BSc. Physical Sciences II Year (Semester - III)

SEC Options (2021-2022)

S. No.	Department	Paper Name
1	Chemistry	IT Skills for Chemists
2	Mathematics	Computer Algebra Systems
3	Physics	Electrical Circuits and Network Skills

Course Descriptions

Chemistry SEC : IT Skills for Chemists

This Course is primarily mathematical in nature.

The learning outcomes for this course can be broadly divided into two categories

(i)   Knowledge-Based Learning Outcomes
(ii)   Skill-based Learning Outcomes

Knowledge- Based Learning Outcomes

On completion of the course the students will be able to

- Identify various types of mathematical functions, plot their graph and do curve-fitting.
- Identify and measure uncertainties.
- Use of some common numerical approximation methods and their specific applications in Chemistry e.g. Newton-Raphson Method, Binary Bisection method, Trapezoidal Method and Simpson Method.

Skill based Learning Outcomes

- Programming in one of the simplest programming language: BASIC
- Able to write programs for curve-fitting, numerical differentiation and integration.
- Use of MS-Word incorporating chemical structures, chemical and mathematical equations in the documents
- Use of MS-Excel including numerical modelling
- Analyze statistical data and testing significance of data ☐ Use of ChemSketch (structure drawing tool) ☐ Use of MS-PowerPoint.

The Course adds much value to the routine courses being taught to the students who pursue Chemistry as it gives the students a fair understanding of importance of data and how to analyse data including its manipulation and assessment. Doing Chemistry laboratory with knowledge about sources of error and uncertainties, together with their management makes the laboratory exercise more significant. The Course will empower students intending to pursue Masters in Chemistry, or pursue research in any discipline. Through the Course students learn how to handle and analyse data, incorporate data tables, equations and structure into word documents and make a presentation thereby equipping the students with the essentials of the three most important components of MS-Office which are required in almost every field of work these days.

Mathematics SEC : Computer Algebra Systems

A Computer Algebra system is a type of software package that is used in manipulation of mathematical formulae. The primary goal of a Computer Algebra system is to automate tedious and sometimes difficult algebraic manipulation tasks. The principal difference between a Computer Algebra system and a traditional calculator is the ability to deal with equations symbolically rather than numerically. The specific uses and capabilities of these systems vary greatly from one system to another, yet the purpose remains the same: manipulation of symbolic equations. Computer Algebra

systems often include facilities for graphing equations and provide a programming language for the user to define his/her own procedures.

Computer Algebra systems have not only changed how mathematics is taught at many universities, but have provided a flexible tool for mathematicians worldwide. Examples of popular systems include Maple, Mathematica, and MathCAD. Thus with this technology, one needs less time for the tradition skills and can focus on problem solving skills, which allows both the instructor and students to focus on the formulation and interpretation phases of the mathematical modelling process.

Physics SEC – Electrical Circuits and Network Skills

The Objective of this Course is to develop an understanding of the basic principles of electricity and its household applications. Apart from imparting basic knowledge of solid-state devices and their applications, the course will also focus on a practical approach to electrical wiring and installation. The learning outcome of this course will be that at the end of this course, students will be able to demonstrate good comprehension of basic principles of electricity including ideas about voltage, current, resistance, power in DC and AC circuits. The students will also acquire proficiency in analyzing and evaluating schematics of power-efficient electrical circuits while understanding the detailed working of consumer devices like generators, transformers, and electric motors. Special emphasis will be given to training the students regarding every safety aspect of electrical protection so that students can understand and implement safety devices like Relays, Fuses, Circuit Breakers, Ground fault protection, Surge protection in real-life use.

BSc. Physical Sciences III Year (Semester- V)

SEC Options (2020-2021)

S. No.	Department	Paper Name
1	Chemistry	Fuel Chemistry
2	Mathematics	Transportation and Network Flow Problems

3	Physics	Renewable Energy and Energy Harvesting

Chemistry SEC : Fuel Chemistry

FUEL CHEMISTRY (Credits: 02) (Hands on Exercises: 60 Lectures)

A fuel is any compound that has stored energy. This energy is captured in chemical bonds through processes such as photosynthesis and respiration. Energy is released during oxidation. The most common form of oxidation is the direct reaction of a fuel with oxygen through combustion. Wood, gasoline, coal , and any number of other fuels have energyrich chemical bonds created using the energy from the Sun , which is released when the fuel is burned (i.e., the release of chemical energy). Chemical fuels or the fossil fuels are useful reserve of fuels and are therefore used extensively to satisfy the demands of an energy-dependent civilization.

Unit :1 Review of energy sources (renewable and nonrenewable). Classification of fuels and their calorific value.

Unit:2 Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas— composition and uses.
Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Fossil fuels can be separated into three categories. The first most prominent and naturally most abundant fossil fuel is coal. Coal also originates from decayed vegetative material buried years ago, but the process is slightly different, being less oxidizing. The resulting material still has some of the original lignin-like structure exhibiting many fused rings and a large fraction of aromatic compounds. Consequently, coal is more of a polymeric substance than petroleum and is found as a solid not a liquid. The carbon to hydrogen ratio in coal is close to 1:1 (depending upon the type of coal), whereas the carbon to hydrogen ratio in petroleum is closer to the 1:2 value expected for a hydrocarbon chain.

Unit:3   Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and nonpetroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

 The second is petroleum or oil. This is a mixture of light, simple hydrocarbons dominated by the fractions with 6 to 12 carbons but also containing some light hydrocarbons (e.g., methane and ethane). Fully half of the energy consumed in the States are from petroleum used to produce fuels for automobiles, recreational vehicles, home heating, or industrial production.

The principal use of petroleum is the production of gasoline. Over 40% all of all production ends up consumed in automobiles and such. Smaller fractions are turned into fuel oil (27%), jet fuel (7.4%), and other miscellaneous fuels, while the small fraction (about 10%) is used for the synthesis of the thousands of petrochemicals used in our daily lives. Indeed, many food compounds and pharmaceuticals owe their synthesis to a petrochemical precursor.

The third major fossil fuel is natural gas . This is a generic term for the light hydrocarbon fractions found associated with most oil deposits. Natural gas is mostly methane with small quantities of ethane and other gases mixed in. It is hydrogen rich, since methane has a carbon to hydrogen ratio of 1:4. It is also an excellent fuel, burning with a high heat output and little in the way of unwanted pollution. It does produce carbon dioxide , which is a greenhouse gas, but all organic compounds also generate carbon dioxide on combustion. Natural gas is also easy to transport through pressurized pipelines

Unit:4 Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting)Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Scope Of Fuel Chemistry

Application of Fuel chemistry to enable humanity experience in the area such as Green Environment, sustainable development, Biofuels, petroleum products etc

Mathematics SEC : Transportation and Network Flow Problems

Many Operation research Problems can be viewed as a problem of minimizing the "transportation" cost of moving materials through a network to meet demands for material at various locations given sources of material at other locations. Such problems are called network flow problems. This course aims at providing applications of linear programming to solve real-life problems such as transportation problem, assignment problem, shortest-path problem, minimum spanning tree problem, maximum flow problem and minimum cost flow problem. This course will enable the students to solve: Transportation, Assignment and Traveling salesperson problems, Network models and various network flow problems. The syllabus contain: Transportation problem and its mathematical formulation, Northwest-corner method, Least cost method and Vogel approximation method for determination of starting basic feasible solution, Algorithm for solving transportation problem, Assignment and Traveling Salesperson Problems, Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem, Traveling salesperson problem, Network models, Minimum spanning tree algorithm, Shortest-route problem, Maximum flow model, Project network representation, CPM and PERT. Transportation, electric, and communication networks provide obvious examples of application areas.

Physics SEC : Renewable Energy and Energy Harvesting

The paper begins with an introduction to the conventional energy resource (the non-renewable energy resources). Amongst them the leading resources - Fossil fuels and nuclear energy - the dwindling resources and the massive environmental damage that is caused from the techniques used to retrieve them, is explained. Hence the need for alternative energy resources (the Renewable resources), clearly bringing out the important differences between the two types- Renewable and Non-Renewable.

The paper covers all the Renewable energy resources. Solar energy – its importance and the various applications of solar energy are covered in detail. Wind turbines and their different machines, Tidal Energy technologies, Ocean Thermal energy, Geothermal resources and technologies, Hydropower resources and technologies, the environmental impact of Hydropower sources are covered.

Next, the physics and characteristics of Piezoelectric effect, materials and mathematical description of piezoelectricity are covered. The Piezoelectric and Electromagnetic Energy Harvesting techniques and their recent applications are also covered. In the end, brief introduction to carbon captured technologies, sustainability and environmental issues and renewable sources are summarised.

BSc. Physical Sciences III Year (Semester-V)

DSE Options

S. No.	Department	DSE Code	Paper Name
1	Mathematics	DSE 1 (*)	Differential equations
2	Mathematics	DSE 2 (*)	Mechanics & Discrete Mathematics
3	Chemistry	DSE	Chemistry of d-Block elements, Quantum Chemistry & Spectroscopy
4	Physics	DSE	Elements of Modern Physics
4	Physics	DSE	Electronics Instrumentation (Electronics Group)

(*) Students must opt for any one of the two papers offered

Course Descriptions

Mathematics DSE-1 : Differential Equations

Differential equations have a remarkable ability to predict the world around us. They are used in a wide variety of disciplines, from biology, economics, physics, chemistry and engineering. They can describe exponential growth and decay, the population growth of species or the change in investment return over time. Differential equation modelling has given us tool to predict the future and analyze the past but it is only possible due to computer revolution. A large part of today's supercomputing powers is used to do modelling of differential equations and help

us understand and predict the behavior of Nature. In this course, we will learn many aspects of ordinary as well as partial differential equations and their real life applications.

Mathematics DSE-2 : Mechanics and Discrete Mathematics

Mechanics: This course deals with the modeling and analysis of static equilibrium problems with an emphasis on real world engineering systems and problem solving. Discrete Mathematics forms the basis of many realworld scientific fields-- especially computer science. The primary techniques learned in a discrete math course can be applied to many different fields. For example: Discrete math in Cryptography, in database, in logistics, in computer algorithm. In this paper, we study Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve), Simple graph, Directed graph, Multi graph, and Pseudo graph etc.

Chemistry DSE : Chemistry of d-Block elements, Quantum Chemistry & Spectroscopy

This paper on Chemistry of d-Block elements, Quantum Chemistry & Spectroscopy covers the most important realms of inorganic and physical chemistry. The aim of this paper is to kindle the curiosity and interest of the students in the field of inorganic chemistry and spectroscopic studies and help them to understand the intricacies of the subject.

The study of Transition metals and their complexes with variety of ligand systems have played an important role in the field of inorganic chemistry due to their extensive and attractive physicochemical properties. The inorganic part of this paper deals with the study of transition elements, lanthanides and actinides. The various properties of coordination compounds will be explained using the valence bond theory and crystal field theory. The physical part of the paper deals with quantum chemistry, spectroscopy and photochemistry and their importance in chemistry. The student will understand the link between spectroscopy and quantum chemistry. Theoretical treatment of rotational, vibrational and electronic spectroscopy will be covered in this paper.

Physics DSE - Elements of Modern Physics

Physics DSE : Electronics Instrumentation (Electronics)