiley, [First sixchapters]
2. Statistical Mechanics: D.A. McQuarrie, University Science Books, California, USA, Viva Books Private Limited, New Delhi (Indian Edn) [First 7 chapters and some otherchapters]
3. An Introduction to Statistical Thermodynamics: T.L. Hill (1987) Dover Publications, Inc, NewYork

IBS-809: Medicinal Chemistry

Contents: Enzyme structure and catalysis, types of inhibitors, inhibitors as thebasis for drug design, receptors, drug-receptor interactions, ion channels, natural products with drug-like activity, DNA damaging and intercalating agents, RNA-based methods, drug metabolism, biodistribution, drug delivery methods, prodrugs.

Recommended Readings:

1. An Introduction to Medicinal Chemistry: G. Patrick (2001) 2nd edition, Oxford University Press,USA
2. The Organic Chemistry of Drug Design and Drug Action: R. Silverman (2004) 2nd edition, AcademicPress
3. Lehninger Principles of Biochemistry: D.L. Nelson and M.M. Cox (2008) 4th edition W.H. Freeman

IBS-810: Advanced Materials Science

Contents: Overview of Novel Materials, Types of Solids- Metals, Alloys,Insulators, Polymers, Semiconductors, Composites, Liquid Crystals, Quasi Crystals, Defects in Solids – Point, Line and Volume or Bulk Defects, Phase Transformations and Phase Equilibria, Solid Solution, Non-Equilibrium Cooling, Eutectic Systems Properties of Materials- Mechanical, Thermal, Optical and Magnetic. Adsorption Fundamentals, Concepts and Application, Adsorption Kinetics, Chemistry and Physics of Conduction, Primary and Secondary Batteries, Types of Batteries- Charging vs Discharging, Chargeable vs Non-Rechargeable Sources. Physical Limitations of Battery Performance. Solar Cells – Principle, Working and Tuning. Impedance Spectroscopy- Methods for Conductivity Meaurements, Electrochemical Kinetics- Butler Volmer Equation, Fick's First Law Of Diffusion, Tafel Equation. Fuel Cells- Design and Measurement, Types of Fuel Cells, Structure of Porous Electrolytes, Electrode Kinetics. Carbon Materials- Nanotubes, Fullerenes, Graphenes as Advanced FunctionalMaterials.

Recommended Readings:

1. CharacterizationofPorousSolidsandPowders:Surfacearea,PoreSizeandDensity:S.Lowell, J.E. Shields, M.A. Thomas and M. Thommes (2010) 4th Revised edition, Springer and Kluwer Academic
2. Modern Batteries: C.A. Vincent and B. Scrosati (2003) 2ndedition,
3. Grob's Basic Electronics: M.E. Schultz (2007) 10th edition, TataMcGraw-Hill

IBS-811: Organometallic Chemistry: Principles and Applications

Contents: Concepts of structure and bonding: definition, 18 electron rule, classesof ligands, bonding and structural considerations. Fundamental reaction process: oxidative addition and reductive elimination; insertion and elimination; ligand substitution processes, transmetallation, nucleophilic and electrophilic addition and abstraction. Preparative and characterization methods: general methods for the preparation of organometallic compounds and spectroscopic and analytical techniques for the elucidation of structure, properties and reactivates. Synthetic applications: coupling reactions, cyclization reactions, addition reactions, carbonylation, Pauson-Khand reaction, olefin oxidation, carbenes and activation reactions. Industrial applications: hydrogenation, hydroformylation, isomerization, metathesis and polymerization reactions. Bio-organometallics: nitrogen fixation, coenzyme B12, hydrogenase, CO dehydrogenase andmethanogenesis.

Recommended Readings:

1. Organometallics: C. Elschenbroich and A. Salzer (1992) 2nd edition,VCH
2. OrganometallicChemistryoftheTransitionMetals:R.H.Crabtree(2005)4thedition,Wiley-

Interscience

3. Basic Organometallic Chemistry: B.D. Gupta and A.J. Elias (2013) 2nd edition, Universities Press(India)
4. Transition Metals in the Synthesis of Complex Organic Molecules: L. Hegedus and B. Soderberg (2009) 3rd edition, University ScienceBooks

IBS-812: Lab Training/Theory Project – IV

Contents: The student has to identify, talk to and mutually agree on a researchproject with the faculty member before registering for this course. The scope, duration, structure, expectations, and evaluation criteria (also see below) for the course are decided by the projectsupervisor.

Recommended Reading: As per suggestions of the project supervisor.

IBS-813: Algebraic Number Theory

Contents: Algebraic numbers and algebraic integers: definitions and basicproperties, Dedekind domains, prime ideals, ideal factorization, ramification index and inertial degree, decomposition groups and inertia groups, finiteness of class groups, Dirichlet's unit theorem, adeles and ideles, adelic proof of finiteness of class number and the unit theorem, Riemann and Dedekind zeta functions, class number formula, DirichletL-functions.

Recommended Readings:

1. Number Fields: D.A. Marcus (1977)Springer
2. Problems in Algebraic Number Theory: J. Esmonde and M. Ram Murthy (2005)Springer
3. Algebraic Number Theory: J.W.S. Cassels and A. Frohlich (1993) AcademicPress
4. Algebraic Number Theory: S. Lang (1984)Springer
5. Algebraic Number Theory: J. Neukirch (1999) Springer
6. Algebraic Number Fields: G.J. Janusz (1996)AMS
7. Algebraic Number Theory and Fermat's Last Theorem: I. Stewart and D. Tall (2001) AK Peters
8. Algebraic Number Theory: R. Narasimhan, S. Raghavan, S.S. Rangachari and S. Lal, TIFR Pamphlets (availableonline)
9. Algebraic Number Theory: J. Milne (availableonline)

IBS-814: Complex Analysis

Contents: Complex Functions: complex numbers, analytic functions, Cauchy-Riemann equations, polynomials, rational functions, exponential and trigonometric functions, sequences & series, power series, inverse and open mapping theorem, maximum modulus theorem, Abel's limit theorem, conformal mappings, Schwarz's lemma, fractional linear transformations, cross ratio. Complex

Integration: Cauchy's integral formula, singularities, calculus of residues. Other Topics: The Gamma function, Riemann zeta function, Weierstrass products, Riemann mapping theorem, analytic continuation, Fourier transforms, Mellin transforms.

Recommended Readings:

1. Function Theory of One Complex Cariable: R.E. Greene and S.G. Krantz (2006)AMS
2. Theory of Complex Functions: R. Remmert (1991)Springer
3. Problems and Solutions for Complex Analysis: R. Shakarchi (1999)Springer
4. Complex Analysis: J. Bak and D.J. Newman (1997) UTMSpringer
5. Complex Analysis: L. Alhfors (1979) 3rd edition, McGrawHill
6. Functions of One Complex Variable I: J.B. Conway (1978) GTMSpringer
7. Complex Variables and Applications: J. Brown and R. Churchill (2008) 8thedition, McGraw Hill
8. Complex Analysis: S. Lang (1999) 3rd edition, Springer

IBS-815: Topics in Geometry & Topology

Elementary homotopy theory, homotopy equivalence, fundamental group, covering spaces. Tensors and tensor bundles, differential forms and Stokes theorem, elementary de Rham cohomology theory.

Recommended Readings:

1. J.R. Munkres,Topology
2. T.W. Gamelin and R.E. Greene, Introduction toTopology
3. M.A. Armstrong, BasicTopology
4. J.M. Lee, Introduction to TopologicalManifolds
5. Th. Br¨ocker and K. J¨anich, Introduction to DifferentialTopology

IBS-816: Topics in Discrete Mathematics

Combinatorics-Pigeonhole principle, Fundamental Theorem of Counting , Permutations, Combinations ,Binomial Theorem, History - Pascal's Triangle, Towers of Hanoi, Euclid's geometric progression. Graph Theory - Euler and Hamiltonian networks, Graph coloring, Directed and undirected, Isomorphisms, Spanning (optional) ,Traveling Salesperson problems,· PERT(Program Evaluation and Resource Technique), CPM(Critical Path Method) , Expression trees (order of operations), History - Euler, Hamilton, Bridges of Konigsberg Induction - History - Gauss formulas, classic plane geometry problems, Recursion - History - Nim, Fibonacci, Pascal Algorithms - Voting methods, Apportionment, Search algorithms, Optimizationalgorithms

IBS-817: Topics in Algebra

Integral extensions, Going-up and Going-down theorems, Extension and contraction of prime ideals, Noether's Normalization Lemma, Hilbert's Nullstellensatz. Localization of rings and modules. Primary decompositions of modules.

Recommended Readings:

1. M.F. Atiyah and I. G. Macdonald, Introduction to Commutative Algebra, Addison Wesley, 1969.

2. D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley,2002.

3. N. Jacobson, Basic Algebra I and II, 2nd Ed., W. H. Freeman, 1985 and1989.

4. S. Lang, Algebra, 3rd Ed., Springer (India),2004.

5. O. Zariski and P. Samuel, Commutative Algebra, Vol. I, Springer,1975.

IBS-818: Topics in Applicable Mathematics

Linear and quadratic equations, systems of linear equations, Linear Programming, matrices, probability, Data Description and Probability Distributions, statistics, exponential and logarithmic functions.

IBS-819: Classical and Quantum Optics

Contents: Review of electromagnetic plane waves in vacuum and in media. Polarisation – Stokes parameters. Fresnel -Kirchoff diffraction theory with examples. Fresnel coefficients, optics of metals, bulk and surface plasmons, Scattering of light, Optical imaging sytems. Fourier viewpoint in optics, Telescopes, microscopes, gratings, holography. Longitudinal and transverse coherence - Wiener Khinchin theorem and Zernike-van Cittert theorem Michelson, Fabry-Perot. Stellar interferometers. Electromagnetic modes and quantization of the electromagnetic field. Photons. Coherent states Interaction of light with matter – dipole approximation. Polarisability and elastic scattering. Spontaneous emission, stimulated emission and absorption. Non linear processes.

Recommended Readings:

1. Optics: E. Hecht (2001) 4th edition,Addison-Wesley
2. Optical Physics: A. Lipson, S.G. Lipson, and H. Lipson (2010) 4th edition, Cambridge University Press
3. Fourier Optics: J.W. Goodman (2004) 3rd edition, Roberts andCompany
4. Principles of Nano-optics: L. Novotny and B. Hecht (2012) 2nd edition, Cambridge University Press
5. Quantum Theory of Light: R. Louden (2000) 3rd edition, Oxford UniversityPress
6. Principles of Optics: M. Born and E. Wolf (1999) 7th edition, Cambridge UniversityPress

IBS-820: Nuclear and Particle Physics

Contents: Overview of particle interactions, Review of relativistic kinematics, Dirac equation, electromagnetic interactions, weak and strong interactions (introductory), properties of nuclei, mass, spin, charge, magnetic moment, classification, fermions and bosons, leptons and hadrons, mesons, quarks, gluons, intermediate vector bosons, structure of subatomic particles, scattering form factors,

conservation laws, angular momentum and isospin-invariance, parity, conservation and breakdown of parity, CPT and breakdown of CP invariance, quark models of mesons and baryons, nuclear models: liquid drop, Fermi gas, shell and collectivemodels.

Recommended Readings:

1. Introduction to Elementary Particles: D. Griffiths(1987) 2nd edition,Wiley
2. Quantum Field Theory in a Nutshell: A. Zee (2010) 2nd edition, Princeton UniversityPress
3. Particle Physics: R.R. Martin and G. Shaw (2008) John Wiley &Sons
4. An Introduction to Nuclear Physics: W.M. Cottingham and D.A. Greenwood (2001) 2ndedition, Canbridge UniversityPress

IBS-821: Advanced Materials Science

Contents: Overview of Novel Materials, Types of Solids- Metals, Alloys,Insulators, Polymers, Semiconductors, Composites, Liquid Crystals, Quasi Crystals, Defects in Solids – Point, Line and Volume or Bulk Defects, Phase Transformations and Phase Equilibria, Solid Solution, Non-Equilibrium Cooling, Eutectic Systems Properties of Materials- Mechanical, Thermal, Optical and Magnetic. Adsorption Fundamentals, Concepts and Application, Adsorption Kinetics, Chemistry and Physics of Conduction, Primary and Secondary Batteries, Types of Batteries- Charging vs Discharging, Chargeable vs Non-Rechargeable Sources. Physical Limitations of Battery Performance. Solar Cells – Principle, Working and Tuning. Impedance Spectroscopy- Methods for Conductivity Meaurements, Electrochemical Kinetics- Butler Volmer Equation, Fick's First Law Of Diffusion, Tafel Equation. Fuel Cells- Design and Measurement, Types of Fuel Cells, Structure of Porous Electrolytes, Electrode Kinetics. Carbon Materials-Nanotubes, Fullerenes, Graphenes as Advanced FunctionalMaterials.

Recommended Readings:

1. Adsorption by Powders and Porous Solids: Principles, Methodology and Applications: J. Rouquerol, F. Rouquerol and K.S.W. Sing (1998) AcademicPress
2. Modern Batteries: An Introduction to Electrochemical Power Sources: C. Vincent and B. Scrosati (1997) 2nd edition, Butterworth-Heinemann
3. An Introduction to Physics of Solar Cells: From Basic Principles to Advanced Concepts: P. Würfel (2009) John Wiley &Sons
4. Fuel Cell Fundamentals: R. O'Hayre, S.-W. Cha, W. Colella and F.B. Prinz (2009) 2nd edition, Wiley
5. Electrochemical Methods: Fundamentals and Applications: A.J. Bard and L.R. Faulkner (2000) 2nd edition, Wiley

IBS-822: Condensed Matter Physics II

Contents: Interacting electrons, Linear response theory: fluctuation-dissipationtheorem, F-sum rule; Physics of disorder: Kubo formula for conductivity, scaling theory of localisation, quantum Hall effect; Magnetism: local moment magnetism, exchange interaction, band magnetism, Stoner theory, spin density wave, Friedel-Anderson model, Kondo problem; Fermi liquid theory: electron spectral

function, quasi-particles and Landau interaction parameter, Fermi liquid in Kondo problem; Superconductivity: Landau diamagnetism, London equation and effect of disorder, Ginzburg-Landau theory, vortices, Type II superconductors.

Recommended Readings:

1. Advanced Solid State Physics: P. Phillips (2012) Cambridge UniversityPress
2. Principles of Condensed Matter Physics: P.M. Chaikin and T.C. Lubensky (2010) Cambridge University Press, Foundation Books, New Delhi (Indianedition)
3. Solid State Physics: N.W. Ashcroft and N.D. Mermin(1976) College edition, Harcourt CollegePublishers
4. Introduction to Solid State Physics: C. Kittel (2012) 8th edition, John Wiley andSons
5. Superconductivity of Metals and Alloys: de Gennes (1999) WestviewPress
6. Theory of Superconductivity: J. R. Schrieffer (1999) PerseusBooks
7. Theory of Solids: J.M. Ziman (1979) Cambridge UniversityPress
8. Theory of Quantum Liquids: Pines and Nozieres (1999) WestviewPress

IBS-823: Gravitation and Cosmology

Contents: Introduction to four-vectors, Principle of equivalence, Einstein'sequation from action principle and its basic properties, Schwarzschild solution and classical tests of relativity; basic ideas of black hole physics, introduction to gravitational waves.Basic introduction to contents and scales in the universe, Friedmann metric, dynamics of the FRW universe and elements of cosmology**.**

Recommended Readings:

1. Gravity: An Introduction to Einstein's General Relativity: J.B. Hartle (2003) Benjamin Cummings

2. Spacetime and Geometry: An Introduction to General Relativity: S. Carroll (2003) Benjamin Cummings

IBS-824: Lab Training / Theory Project

Contents: The student has to identify, talk to and mutually agree on a researchproject before registering for this course. The scope, duration, structure, expectations, and evaluation criteria for the course are decided by the project supervisor.

Recommended Reading: As suggested by the project supervisor

IBS-825: Literature Review

Content: The scientific literature – primary, secondary, and tertiary literature; Database searches – tools and strategies; Reading and evaluating the scientific literature - Academic writing – plagiarism and referencing, Format and Style; writing a literature review. Different members of the Biology

faculty will contribute to this course. Faculty member will choose topics from their own area of research expertise, and highlight through readings and discussions the nuances of reading and evaluating the literature in diverse topics like biochemistry, neurobiology, theoretical biology, etc.

Recommended Reading:
Reading assignments for this course will be from a variety of scientific journals.

SEMESTER IX

IBS- 901: Research project and thesis

Students are supposed to carryout field / laboratory training cum experimental works and prepare a comprehensive report along with a research proposal for future career. The area should include from basics to latest developments and discoveries, which will impart a broad training in various disciplines of Life Sciences and Biotechnology, These students will be able to pursue careers in pharmaceutical industries, research laboratories, clinical research organizations, school, colleges and Universities as researcher or academician

IBS- 902: Research Methodology

Unit 1: General Research

- Defining research question, Approaches andMethodology,
- Documentation and presentation of data, Analysis and Interpretation ofData,
- Writing of research proposal, report and Research paper, Footnotes andBibliography,
- Editing the final draft, Evaluating the finaldraft,
- Checklist for the good proposal /researchreport.
- A brief idea of funding agencies such DST, DBT, ICMR, CSIR, ICAR, UPCAR, UPCST, andUGC.

Unit II: Computer Application

- Computer basics: MS Office including Word, Excel, Powerpoint andinternet.
- Tabulation and graphical presentation ofdata.
- Statistical Packages and analysis: Sigma Stat, Sigma Plot, KyPlot,SPSS.

Unit III: GLP & Bio-safety

- Good Laboratory Practices, Protection- Personal an Laboratory, Signs of danger, Material Handling and Storage- MSDS andHAZOP;
- Handling harmful, hazardous and toxic chemicals. Biosafety cabinets, Primary containment for biohazards, Biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infectedanimals
- Biosafety guidelines: Government of India. Definition of GMOs an LMOs, Role of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture,
- Release of GMO in environment- Risk analysis, risk assessment and riskmanagement.
- National regulations and relevant International Agreement include CartagenaProtocol.
- Overview of national regulations and relevant international agreements. Ecolabelling,IS 22000, Generally Recognized as Safe(GRAS)

Unit IV: IPR & Bioethics

- Intellectual Property Rights(IPR),
- Patenting, Copyright, Productdevelopment,
- Process in Research and development
- Ethical, legal, social and scientific issues in biologicalresearch.

Laboratory Course:

1. To prepare power point presentation of a givenstudy
2. To write a research proposal for any funding agency inIndia
3. Other experiments as designed during thecourse
4. To evaluate research proposal/ report/ paper usingchecklists.

Suggested Readings:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers' Distributors,
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley EasternLimited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed), Singapore, PearsonEducation

IBS- 903: Biostatic andBioinformatics

Unit I:General Statistics &Probability

- Introduction, scope, applications and uses of statistics, collection and classification of data, census and sampling surveys, graphs and diagrams, central tendency and its measures : arithmetic mean, median, dispersion and its measures : range and its coefficient, variance and standard deviation, coefficient ofvariation.
- Bivariate data, scatter diagram and interpretation, calculation and interpretation of Karl Pearson's correlation coefficient, equation of the lines of regression and properties of regressionlines.
- Probability, definition, addition and multiplicative laws (without proof). Random variable and its distribution, binomial probability distribution, examples and conditions, means and variance, Poisson probability distribution, examples and conditions, means and variance, continuous variable, normal distribution, use of normal probability table for finding probabilities.

Unit II:Population Sampling

- Population parameters and sample statistics, sampling techniques: simple random sampling , stratified random sampling, systematic sampling, standarderror.
- Estimation: point & interval, Estimators of population mean & proportion (without proof), confidence intervals for population mean & proportion. Data, graphical presentation of data – frequency distribution Sample means and standarddeviations

Unit III:Experimental design

- Testing of hypothesis: Hypothesis and its types, errors and its types, levels of significance, one-tailed, and two-tailed tests, tests for single mean and single proportion, equality of the two population means and two populationproportions.
- Chi-square test, Student's test for significance, fishers Z test. Experimental designs- completely randomised, randomised block and factorial experimental designs. Analysis of variance for different experimental designs, F distribution. Correlation and regression, linear and non-linear regression, multiple regressions. Non-parametrictests

Unit IV: Bioinformatics Tools

- Introduction to Bioinformatics, Basic concepts of biologicaldatabases;
- Access to sequence databases on theInternet,
- Protein and Genome Information Resources
- Computer tools for sequence analysis: finding and retrievingsequences

Laboratory Course:

1. Data base search for sequences of givengene
2. Primer designing using different sequencelibrary
3. To find out statistical significance of given researchpaper
4. Other experiments as designed during thecourse

Suggested Readings:

1. Basic statistics for behavioral science research by Mary B.Harris
2. Biometry: the principles and practice of statistics in biological research by Robert R. Sokal and F. JamesRohlf
3. Statistics in applied sciences by B. K.Bhattacharyya
4. Bioinformatics Higgins &Taylor
5. Bioinformatics – A Primer, P. Narayanan New Age Internat.Pub.
6. Bioinformatics. Methods and Protocols. Misner & Krawetz Humana Press,NJ
7. Biostatistics A.E. LewisLatest
8. Introduction to Biostatistics by Khan & Khanun, UkaazPublication
9. Fundamentals of Biostatics – Practical Approach Dutta Kanishka Publ., NDelhi

IBS- 904: Introduction to Computing

Contents: Variables, expressions and statements; Values and types; Variablenames and keywords; Operators and operands; Expressions and statements; Order of operations; String operations; Functions; Function calls; Type conversion functions; Math functions; Composition; Adding new functions; Flow of execution; Parameters and arguments; Variables and parameters are local; Stack diagrams; Fruitful functions and void functions; Encapsulation; Generalization; Conditionals and

recursion; Modulus operator; Boolean expressions; Logical operators; Conditional execution; Alternative execution; Chained conditionals; Nested conditionals; Recursion; Infinite recursion; Composition; Iteration; Multiple assignment; Updating variables; The while statement; break; Square roots; Algorithms; Strings; Lists; List operations; List slices; List methods; Map, filter and reduce; Dictionaries; Dictionary as a set of counters; Looping and dictionaries; Reverse lookup; Memos; Global variables; Long integers; Sequences of sequences; Random numbers; Files; Reading and writing; Filenames and paths; Classes and methods; Object-oriented features; Operator overloading; Polymorphism; Debugging; Inheritance; Card objects; Class attributes; Class diagrams; Analysis of Algorithms; Order of growth; Analysis of basic Python operations; Analysis of search algorithms.

Recommended Reading:

1. Think Python: How to Think Like a Computer Scientist: A. Downey (2012)O'Reilly
2. Python Programming: An Introduction to Computer Science: J. Zelle (2003) Franklin Beedle &Associates
3. Programming Pearls: J. Bentley (1999) 2nd edition,Pearson
4. How to Solve It by Computer: R.G. Dromey (2006)Pearson
5. Thinking in Java: B. Eckel (2000)Pearson
6. Structure and Interpretation of Computer Programs: H. Abelson, G.J. Sussman and J. Sussman (1996) MITPress
7. Introduction to Computing: Explorations in Language, Logic, and Machines: D. Evans (1996) Createspace.

SEMESTER X

IBS-1001: Research Project and thesis continued

Students are supposed to carry forward their field / laboratory training cum experimental works which they have done in 9thsemester.

IBS-1002: Study Tour

Students are required to visit nature for diversity, research institutes and industries for real exposure in subject and qualitative interactions to understand applications of the subject. A study tour may be organized pertaining to different Life Sciences/ Microbiological/ Environmental/ Biotechnological/ Pharmaceutical industries/ research institutes/ various ecosystems. The study tour is highly essential for study various concepts, processes and technology pertaining to Basic Sciences.

IBS-1003:Viva voce

IBS-1004: Field/ Industry Attachment

Students are required to visit research institutes and industries for real exposure in subject and qualitative interactions to understand applications of the subject. The field/ Industrial attachment is highly essential for study various concepts, processes and technology pertaining to Basic Sciences.