Level III Course Units
Offered by
The Department of Chemistry
For
General Degree
[Bachelor of Science – SLQF5]
Course Code and Title:
CH 3001 - Topics in Analytical Chemistry I
Credit Value:
2C
Rationale:
This course is designed to provide advanced knowledge in separational methods and electroanalytical techniques.
Pre-requisites:
First year and second year chemistry core courses
Intended Learning Outcomes:
Upon completion of this course students should be able to:
• explain the processes involve in chemical separations and electro analytical techniques.
• apply the underlying principles in qualitative and quantitative analysis.
• familiarize with the analytical equipment and their usage.
Course Content:
Separational Methods: Ion Exchange: Kinetics, Donan Equilibrium, Affinity; Solvent Extraction: Distribution coefficient and distribution ratio, Extraction strategies, Chelating agents for the extraction, Masking; Chromatography: Elution chromatography, Selection of the mobile and stationary phases, Separation mechanisms, Sorption Isotherms, Retention time, Distribution coefficient, Capacity Factor, Selectivity, Efficiency, Resolution, Temperature (solvent strength) programming, Band broadening process, van deemter Equation for GC, H vs u curves for GC and LC, Chromatographic methods for qualitative and quantitative analysis, Instrumentation, GC and HPLC trouble shooting, Size-exclusion chromatography, Supercritical fluids and its applications, Supercritical fluid extraction and Supercritical fluid chromatography. Electroanalytical Techniques: Electrophoresis, Applications Electro analytical methods; Coulometry, coulometric titration, electrogravimetry, polarography: dc-, ac-, pulse, differential pulse, stripping voltammetry, amperometry, potentiometry, ion and molecular selective electrodes, carbon paste electrodes potentiometric titration, conductometry, conductometric titration.
Method/s of Evaluation:
End of semester examination
Recommended Readings:

Course Code and Title:
CH 3002 - Practical Analytical Chemistry I
Credit Value:
1C
Rationale:
This course is designed to provide advanced training in experimentation, use of instruments, data collection, analysis and presentation.

**Pre-requisites:**
Level I and Level II chemistry core courses

**Intended Learning Outcomes:**
Upon completion of this course students should be able to:
- apply advanced instrumental techniques for chemical analysis.
- investigate and solve research based problems using scientific methods.
- effectively communicate any findings and defend the work in a professional manner.

**Course Content:**
Practical conducted in the relevant areas to develop research techniques and advanced analytical techniques.

**Method/s of Evaluation:**
End of the semester examination

**Recommended Readings:**
Handouts issued in the laboratory.

**Course Code and Title:**
CH 3003 - Industrial Chemistry

**Credit Value:**
2C

**Rationale:**
This course is designed to provide knowledge in the use of chemical principles in industry.

**Pre-requisites:**
CH 1006

**Intended Learning Outcomes:**
Upon completion of this course students should be able to:
- interpret the TGA graph and determine the component constituents.
- explain the cement manufacture process.
- analyse the given situation and identify the best type of cement for a given set of conditions based on the cement constituent properties.
- differentiate between homogeneous and heterogenous catalyst.
- explain the application of catalyst in the industry.
- identify types of polymerization reactions and mechanisms.
- interpret polymer properties.
- identify structure – end use relationship.
- device polymers for particular end use.
- explain the distribution of POPs in the environments on the basis of their physico-chemical properties.
- explain the mechanism of action of POPs.

**Course Content:**
Thermal analysis Introduction to Thermal analysis, Thermogravimetric analysis (TGA) – Introduction, instrumentation, interpretation of thermogram, Industrial application of TGA Manufacture of Portland cement, properties of different constituents of cement on setting and
hardening, types of cement, weathering of cement, Catalytic terminology, classification of catalyst, differentiate between homogenous and heterogeneous catalysis, application of homogenous and heterogeneous catalysis in industry, Introduction to polymer chemistry, vinyl polymers; mechanism of addition polymerization and introduction of terms and concepts, polymerization of diene monomers, condensation polymerization; polyesters, polyamides, polycarbonates, ladder polymers, formaldehyde resins, ring opening polymerization; polycaprolactam, epoxy resins, poly propylene oxide, cationic polymerization, anionic polymerization, coordination polymerization, bonding and polymer structure, chemical bond and intermolecular forces, configuration, tacticity, crystalline and amorphous structure of polymers, polymer properties, glass transition temperature and crystalline melting point, factors affecting $T_g$ and $T_m$, copolymerization and polymer modification, molecular weight, polymer applications, Persistent Organic Pollutants (POPs), namely PCDDs / PCDFs; PCBs, PAHs, PBDEs, Organochlorine pesticides: What they are, why they are important, how their physico-chemical properties ($K_{ow}$, $K_{oa}$, $W_s$, $K_{oc}$, VP, H, Environmental persistence) govern their environmental fate and behavior, mechanism of action, toxic effects. Source inventories. Environment budgets.

**Method/s of Evaluation:**
End of semester examination

**Recommended Readings:**

**Course Code and Title:**
CH 3004- Laboratory Management

**Credit Value:**
1C

**Rationale:**
This course is designed to provide knowledge on good laboratory practices and the process of documentation.

**Pre-requisites:**
None

**Intended Learning Outcomes:**
Upon completion of this course students should be able to:
- demonstrate and apply the principles, theories, and regulations related to laboratory management.
- demonstrate the ability to use appropriate tools to solve issues related to safety and efficiency of laboratory.

**Course Content:**

**Method/s of Evaluation:**
End of semester examination

**Recommended Readings:**
(i) Successful Management of the Analytical Laboratory (O. I. Milner) (ii) Occupational Safety and Health Administration - https://www.osha.gov/

**Course Code and Title:**
CH 3005- Chemical Technology

**Credit Value:**
2C

**Rationale:**
This course is designed to provide an advanced knowledge on processes involved in chemical industries.

**Pre-requisites:**
CH 3003

**Intended Learning Outcomes:**
Upon completion of this course students should be able to:

- interpret E-pH diagrams and identify corrosion control methods using the diagrams.
- analyse the mixed potential theory diagrams and predict the effects of pH, cathodic reaction, reducible species, solution velocity, inhibitors.
- explain types of corrosion and types of corrosion prevention.
- explain why additives are needed for the stability of polymers and in applications.
- differentiate between polymerization methods and their applications.
- selection of reactors for different applications.

**Course Content:**
Introduction to corrosion, E-pH (Pourbaix) diagram of metals – Fe, Au, Cu, Zn, Al; Strategies for corrosion control from E-pH diagrams; Limitations of using E-pH diagrams on corrosion control Kinetics of corrosion; Tafel plots of different metals; Polarization – activation, concentration, ohmic polarization, Application of mixed potential theory diagrams – effect of pH, increasing rates of the cathodic reaction, increasing concentration of the reducible species, increasing solution velocity, effect of inhibitors on corrosion of active metals and active-passive metals.

Types of corrosion: Corrosion due to differential aeration, crevice, galvanic, pitting, stress cracking, Corrosion prevention by cathodic protection, anodic protection, inhibitors, sacrificial anode, protective coating. Polymer stability; Polymer additives: plasticizers, antioxidants, thermal and UV stabilizers, flame retardants; Polymerization methods: bulk, solution, suspension and emulsion polymerization; Polymerization reactors: batch and continuous stirred reactors; Unit operations: extrusion, injection molding, blow molding; Applications:
Introduction, Recent history of chemical industries, Introduction to chemical technology and chemical industries, Background and technical aspects, The economy of scale $M = M_0(Q/Q_0)^n$, $C = C_0(Q/Q_0)^n$, Chemical processing, unit operations, unit process, thermal and mechanical unit operations, Type of reactors, batch, semi-batch, CSTR, multistage CSTR, tubular flow, Conversion and yield, Academic yield, industrial yield, % conversion, Catalysts Homogeneous, heterogeneous and biocatalysts, Production and characterization of catalysts, Deactivation of catalysts, Environmental aspects of chemical technology, pollution, water treatment and waste water management, Green chemistry, Examples of industrial processes.

**Method/s of Evaluation:**
End of semester examination

**Recommended Readings:**
(i) Corrosion understanding the basics (J. R. Davis) (ii) Fundamentals of electrochemical corrosion (E.E. Stansbury, R.A. Buchanan) (iii) Polymer Science and Technology (Robert O. Ebewele).

**Course Code and Title:**
CH 3007 – Topics in Analytical Chemistry II

**Credit Value:**
1C

**Rationale:**
This course is designed to provide in depth knowledge in analytical methods and method validation.

**Pre-requisites:**
CH 2008, CH 3001 recommended

**Intended Learning Outcomes:**
Upon completion of this course students should be able to:
- demonstrate and understand the basics principles, theories, and calculation related to analytical chemistry.
- demonstrate the ability to use appropriate tools and techniques to develop new analytical method.
- explain the recent developments in analytical chemistry.

**Course Content:**

**Method/s of Evaluation:**
End of semester examination

**Recommended Readings:**
Course Code and Title:
CH 3008 - Quality Management

Credit Value:
1C

Rationale:
This course is designed to provide knowledge in quality assurance methods and standards in analytical chemistry.

Pre-requisites:
None

Intended Learning Outcomes:
Upon completion of this course students should be able to:

- demonstrate and understand the basics principles, theories, and regulations related to the quality management.
- demonstrate the ability to use appropriate tools to solve issues related to quality in laboratories.

Course Content:

Method/s of Evaluation:
End of semester examination

Recommended Readings:

Course Code and Title:
CH 3010 Environmental Chemistry
Credit Value:
2C

Rationale:
This course is designed to provide knowledge on Method/s of Evaluation of the quality of air, water and soil and treatment methods.

Pre-requisites:
None

Intended Learning Outcomes:
Upon completion of this course students should be able to:

• explain the environmental problems related to air, water and soil.
• illustrate the principles and procedures to sample and analyze airborne pollutants.
• analyze the health effects of airborne pollutants and predict the consequences using a model.
• distinguish the suitability of water for drinking and irrigation purposes.
• illustrate the principles of wastewater treatment.
• recognize the importance of chemical speciation.
• interpret a Pourbaix diagram.
• correlate the soil structure to its properties and transport of water through soil.

Course Content:
Chemistry of Air: Indoor air quality, Understanding the problems associated with indoor air, Indoor pollutant sources, Health impacts due to inhalation of indoor air, Handling indoor air pollution problems, Indoor air quality modelling, Continuous Fluid Stirred Tank Reactor model, Basis for the model and its applications, Method/s of Evaluation of the exposure and health effects, Real time vs continuous air sampling, Active and passive sampling, Sampling of particles and analysis methods, Sampling of gaseous pollutants and semi-volatiles, Sampling and analysis of CO, SO\text{x} and NO\text{x}.

Method/s of Evaluation:
End of semester examination

Recommended Readings:

Course Code and Title:
CH 3024 - Pharmaceutical Chemistry
Credit Value:
2C

Rationale:
This course is designed to provide an in depth knowledge on structure-activity relationship of drugs and their action.

Intended Learning Outcomes:
Upon completion of this course students should be able to:

- develop critical thinking skills towards what the body does to the drugs and what the drug does to the body.
- recognize representative anticonvulsant, local anesthetic, anti-inflammatory, diuretics, anti-diabetic, anti-bacterial anti-fungal, anticancer, and antiviral drugs and their respective mechanisms of action.
- explain structure-activity relationships of some selected drugs.
- propose routes to some synthetic drugs.
- explain beta-lactam drug resistance mechanisms.

Course Content:
Pharmaceutical, Pharmacokinetic, Pharmacodynamic aspect of a drug molecule: Biopharmaceutical properties of drug substances (Gastrointestinal physiology, Mechanisms of drug absorption, Drug dissolution versus drug absorption), Receptors and drug action (Affinity-the role of chemical bonding, Dose-response relationships, Receptors and biological response), Drug metabolism (Drug biotransformation pathways and Drug conjugation pathways), Drugs related to the Central Nervous System: Volatile Anesthetics, Anticonvulsants (Seizures, Anti-convulsants with ureide structure and synthesis, Benzodiazepines, Local Anesthetics (Electrophysiology of nerve membrane and mechanism of action), Cholesterol lowering drugs and Adrenocorticoids: Cholesterol biosynthesis (highlight the connection to anti-fungal agents) and statins, Development of adrenocorticoid drugs (Anti-inflammatory steroids), Introduction to Adrenocorticoid antagonists which will be expanded under diuretics), Diuretics: Osmotic diuretics, Carbonic anhydrase inhibitors, Thiazide diuretics, Loop diuretics, Potassium sparing diuretics, Drugs affecting sugar metabolism: Hormonal inter-relationships, Insulin, Oral anti-diabetic agents (Biguanides, sulfonylureas), Anti-microbial agents: General principles and important definitions, Anti-bacterial compounds (Sulfonamides, beta-lactam antibiotics, Aminoglycosides, Tetracyclines), Anti-mycobacterial agents, Anti-fungal agents (Polynes, Azoles and allylamines), Antiseptics and Disinfectants, Anti-cancer and Anti-viral drugs: Anti-neoplastic drugs (Anti-metabolites, Alkylating agents, DNA-intercalating agents, Anti-mitotic agents), Anti-viral agents, Approach to Anti-Aids agents.

Method/s of Evaluation:
End of semester examination

Recommended Readings:
(i) Principles of Medicinal Chemistry (William O. Foye, Thomas L. Lemke, David A. Williams) (ii) Introduction to Medicinal Chemistry (Patrick Graham) (iii) Medicinal Chemistry (Thomas Nogrady, Donald F. Weaver).

Course Code and Title:
CH 3027 – Molecular Biology

Credit Value:
Rationale:
This course is designed to provide an in depth knowledge on gene structure, DNA technology and its applications.

Pre-requisites:
None

Intended Learning Outcomes:
Upon completion of this course students should be able to:
- identify operon, and list its parts.
- explain how a regulator gene controls transcription of an operon.
- explain the regulation of the *trp* and *lac* operons.
- identify different levels at which gene expression in eukaryotes may be regulated.
- explain how DNA modifications, Chromatin remodeling etc., used in activation and repression of gene expression.
- describe the different tools used in rDNA technology.
- compare the different strategies used for gene cloning.
- design a PCR assay.
- explain how DNA is characterized and analyzed.
- describe the different applications of rDNA technology.

Course Content:
Gene structure; Prokaryotic and eukaryotic gene transcription; Transcription factors, activators and repressors, Mechanism of activation and repression; DNA modifications, Chromatin remodeling. Tools of Molecular Biology; Microorganisms, enzymes & vectors. Cloning; Techniques of cloning; Cutting & joining DNA molecules using enzymes, gene transferring methodologies, Gel Electrophoresis, Blotting techniques (Southern and Northern) DNA Labelling techniques, Nucleic acid Hybridization; Strategies for gene isolation, Construction and screening of genomic & cDNA libraries, DNA sequencing and analysis, Chromosome walking, PCR. Applications of recombinant DNA technology in Medicine, Agriculture and Industry, Recent advances in rDNA technology.

Method/s of Evaluation:
End of semester examination

Recommended Readings: