Tentative Course Structure and Content for

Master of Science

School of Applied and Interdisciplinary Sciences

Indian Association for the Cultivation of Science

June-2018

General Information - MS Courses at SAIS

SAIS, in collaboration with other Schools of the institute, offers two years Master of Science (MS) program in the Interdisciplinary and Applied Sciences. The programme aims to educate students in the emerging areas of science by combining contemporary topics in Chemistry, Biology and Physics. After successful completion of the course, the MS degrees will be conferred either on **Applied Chemistry, Applied Biology** or **Applied Physics** (corroborating with the subject in which a particular candidate had the Bachelor's degree) with specialization in emerging topics including:

(a) Biomedical Science
(b) Green Chemistry
(c) Polymer Science and Soft Matter
(d) Natural Products and Indian Ancient Medicine
(e) Sustainability and Energy

Students from Chemistry background may opt for any one of (a)/ (b)/ (c) specializations, from Biology/ Medicine background may opt for (a)/ (d); from Physics background may opt for (c)/ (e); from Chemical Engineering background may opt for (a) or (c).

For each specialization, the course structure has been framed in a specific manner depending on the background of the student. For example, the specialization in (a) will have substantial overlap between Chemistry, Biology and Chemical Engineering. Therefore students entering into this course with Chemistry/ Chemical Engineering background will be offered a few courses in Biological Sciences in the first two semesters in addition to the core courses in Chemistry so that they are well prepared to credit the specialized courses on this topic in the subsequent semesters along with hands on experience in laboratory projects on the specialized area. Similarly a student entering to this course from Biology background will have to credit a few Chemistry courses prior to entering into the specialization topics. Likewise option (b) will have overlap between Organic Chemistry and Environmental Science while option (c) will have overlap between Physics, Chemistry and Macromolecular Sciences.

In addition to the core courses, students will have the opportunity to choose electives from a large number of courses offered in the institute in other disciplines including Chemistry, Physics, Biology and Materials.

After successful completion of the course, students will be well prepared to enter into a doctoral programme in any of these highly important and contemporary

interdisciplinary areas of research either in the institute (any School subject to clearing the eligibility criteria and consent from the supervisor) or elsewhere.

Eligibility: Students from Biology, Chemistry, Physics, Chemical Engineering or Medicine background are welcome to enter into the MS programme in the Interdisciplinary and Applied Sciences. The minimum eligibility criteria and other general terms and conditions remain the same as mentioned for the MS programme of IACS in any of the core disciplines. **Students will not have to appear for a separate entrance test for admission in the MS programme in SAIS. They have to clear the entrance test of their subject in the Bachelor's degree. For example a student coming from Chemistry background has to clear the entrance test of IACS in Chemistry and subsequently if they give an option for SAIS, they will be interviewed separately by the interview board of SAIS/ School of Chemical Sciences.** Students finally selected for admission in more than one discipline will have the option to choose to take admission in one of the Schools.

M.S. Degree

Background (bachelor's degree)	MS Degree	Specialization	Subgroup
Chemistry	Applied Chemistry	Polymer Science and Soft Matter	C1
		Biomedical Science	C2
		Green Chemistry	C3
		Natural Products and Indian Ancient Medicine	C4
Biology	Applied Biology	Drug Delivery and Design	B1
Physics	Applied Physics	Polymer Science and Soft Matter	P1
		Sustainability and Energy	P2

In addition to the following courses, mandatory non-CGPA courses (Communicative English, Ethics, Scientific writing, Seminar/ Colloquium etc will be included as per institute rule)

Subgroup C1

Applied Chemistry (Specialization in Polymer Science and Soft Matter)

SEMESTER-1			
Course Name	Course Title	L-T-P	Remarks
CH412	Quantum Mechanics	4-0-0	Existing course in CS
CH413	Inorganic Chemistry: Structure and Reactivity	4-0-0	Existing course in CS
AIS-1	Organic Chemistry: Structure, Dynamics and Reactivity	4-0-0	Course offered by SAIS
CH416	Elementary Chemical Biology	4-0-0	Existing course in CS
AIS-L1	Chemistry/ Physics Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-2			
CH421	Thermodynamics and Statistical Mechanics	4-0-0	Existing course in CS
AIS-2	Organic Chemistry: Reagents and Synthetic Methods	4-0-0	Course offered by SAIS
AIS-3	Polymer Chemistry	4-0-0	Course offered by SAIS
CHS4204	Group Theory and Molecular Spectroscopy (AP)	4-0-0	Existing course in CS
AIS-L2	Chemistry/ Physics Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-3			
AIS-4	Physical Properties of Polymers	4-0-0	Course offered by SAIS
AIS-5	Supramolecular Chemistry and Biology	4-0-0	Course offered by SAIS
Elective-1	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
Elective-2	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
	Project	0-0-12	Course offered by SAIS
SEMESTER-4			
AIS-6	Complex Fluids & Dynamics	4-0-0	Course offered by SAIS
AIS-7	Liquid Crystals & Display	4-0-0	Existing course in CS
Elective-3	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
Elective-4	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
	Project	0-0-12	Course offered by SAIS

Subgroup C2

Applied Chemistry (Specialization in Biomedical Science)

SEMESTER-1			
Course Name	Course Title	L-T-P	Remarks
CH412	Quantum Mechanics	4-0-0	Existing course in CS
CH413	Inorganic Chemistry: Structure and Reactivity	4-0-0	Existing course in CS
AIS-1	Organic Chemistry: Structure, Dynamics and Reactivity	4-0-0	Existing course in CS
CH416	Elementary Chemical Biology	4-0-0	Existing course in CS
AIS-L3	Chemistry/ Biology Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-2			
CH421	Thermodynamics and Statistical Mechanics	4-0-0	Existing course in CS
AIS-2	Organic Chemistry: Reagents and Synthetic Methods	4-0-0	Course offered by SAIS
AIS-3	Polymer Chemistry	4-0-0	Course offered by SAIS
CHS4204	Group Theory and Molecular Spectroscopy (AP)	4-0-0	Existing course in CS
AIS-L4	Chemistry/ Biology Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-3			
AIS-5	Supramolecular Chemistry and Biology	4-0-0	Course offered by SAIS
AIS-8	Drug Design and Delivery	4-0-0	Course offered by SAIS
Elective-1	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
Elective-2	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
	Project	0-0-12	Course offered by SAIS
SEMESTER-4			
AIS-9	Chemistry of Biological Systems	4-0-0	Course offered by SAIS
CH521	Advanced Organic Synthesis	4-0-0	Existing course in CS
Elective-3	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
Elective-4	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
	Project	0-0-12	Course offered by SAIS

Subgroup C3

Applied Chemistry (Specialization in Green Chemistry)

SEMESTER-1			
Course Name	Course Title	L-T-P	Remarks
CH412	Quantum Mechanics	4-0-0	Existing course in CS
CH413	Inorganic Chemistry: Structure and Reactivity	4-0-0	Existing course in CS
AIS-1	Organic Chemistry: Structure, Dynamics and Reactivity	4-0-0	Existing course in CS
CH416	Elementary Chemical Biology	4-0-0	Existing course in CS
AIS-L3	Chemistry/ Biology Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-2			
CH421	Thermodynamics and Statistical Mechanics	4-0-0	Existing course in CS
AIS-2	Organic Chemistry: Reagents and Synthetic Methods	4-0-0	Course offered by SAIS
AIS-3	Polymer Chemistry	4-0-0	Course offered by SAIS
CHS4204	Group Theory and Molecular Spectroscopy (AP)	4-0-0	Existing course in CS
AIS-L4	Chemistry/ Biology Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-3			
AIS-10	Green Chemistry	4-0-0	Course offered by SAIS
AIS-11	Energy & Sustainable Applications-I	4-0-0	Course offered by SAIS
Elective-1	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
Elective-2	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
	Project	0-0-12	Course offered by SAIS
SEMESTER-4			
AIS-12	Applied Green Chemistry & Catalysis	4-0-0	Course offered by SAIS
AIS-13	Environment, Water & Climate Science	4-0-0	Course offered by SAIS
Elective-3	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
Elective-4	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
	Project	0-0-12	Course offered by SAIS

Subgroup C4

Applied Chemistry (Natural Products and Indian Ancient Medicine)

SEMESTER-1			
Course Name	Course Title	L-T-P	Remarks
CH412	Quantum Mechanics	4-0-0	Existing course in CS
CH413	Inorganic Chemistry: Structure and Reactivity	4-0-0	Existing course in CS
AIS-1	Organic Chemistry: Structure, Dynamics and Reactivity	4-0-0	Existing course in CS
CH416	Elementary Chemical Biology	4-0-0	Existing course in CS
AIS-L3	Chemistry/ Biology Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-2			
CH421	Thermodynamics and Statistical Mechanics	4-0-0	Existing course in CS
AIS-2	Organic Chemistry: Reagents and Synthetic Methods	4-0-0	Course offered by SAIS
AIS-3	Polymer Chemistry	4-0-0	Course offered by SAIS
CHS4204	Group Theory and Molecular Spectroscopy (AP)	4-0-0	Existing course in CS
AIS-L4	Chemistry/ Biology Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-3			
AIS-8	Drug Design and Delivery	4-0-0	Course offered by SAIS
AIS-14	History of Medicine in India	4-0-0	Course offered by SAIS
Elective-1	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
Elective-2	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
	Project	0-0-12	Course offered by SAIS
SEMESTER-4			
AIS-9	Chemistry of Biological Systems	4-0-0	Course offered by SAIS
CH521	Advanced Organic Synthesis/Natural Product Synthesis	4-0-0	Existing course in CS
Elective-3	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
Elective-4	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
	Project	0-0-12	Course offered by SAIS

Subgroup P1

Applied Physics (Specialization in Polymer and Soft Matter Physics)

SEMESTER-1			
Course Name	Course Title	L-T-P	Remarks
PH403	Quantum Mechanics-I	4-0-0	Existing course in PS
PH405	Mathematical Methods-I	4-0-0	Existing course in PS
	Classical Mechanics	4-0-0	Existing course in PS
AIS-15	Electronics	3-1-0	Course offered by SAIS
AIS-L1	Physics/Chemistry Interface Laboratory	0-0-4	Course offered by SIAS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-2			
Course Name	Course Title	L-T-P	Remarks
PH408	Statistical mechanics	4-0-0	Existing course in PS
PH402	Electromagnetic Theory	4-0-0	Existing course in PS
AIS-3	Polymer Chemistry	4-0-0	Course offered by SIAS
PH404	Quantum Mechanics-II	4-0-0	Existing course in PS
AIS-L2	Physics/Chemistry Interface Laboratory	0-0-4	Course offered by SIAS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-3			
AIS-4	Physical Properties of Polymers	4-0-0	Course offered by SAIS
AIS-16	Soft Matter Physics	4-0-0	Course offered by SAIS
Elective-1	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
Elective-2	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
	Project	0-0-12	Course offered by SAIS
SEMESTER-4			
AIS-6	Complex Fluids & Dynamics	4-0-0	Course offered by SAIS
AIS-7	Liquid Crystals & Display	4-0-0	Course offered by SAIS
Elective-3	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
Elective-4	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
	Project	0-0-12	Course offered by SAIS

Subgroup P2

Applied Physics (Specialization in Energy, Environment & Sustainability)

SEMESTER-1			
Course Name	Course Title	L-T-P	Remarks
PH403	Quantum Mechanics-I	4-0-0	Existing course in PS
PH405	Mathematical Methods-I	4-0-0	Existing course in PS
	Classical Mechanics	4-0-0	Existing course in PS
AIS-15	Electronics	3-1-0	Course offered by SAIS
AIS-L1	Physics/ Chemistry Interface Laboratory	0-0-4	Course offered by SIAS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-2			
Course Name	Course Title	L-T-P	Remarks
PH408	Statistical mechanics	4-0-0	Existing course in PS
PH402	Electromagnetic Theory	4-0-0	Existing course in PS
CH-426	Spectroscopic Techniques for Structure Elucidation	3-1-0	Existing course in CS
PH404	Quantum Mechanics-II	4-0-0	Existing course in PS
AIS-L2	Physics/ chemistry Laboratory	0-0-4	Course offered by SIAS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-3			
AIS-11	Energy & Sustainable Applications-I	4-0-0	Course offered by SIAS
AIS-17	Energy & Sustainable Applications-II	4-0-0	Course offered by SAIS
Elective-1	Depends on the option	4-0-0	Can be chosen from PS/BS/CS/MS
Elective-2	Depends on the option	4-0-0	Can be chosen from PS/BS/CS/ MS
	Project	0-0-12	Course offered by SIAS
SEMESTER-4			
AIS-6	Complex fluids and Dynamics	4-0-0	Course offered by SIAS
AIS-13	Environment, Water & Climate Science	4-0-0	Course offered by SAIS
Elective-3	Depends on the option	4-0-0	Can be chosen from BS/CS/SIAS
Elective-4	Depends on the option	4-0-0	Can be chosen from BS/CS/SIAS
	Project	0-0-12	Course offered by SIAS

Subgroup B1

Applied Biology (Specialization in Biomedical Science)

SEMESTER-1			
Course Name	Course Title	L-T-P	Remarks
BS40005	Carbohydrates and Lipids: Structure and Function	4-0-0	Existing course in BS
AIS-1	Organic Chemistry: Structure, Dynamics and Reactivity	4-0-0	Existing course in CS
CH416	Elementary Chemical Biology	4-0-0	Existing course in CS
BS41003	Biophys. & Biochem. Methods	3-1-0	Existing course in BS
AIS-L3	Chemistry/ Biology Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-2			
BS41004	Advances in Protein Structure and Function	4-0-0	Existing course in BS
BS40004	Infection and Immunity	4-0-0	Existing course in BS
AIS-3	Polymer Chemistry	4-0-0	Course offered by SAIS
BS40002	Molecular Microbiology	4-0-0	Existing course in BS
AIS-L4	Chemistry/ Biology Interface Laboratory	0-0-4	Course offered by SAIS
	Common Institutional Course on Programming	0-0-2	
SEMESTER-3			
AIS-5	Supramolecular Chemistry and Biology	4-0-0	Course offered by SAIS
AIS-8	Drug Design and Delivery	4-0-0	Course offered by SAIS
Elective-1	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
Elective-2	Depends on the option	4-0-0	Can be chosen from PS/CS/SAIS/MS
	Project	0-0-12	Course offered by SAIS
SEMESTER-4			
AIS-9	Chemistry of Biological Systems	4-0-0	Course offered by SAIS
AIS-13	Environment, Water & Climate Science	4-0-0	Course offered by SAIS
Elective-3	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
Elective-4	Depends on the option	4-0-0	Can be chosen from BS/CS/SAIS
	Project	0-0-12	Course offered by SAIS

Course Content

For course codes starting with CH: See the website of School of Chemical Sciences
For course codes starting with PH: See the website of School of Physical Sciences
For course codes starting with BS: See the website of School of Biological Sciences
For course codes starting with MS: See the website of School of Material Sciences

Courses offered by SAIS

AIS-1: Organic Chemistry: Structure, Dynamics and Reactivity

Conformational analysis of acyclic and cyclic structures, conformational effect on reactivity; Baldwin"s rule and Thorpe ingold effect, Stereoelectronic Effects (Cram's rule, Felkin-Anh Model, Cieplak Model), different aspects of chirality.

Frontier orbitals in organic reactions; orbital symmetry and pericyclic reactions; control of stereochemistry and secondary orbital interactions;

Reactive intermediates; carbenes and nitrenes; introduction of free radical chemistry; SET pathways.

Introduction to reaction mechanism; physical methods of determination of reaction mechanism; kinetic vs thermodynamic control, kinetic isotope effect, Curtin–Hammett principle.

Organic photochemistry; Principles and reactions - photolytic cleavage, photoreduction, photooxidation, photoaddition, photorearrangement.

AIS-2: Organic Chemistry: Reagents and Synthetic Methods

- Reducing agents, Birch reductions, Oxidizing agents
- Protecting group chemistry
- Wittig olefination and Horner-Wadsworth-Emmons Olefination
- The Olefin Metathesis Reaction
- Pd-mediated carbon-carbon bond formation
- Directed ortho-metallation and Grignard reaction
- Selective name reactions (Bamford-Stevens reaction, Eschenmoser Fragmentation, Mitsunobu reaction, Macrocyclization, Stuadinger reaction or ligation, Baldwin's rule for ring closure, Michael reaction, Robinson's annelation, Curtius rearrangement, Iodolactonization or halolactonization, Fischer indole synthesis, Larock's heteroannulation, Dihydroxylation of olefins), Umpolung effect.
- Epoxidation and aziridination reactions
- Use of DCC, HOBt, HOAt, HBTU for peptide synthesis
- Combinatorial chemistry and diversity oriented synthesis (DOS).
- Useful reactions in bioconjugation chemistry

AIS-3: Polymer Chemistry

Introduction to polymers: Natural polymers; synthetic polymers; structures of commonly used polymers; various terms (average molecular weight, number average, weight average, polydispersity index etc.) used in polymers literature.
Classification of polymers based on various parameters: Stereochemistry, structure, crystallization nature etc.
Synthesis of polymers: Step growth polymerization- various polymerization reactions, control of molecular weight (mono-functional impurity, stoichiometric imbalance); Chain polymerization- radical polymerization, mechanism, kinetics, reactivity ratios, various ring-opening polymerization, chain transfer polymerization, ionic polymerization, coordination polymerization; Introduction to controlled ("living") polymerization- ATRP, RAFT, NMP, GTP; Emulsion polymerization, precipitation polymerization, copolymerization,
Branched polymers: Hyperbranched polymers, star polymers, dendrimers.
Basic Polymer Characterization: Thermal analysis (glass transition temperature, crystalline melting temperature); Introduction to Mechanical properties (Elastomers, fibres, thermoplastics etc.); Determination of molecular weight (end group analysis, GPC, viscosity, VPO).
Supramolecular Polymer: Concept, examples, characterization tools.
Bioplastics: Examples, synthesis, implications

AIS-4: Physical Properties of Polymers

Solids State Properties: Morphological, Structural properties, thermal behaviours, Glass Transition behaviors, Degradation behaviors, Structure-property relationship, solid state packing, Macromolecular Crystals, Growth and Kinetics.
Solution Properties : Viscosity, Osmometry, Light Scattering behaviors and Zimm's plot, Flory-Huggin's theory, Enthalpy and Entropy of mixing, Polymer-solvent interaction
Mechanical Properties: Stress-strain (static and dynamic), modulous, Maxwell's model, Voigt Model
Rheological Properties: Basic terms and Definitions, Modulous (storage or loss), Types of fluid and typical behavious, Rheological models and mechanics.
Electrical Properties : Electrical transport and conduction behaviors. Mott's model.

AIS-5: Supramolecular Chemistry and Biology

Surfactants: Classification, aggregation, characterization, packing parameters and morphologies, thermodynamics
Engineered amphiphiles: Peptide amphiphiles, supra-amphiphiles, π-amphiphiles
Gels: Supramolecular Gel/ Cross-linked gels- Formation, physical properties & application
Amphiphilic polymers: Amphiphilic linear lock copolymers/ hyperbranched polymers/ dendrimers- aggregations, structural variation, techniques, stimuli-responsive

amphiphilic polymer aggregates, multi-valent binding and implication

Biomedical applications of amphiphiles: Drug delivery, Gene delivery, protein delivery, cellular uptake, targeting, antibacterial material

Polymer bio-conjugates: Polymer-protein, polymer-DNA, polymer-peptide, polymer-drug conjugates and other conjugates and relevance in biological application

AIS-6: Complex Fluids & Dynamics

Surface and colloid systems, Thermodynamics of interface. Surface tension, Monolayer formation. LB layer. Self-assembled monolayer, Wetting. Contact angle, Surface free energy, Adsorption, Surface active agent: Surfactant in solution, Surface active agent: Application of surfactant, Dispersion systems: Sedimentation. Rheology, Electrokinetics phenomena: The electro double layer, Zetapotential-Double layer interaction (DLVO theory), Adsorption of polymer. Stability and flocculation of colloids using polymer, Synthesis for colloidal systems, The supplementary lecture: Solution chemistry, Electrical chemistry

AIS-7: Liquid Crystals & Display

Structure and classification of mesophases, Thermotropic and lyotropic liquid crystals; Different molecular order-nematic, smectic and cholesteric phases; Recent interests in liquid crystals; X-ray analysis of unoriented and oriented liquid crystals; Measurement of nematic order parameter by NMR; Polymer liquid crystals. Molecular theory of nematic liquid crystals, Molecular theory of smectic A liquid crystals Symmetry, structure and order parameter; Phase diagram of homologous series, McMillan's theory. Elastic continuum theory of liquid crystals, General expression of free energy of a deformed nematic liquid crystal; Franck's elastic constants; Distortion due to external electric or magnetic field; Freederickz's transition; The twisted nematic cell. 5. Numerical methods for studying liquid crystal phase transitions, Monte-Carlo simulation; Lebhwol-Lasher simulation of N-I transition; Gey-Berne potential. 6. Landau's theory of phase transition, Generalization of Landau's theory to liquid crystals; Fourth order and sixth order Landau expansion for studying N-I transition; de Gennes' Generalization to smectic phase; Critical fluctuation; Liquid crystal displays-Optical properties of on ideal helix, agents influencing the pitch; Basic principle of liquid crystal displays; Advantages of liquid crystal displays; Twisted nematic crystal and cholesteric liquid crystal displays; Discotic liquid crystals, Lyotropic liquid crystals

AIS-8: Drug Design and Delivery

Principle of Drug Design: Process of drug discovery and development from the identification of novel drug targets to the introduction of new drugs into clinical practice; lead identification, lead optimization, classification and kinetics of molecules

targeting enzymes and receptors, prodrug design and applications, as well as structure-based drug design methods. Recent advances in the use of computational and combinatorial chemistry in drug design. Overview of approaches for both ligand and target discovery such as similarity searching, pharmacophore modelling, QSAR, structure-based drug design (docking and scoring), virtual screening, ADMET property prediction, as well as relevant elements of bioinformatics (DNA and protein sequence) and structure analysis

Drug Delivery: Drug delivery systems and pharmaceutical dosage forms; Solubility, Drug diffusion and dissolution, pH and drug action, Stability, Biopharmaceutics and bioavailability, Commonly used pharmaceutical excipients, Pulmonary drug delivery, Tablets and capsules, Ocular, nasal and otic drug delivery, Rectal, vaginal and urethral delivery, Pharmaceutical suspensions and emulsions, Topical and transdermal drug delivery, pharmacokinetics, Controlled release, Liposome in targeted delivery, Vaccines.

AIS-9: Chemistry of Biological Systems

Biochemistry: A general overview on agricultural, biological, chemical, and nutritional sciences. Metabolism of carbohydrates, amino acids, nucleotides and lipids; formation, turnover, and molecular relationships among DNA, RNA, and proteins; Structure of nucleic acids; Base pairing in DNA – The Watson-Crick model; Nucleic acid and heredity; Replication of DNA; Structure and synthesis of RNA – Transcription; RNA and protein biosynthesis – translation; DNA sequencing; DNA synthesis; polymerase chain reaction.

AIS-10: Green Chemistry

Green Chemistry: Definition of green chemistry, need of green chemistry and eco-efficiency, Environmental protection laws, challenges and green chemistry education, pollution control and pollution prevention-Principle of green chemistry:

Green Solvents: Aqueous phase reactions: Mechanism and application of Baeyer-Villiger Oxidation, Claisen rearrangement, Claisen-Schmidt reaction, Diels-Alder reaction, Heck reaction, Knoevenagel condensation, Michael addition, Mukaiyama Reaction and Wurtz reaction. Ionic liquids: Properties of ionic liquids and applications in organic synthesis (illustrate with three examples such like DielsAlder reaction, Heck reaction, Knoevenagel condensation, Michael addition, Witting reaction.

Non-conventional energy sources: Microwave Solvent free reaction: Solid state reactions-Deacetylation, deprotection, Saponification of esters, alkylation of reactive methylene compounds, synthesis of nitriles from aldehydes, reductions. Microwave assisted reactions in water-Hoffmann elimination, hydrolysis, oxidation, saponification reactions. Microwave assisted reactions in organic solvents-Esterification reactions,

Fries rearrangement, Orthoester rearrangement, Diels-Alder reaction, decarboxylation. Microwave assisted reactions under PTC conditions: Ultrasound assisted reaction: Introduction, substitution reactions, addition, oxidation and reduction reactions. Photochemical reactions using sunlight: Benzopionacol, conversion of trans azobenzene to cis azobenzene and conversion of trans stilbene to cis stilbene.
Designing Green Synthesis: choice of starting materials, choice of reagents, choice of catalystsbiocatalysts, polymer supported catalysts, choice of solvents. Synthesis involving basic principles of green chemistry – Examples - Synthesis of ibuprofen, adipic acid, methyl methacrylate and paracetamol.

AIS-11: Energy & Sustainable Applications-I

Energy Fundamentals. Energy usage. Overview of energy resources Fossil fuel: oil, gas, coal, nuclear (fission, fusion). Industrialised country energy usage. Energy use in First world and third world countries-a comparison.
Renewables: wind, wave, tidal, solar, biomass, geothermal and hydropower. Environmental and financial aspects of traditional technologies.
Autonomous systems, energy requirements and power sources. Harvesting of energies viasolar, heat, vibration, magnetic, wind, wave, geothermal energy, biomass and tidal power. Relevant materials and technological considerations.
Energy conversion and storage, including microbatteries and supercapacitors: physics & applications.
Role of nanotechnology in energy technologies. Strategies and technologies that improve energy efficiency, conserve or otherwise reduce the environmental impact.
Overview of the latest trends in energy research: discussion on the technologies paving pathways for an energy efficient sustainable future. Industries involved & technologies explored & exploited currently.

AIS-12: Applied Green Chemistry & Catalysis

Green Catalysis: Fundamentals of catalysis; Correlation between surface structure, catalytic properties, and choice of materials and preparation methods to produce industrial catalysts; Methods to characterise chemical and physical properties of heterogeneous catalysts; mechanisms for deactivation of industrial catalysts; methods to avoid catalyst deactivation. Metal free catalysis, catalysis in water, new developments in green synthesis and catalytic methods. Heterogeneous catalysis: use of zeolites, silica, alumina, clay, polymers, cyclodextrin and supported catalysts. Biocatalysis: enzymes, microbes etc Phase-transfer catalysis: micellar/surfactant etc.

AIS-13: Environment, Water & Climate Science

The course combines aspects of physics, geology, climatology, hydrology, and

environmental economics to present a coherent knowledge to the guiding elements of Earth's natural processes and human role in preserving our planet, with emphasis on both fundamental concepts and practical facts &applications, as a basis for understanding and intelligent management of the Earth's physical and chemical environment.

Understanding of Solid Structure of earth, Topography & Maps, Heating and Cooling cycles of earth, Minerals and Rocks, Mineral resources of India and the world, their use and limitations. High pressure and temperature rock properties, origin of earthquakes, rock mechanics& physics; seismic studies of the continental lithosphere, remote sensing data & science. Physics and chemistry of the Earth's atmosphere. Green house and Global warming. Earth's surface: Production of Soils and soil erosion; precipitation; streams and lakes; glaciers and their deposits. Earth's resource conservation steps.

Hydrosphere -lithosphere interaction: The structure of water at an interface. The fresh water chemistry, the physics of groundwater movement. The ocean water cycle. Chemical deposits underneath ocean. Water Pollution/Monitoring. Waste-water Treatment. Drinking water and sanitation. Risks in drinking water such as arsenic, pesticides and pathogenic micro-organisms and new risks such as pharmaceuticals, nanoparticles, anti-biotic resistance and emerging pathogens.

Climate studies, Earth's time scales, and climate in human history. Physical and chemical processes in climate, including primordial atmosphere, ozone chemistry, carbon and oxygen cycles, internal feedback mechanisms, including ice, aerosols, water vapour, clouds, and ocean circulation. climate forcing, including orbital variations, volcanism, plate tectonics, and solar variability. climate models and mechanisms of variability.

Environment and Climate management: physical, chemical and biological processes and parameters that define environmental quality. Issues of poverty and environment, deforestation and construction in rural and urban scenario, human health and environment. Green taxes, carbon trading mechanisms, environmental valuation and incentive design for sustainable management.

AIS-14: History of Medicine in India

Prehistoric Medicine, Indian Medicine- eight divisions of Ayurved: Kayachikitsa (Internal Medicine), Salakya Tantra (Surgery of Head & neck,Ophthalmology and Otolaryngology), Shalya Tantra (Surgery), Agada Tantra (Toxicology), Bhuta Vidya (Psychiatry), Kaumarabhrity (Pediatric), Rasayana (Anti-aging or Gerontology or Science of Rejuvenation) and Vajkarana (The Science of Fertility): Specific role of natural products in these medicines, Ancient history of Pathology in India-Nidanasthanam and role of natural products, Ayurveda – the ancient science of life,

Herbal drug development: issues and regulations, role of ayunveda in modern drug development.

AIS-15: Electronics

Circuit theory: lumped circuit approximation, circuit elements, Kirchoff's current and voltage laws, resistive networks, node and loop analysis, Thevenin and Norton's theorem, time domain response of RL, RC and RLC circuits, frequency domain response, impedance, filters and transfer function.

Analog electronics: discrete devices, characteristics and operation - diode, Zener diode, LED, photodiode. Simple diode circuits. Bipolar junction transistor (BJT): biasing, h parameters, small and large signal response, amplifiers. Field effect transistors. Operational amplifiers - device properties, integrator, differentiator, RC active filter, negative and positive feedback, oscillators.

Digital electronics: logic gates, truth table, multiplexer, combinatorial circuits, flip-flop, counters, programmable logic devices, microprocessors.

Physics of Semiconductor devices: Metal semiconductor junctions: Schottky barriers; Rectifying contacts; Ohmic contacts; Typical Schottky Barriers, Miscellaneous semiconductor devices: Tunnel diode; Photodiode; Solar cell; LED; LDR; p-n-p-n switch, SCR; Unijunction transistor (UJT); Programmable Unijunction transistor (PUT), Solid state detectors (Si and HPGe).

AIS 16: Soft Matter Physics

Introduction; hard vs. soft solids; polymerization; Chains; thermodynamics of polymer solutions; Thermodynamics (cont.): Mean field; Flory Huggins and lattice theory; entropy and enthalpy of mixing; phase diagrams; Polymer blends; viscosity; osmometry; Osmometry (cont.); SEC (size exclusion chromatography) and GPC (gel permeation chromatography); Scattering; Zimm plots; Glass transition temperature Tg, Diffusion of polymers; reptation; elasticity, Gels; Flory-Rehner theory, Intermaterial dividing surface (IMDS); polymer-based photonics; Photonic crystals; Influence of chain architecture on microdomain characteristics; Block copolymer-homopolymer blends; Hierarchically ordered BCP-nanoparticle composites; Top down meets bottom up; Chain folding; polyethylene and nylon; spherulites; Mechanical properties; Conducting polymers; optical interactions

AIS-17: Energy & Sustainable Applications-II

Solar Energy and Materials: Introduction to photovoltaic (PV) systems: Historical development of PV systems. Overview of PV usage in the world. Solar radiation and spectrum of sun. Geometric and Atmospheric effects on sunlight, Calculation of solar

irradiance at surfaces.

Solar cells, basic structure and characteristics: Fundamentals, First-Generation Solar Cells, Second-Generation Solar Cells, Third-Generation Solar Cells and emerging new technologies.

Organic Photovoltaics: Working Principles, Differences between Conventional and Organic Solar Cells, Materials design principles, Advantages and Challenges of Organic Photovoltaics.

Dye-Sensitized Solar Cells: Working Principles, Electrodes Sensitizers, Electrolytes.

Solar concentrators: Properties of optical concentration systems, Overview of the different components in a solar concentrator and their functions. Solar cells in concentrated sunlight. Examples of solar concentrators globally.

Fuel cells and Materials: Fuel cell definition, historical developments, working principle of fuel cell, components of fuel cell, EMF of the cell and general performance characteristics, Potential convention, current conventions, equilibrium constants, mass transfer limited current, cottrellequation, factors affecting reaction rate and current, mechanism involving electrode reactions, reversibility kinetics, Butler-Volmer Equations, Tafel plots , Tafel equation, equations governing modes of mass transfer – Nernst-Planck Equation, Ficks law of diffusion, concept of Helmholtz plane.

Types of fuel cells and Principles: Hydrogen fuel cell, Proton Exchange Membrane Fuel Cell, Solid Oxide Fuel Cells, Advantages and disadvantages of fuel cells.

Laboratory Courses

AIS-L1: Physics/ Chemistry Interface Laboratory

- Contact angle measurement experiment
- Thermodynamics and Kinetics of Phase Transformations Experiment
- Preparation Polymer/nanomaterials based photonic crystals
- Fabrication of Sensors
- Soil & Water analysis to examine micronutrients and foreign elements-risk assessment
- Acylation of 6-aminopenicillanic acid and studying its antibacterial properties
- Determination of Critical Micelle Concentration (CMC) of a surfactant using a fluorescent probe
- Synthesis of a hydrogel and its rheological studies

AIS-L2: Physics/ Chemistry Interface Laboratory

- Synthesis and characterization of a polymer
- Determination of Lower Critical Solution Temperature of (LCST)of a polymer by

absorption spectroscopy

- Electrochemical synthesis of a conducting polymer
- Determination of Association constant of a known aromatic charge-transfer complex by absorption spectroscopy
- Thermoelectric Power Factor Measurement
- Dye Sensitized Solar Cell Preparation and Measurement
- Fabrication of Liquid crystal single pixel display
- Light Emitting Diodes

AIS-L3: Chemistry/ Biology Interface Laboratory

- Soil & Water analysis to examine micronutrients and foreign elements-risk assessment
- Acylation of 6-aminopenicillanic acid and studying its antibacterial properties
- Determination of Critical Micelle Concentration (CMC) of a surfactant using a fluorescent probe
- Synthesis of a hydrogels and their rheological studies
- Demonstration of computer-aided drug discovery tools
- Synthesis of particular drug molecule like Amphetamine
- Evaluation of interaction between a protein and a drug
- Enzyme Kinetics and Inhibition

AIS-L4: Chemistry/ Biology Interface Laboratory

- Synthesis and characterization of a polymer
- Determination of Lower Critical Solution Temperature of (LCST)of a polymer by absorption spectroscopy
- Electrochemical synthesis of a conducting polymer
- Determination of Association constant of a known aromatic charge-transfer complex by absorption spectroscopy
- Culture of bacteria and determination of IC_{50} value of a particular drug like levofloxacin
- Transformation of E. coli using GFP plasmid
- Isolation of plasmid DNA from transformed colonies
- Agarose gel electrophoresis of isolated plasmid and DNA quantization / purity of DNA