# Syllabus for the Degree of M.S.
# Subject: Applied Chemistry and Chemical Engineering (ACCE)
# Session: 2021-2022 & 2022-2023

**Vision and Mission of the Department:**

**Vision:**

To develop highly creative human resources capable of creating sustainable processes in various industries, reducing environmental footprint and improving quality of life by applying the innovative science and technology in chemistry and related fields.

**Mission:**

To instill and disseminate the knowledge, passion, attitude, and skill set among the graduates towards science, technology, and engineering. To prepare the students for professional practice, and life-long learning by conducting research through innovation and advancement of the chemical technology and engineering.

**Skill Mapping of the Program:**

**MS in ACCE Program:** In the MS program, students will go through on in-depth knowledge on Chemical Engineering, Pharmaceuticals and Medicinal Chemistry, Advanced Polymer Technology, Textile Fibers and Dyeing Technology, Nanoscience and Nanotechnology, and Sustainable Energy Conversion Engineering courses. The key feature of a student successfully finishing this year would require a piece of research work for Thesis Group students and Advanced Lab work/Internship with a project work for General Group students at the Departmental Research Lab, Training Institute or Chemical Industries in Bangladesh.

# Syllabus for the Degree of M.S.
# Subject: Applied Chemistry and Chemical Engineering (ACCE)
# Session: 2021-2022 & 2022-2023

There will be two groups in M. S. course in the department viz.,
(i) General Group (GG) and (ii) Thesis Group (T)

Details of the offered course are listed below:

| Course No. | Course Title | Credits | Marks | |
|---|---|---|---|---|
| ACCE 501 | Advanced Chemical Engineering | 4 | 100 | GG+T |
| ACCE 502 | Environmental Engineering | 4 | 100 | |
| ACCE 503 | Advanced Medicinal Chemistry | 4 | 100 | |
| ACCE 504 | Advanced Polymer Technology | 4 | 100 | |
| ACCE 505 | Textile Fibres and Dyeing Technology | 4 | 100 | |
| ACCE 506 | Engineering of Nanomaterials | 3 | 75 | |
| ACCE 507 | Sustainable Energy Conversion Engineering | 3 | 75 | |
| ACCE 508 | Lab-I: Chemical Process Technology-I/Internship | 3 | 75 | GG |
| ACCE 509 | Lab-II: Chemical Process Technology-II /Internship | 3 | 75 | |
| ACCE 510 | Lab-III: Project Work | 2 | 50 | |
| ACCE 511 | Sessional+General Viva-Voce | 4 | 100 | GG+T |
| ACCE 512 | Thesis | 6 | 150 | T |
| ACCE 513 | Thesis Viva-Voce | 2 | 50 | |

- **For each Theoretical Courses (ACCE-501 to ACCE-507) the marks distribution will be as follows:**

**(i) Final Examination-75%**
**(ii) Class attendance- 10%**
**(iii)Tutorial/Class test/Term paper/Assignment/Quiz Test/Class Performance-15%**

- **The duration of examinations for Theoretical and Practical Courses will be as follows:**

| Theoretical | Lab |
|---|---|
| 2 hours for 25 marks | 4 hours for 25 marks |
| 3 hours for 50 marks | 6 hours for 50 marks |
| 4 hours for 75-100 marks | 9 hours for 75 marks |
| | 12 hours for 100 marks |

# Course No. ACCE-501
# Advanced Chemical Engineering

Marks: 100 Time: 4 Hours
**Credit: 4** **Exam. 2022 & 2023**

**Rationale**: Chemical engineering is a continuously evolving discipline linked to a variety of industries. Chemical engineers lead the design of large-scale facilities in the chemical, petrochemical, and industrial biotechnology sectors. This course enables students to perform basic design calculations and analysis of typical industrial processes involving particulate matters.
**Objectives of the Course:** The objectives of the course are to:

- Provide students with advanced technical skills in chemical engineering.
- Enable students to solve problems related to chemical engineering.
- Provide training.

**Intended Learning Outcomes (ILOs):** Upon completion of this course students will gain

- An advanced knowledge of advanced chemical engineering.
- An understanding of how discoveries and other ideas can be exploited effectively, including new company spin-outs, re-organisation of existing company structures.
- Produce workable solutions to engineering problems.

## Course Content

**1. Equilibrium Stage Operations:** Principles of stage processes, calculation of stages by graphical methods and other short cut methods using Fenske, Underwood, Colburn and Gilliland correlation, binary distillation, x-y diagrams, multicomponent distillation-phaseequilibria and concept of key components, pinch point etc., calculation of multicomponent system,design calculations, theoretical analysis. Azeotropic and extractive distillation, distillation equipments, plate and packed towers, design procedures.

**2. Multistage Counter Current Gas Absorption:** Calculation of theoretical stages in absorption column, graphical design procedure, multicomponent absorber and stripper, absorption in single equilibrium stage, continuous differential-contact packed column design.

**3. Design of Fluid Flow Equipment:** Centrifugal, reciprocating and rotary pumps, compressors, liquid, gas and slurry pipelines, thrust nozzle, different types of valves, fittings, storage tanks, thickener, venturi scrubber.

**4. Industrial Catalysis**: Surface chemistry & catalysis, solid-liquid interface, solid-gas interface, surface area of solids, adsorption of gases and vapours on solids, Langmuir adsorption isotherm–BET and related isotherms, thermodynamics of adsorption, kinetics of adsorption and desorption, poly-functional catalysis, electrocatalysis, catalysis by metal complexes, deactivation of catalysts, regeneration of deactivated catalysts, catalyst preparation methods, design of industrial catalysts.

**5. Design of Heterogeneous Reactors:** Introduction to catalytic and non- catalytic reactions; steps in a catalytic reaction; adsorption isotherms, surface reaction and desorption; classical ward and testing of models; determination of a rate law; model of reaction and rate-limiting step; experimental reactors and treatment of data; design of Heterogeneous Reactors moving bed, packed bed and fluidized bed reactors and reactors for uncatalized heterogeneous reactions.

**Books recommended**:


1. Introduction to Chemical Engineering : W.L. Badger & J.T. Banchero
2. Elementary Principles of Chemical Processes : R.M. Felder & R.W. Rousseau
3. Unit Operations of Chemical Engineering : W.L. McCabe, J.C. Smith & P.Harriot
4. Introduction to Chemical Engineering : L.B. Andersen & L. Wenzel
5. Handbook of Chemical Engineering : Peery Robert H
6. Introduction to Chemical Engineering : S.K. Ghosal, S.K. Sanyal & S. Dutta
7. Mass Transfer Operations : R.E. Treybal
8. Chemical Engineering Thermodynamics : B.F. Dodge
9. Principles of Unit Operations : A.S. Foust et al
10. Separation Process Principles : Seader J.D. & Henley E.J
11. Multi-component Distillation C. D. Holland
12. Distillation. :M. Van Vincle
13. Design of Equilibrium Stage Processes :B.D. Smith
14. Chemical Reaction Engineering : Levenspiel Octave
15. Fluid Mechanics with Engineering Applications : Franzini Daugherty
16. Fluid Mechanics : F. M. White
17. Handbook of Chemical Engineering. Calculation : Chopey N.P
18. Conceptual Design of Chemical Process : Douglas
19. Plant Design and Economics for Chemical Engineering : Peters and Timerhaus
20. Systematic Method for Chemical Process Design : Beigler, L. T
21. Industrial Catalysis and Separations: Innovations for Process Intensification : K. V. Raghavan, B. M. Reddy
22. Industrial Catalysis: A Practical Approach : Jens Hagen
23. Handbook of Industrial Catalysts : Lloyd, Lawrie

# Course No. ACCE-502Environmental Engineering

Marks: 100 Time: 4 Hours
**Credit: 4** **Exam. 2022 & 2023**

**Rationale:** Environmental Engineering helps to minimize the impact of engineering and technology on the natural world. This includes water purification, pollution control, public health, recycling, waste disposal and sustainable design and manufacturing.
**Objectives of the Course:** The course will have the following objectives

- The course will cover and act as a support to understand the environmental engineering topics.
- An Engineer is in charge of designing, planning and creating procedures and features aimed at controlling environmental damage and hazards.

**Intended Learning Outcomes (ILOs):** Upon completion of this course students will be able to

- Understand how to control, conduct carry out treatment, and development and management of toxic materials and their effects on the environment.
- Environmental impact assessment and mitigation.
- Improve recycling and waste disposal.
- Improve water and air pollution control.
- Develop methods of cleaning up existing hazards.

## Course Content

**1. Carbon Sequestration Technology:** Importance of carbon capture & storage, carbon capture approaches, carbon separation technologies, pre-combustion capture, post-combustion capture, oxyfuel processes, zero emission technology, $CO_2$ transport, use of captured carbon.

**2. Industrial Monitoring:** Concept of TLV, time weighted average and short term exposure limits, Methods of sampling, preservation, monitoring techniques and methodology of various environmental samples.

**3. Environmental Problems and Regulatory Systems:** Definition of laws and protocols, major international conventions, treaties and protocols in the field of environment, environmental management, the agenda 21 adopted at the UNCED, 1992, Kyoto protocol, sectorial environmental legislation's in Bangladesh and their limitations, conservation act 1995, environmental conservation rules (1997), environmental court act 2000, environmental policy (1992), environmental action plan of Bangladesh (1992), and the role of DoE in the implementation of existing national and international rules in Bangladesh, formulation of guidelines and discharge standards of various industries.

**4. Remote Sensing and GIS Applications in Environmental Management : Idea on Base map ,GIS and airpollution, Map delineation , Remote sensing in waste management**

***Or*Clean Technologies in Water Energy and Food Nexus :** Water-energy-food nexus approaches**,**Solar energy technologies, concentrated solar power**,**Water and wastewater treatment technologies**,**Bioenergy including anaerobic digestion and biogas upgrade/cleanup**,**Nutrient and resource recovery**,**Renewable energy**,**Water and sustainable Agrifood systems**,**Decision support technology

**5. Sustainable Technology: New Approaches:** Approaches to achieve sustainable development, green chemistry, life cycle assessment, preventive environmental management, occupational safety and health regulations, energy utilization, heat engines and heat engine efficiency, combined cycle power plants, heat pumps, fuel cells, dematerialization.

**6. Application of Biotechnology in environmental protection:** Introduction, bioinformatics, biotechnology and pollution control, bioremediation, biological deodorization, biological purification of contaminated air.

**Books recommended**:


1. Environmental Chemistry : S.E. Manahan
2. Environmental Chemistry of Soil : M. McBride
3. A Guide to the Study of Environmental Pollution : William Andrews
4. A Text Book of Environmental Chemistry and Pollution Control : S.S. Dara & D.D. Mishra
5. Environmental Chemistry : A.K. De
6. Environmental Chemistry : H. Kaur & B.K. Sharma
7. Environmental Chemistry : S.C. Bhatia
8. Environmental Toxicology : J.N. Duffins
9. The Chemistry of our Environment : R.A. Horne
10. Air and Water Pollution : A.S. Stoker

# Course No. ACCE-503
# Advanced Medicinal Chemistry

Marks: 100 Time: 4 Hours

**Credit: 4** **Exam.-2022 & 2023**

**Rationale:** In keeping with the many changes occurring in health care, pharmacy organizations have recently adopted new principles, skills and standards for pharmacy education and practice

**Objectives of the Course:** This course will

- Bring practical relevance to the scientific classroom, and encourage students to meet practice-based outcomes with an understanding of the scientific rationale behind the practice decisions they will make as professionals.

**Intended Learning Outcomes (ILOs):** This course aims to

- Provide knowledge, skills, attitudes, and values for the provision of pharmaceutical care.
- Instill professional competencies (monitoring, communicating with and counseling patients, and appropriately modifying drug therapy) as well as the ability to identify, assess and solve Problems.
- Provide sufficient basic and pharmaceutical science instruction to serve as a foundation and support for the clinical and intellectual objectives

## Course Content

**1. Parenteral Drug:** Routes of administration, classification of Small Volume Parenterals (SVPs), types of vehicles, selection of vehicles and added substance, processing and manufacturing of SVPs, types of Large Volume Parenterals (LVPs), processing and manufacturing of LVPs, packaging of parenterals, GMP-design of parenteral production facility.

**3. Drug Formulation and Metabolism:** Receptor theories and receptor models, drug receptor interactions, drug design: physiochemical principles and basis of drug design, physicochemical approach of drug molecules, chemical parameters in drug design: Stereochemistry, biological isosterism, pro-drugs and analogous, different methods of drug design, Free Wilson method and its application to extra thermodynamic approach, biomimetic synthesis, commercial synthesis. Drug transport mechanism and absorption processes, Drug metabolism- Phase-I & Phase-II Metabolic Reactions with selected examples of Diazepam, Paracetamol, Amphetamine.

**4. Antiulcer and Antidiabetics Drug:** Chemistry, biological action and uses of non-systemic antacids such as aluminium hydroxide, aluminium carbonate, magnesium hydroxide and oxide, chemistry, biological action and uses of systemic drugs such as $H_2$ receptor antagonists, proton pump inhibitors, like ranitidine, cimitidine, omeprazole etc.

Diabetes mellitus and hyperglycemia, antidiabetic agents: sulfonureas, glucosidase inhibitors, meglitinides, Insulin–biological properties, principal types and duration of action of insulin preparations, species of insulin, insulin delivery systems, adverse effects.

**5. Chemotherapeutic agents and Anti-cancer Drugs:** Definition, Classification and uses of chemotherapeutic agents, Sulfa drugs, Antimalarials, Anticancer drugs.

**6. Cardiovascular Drugs:** Chemistry, mode of action of cardiac drugs such as glycosides, β-Blockers, Vasodilators, Ca-channel blocking agents.

**7. Nanomedicine and Nanotheraphy:** Introduction to nanomedicine, cellular processes at nanoscale, nanonephrology and molecular imaging, cancer nanotherapy, active and passive targeting, toxicity of nanomaterials in medicine.

**Books recommended**:


1. Medicinal Chemistry : A. Burger
2. A Text Book of Pharmaceutical Chemistry : Driver
3. A Text Book of Inorganic Pharmaceutical Chemistry : Rogers
4. Modern Methods of Plant Analysis : PACCEh and Tracy
5. Plant Alkaloids : Henry
6. May's Chemistry of Synthetic Drugs : R. Fleck
7. General Biochemistry : Fruton and Simmonds
8. Antibiotics : Flowry
9. Organic Chemistry (Vol. I & II) : I.L. Finar
10. Chemistry and Physiology of Vitamins : Rosenbudrg
11. The Vitamins : Dyke
12. Husa's Pharmaceutical Dispensing : E.W. Martin
13. Principles of Biochemistry : White, Handler & Smith
14. Tablet Making : A.E. Fribance
15. Process Engineering Economics : A.I. Little
16. Hormones : Pincus
17. Remington's Pharmaceutical Sciences : Remington
18. Chopra's Indigenous Drugs of India : Chopra et al

# Course No. ACCE-504
# Advanced Polymer Science and Biomaterials

Marks: 75 Time: 4 Hours

**Credit: 3** **Exam.-2022-2023**

**Rationale:**

To study on macromolecules has tremendous importance due to its huge contributions to mankind. This course aims to introduce the theoretical underpinnings of different properties of polymers. It discusses the structure and morphology of polymers, properties and rheology of polymers. This course also discusses the thermodynamics and solution behavior of polymers and familiarizes students with the polymer formation via ATRP methods and polymers applications towards composite materials and tissue replacement. This course also intends to provide a clear understanding to evaluate the synthesized polymers. Taken together, study on the advanced polymer science is very much rationale.

**Objectives of the course:** The course will help students to gain understanding and knowledge in:

- The explanation of structure and morphology of polymers.
- The variable properties and rheology of polymers.
- Enable students to explain the theories related to thermodynamics of polymer dissolution and polymer solution.
- Polymer composites and tissue replacement using polymers, therefore students will know the beneficial applications of polymers.
- Synthesis of special kind of polymer using special techniques entitled as ATRP and RAFT.
- Analysis and testing of synthesized polymers using modern instruments.
- Applications of polymers in medicinal field.

**Intended Learning Outcomes (ILOs):** After studying this course, students should be able to:

- Understand the structure and morphology of polymers and apply it.
- Apply and evaluate the rheology of polymers.
- Know the concept of controlled polymer structure and their synthetic route named ATRP and RAFT.
- Acquired knowledge on the behavior of polymer in solution including their molecular weight effect on polymer solubility and Flory-Huggins theory.
- Explain click chemistry and apply it to synthesize polymer.

## Course Content

**1. Structure and Morphology of Polymer:** Introduction, molecular microstructure of polymer-single crystal, poly crystal, structure and function of microstructure, nano polymeric materials-composition, size and shape, physical and chemical properties of different states of polymer-amorphous, semi-crystalline and crystalline phases.

**2. Properties and Rheology of Polymer:** Introduction, viscous flow- phenomenon of viscous flow, dynamics of polymer melts, flow measurement, rational and capillary viscometry, Kinetic theory of rubber elasticity-thermodynamics of rubber elasticity, stress-strain and high extension behavior of

elastomers; Viscoelasticity-The Boltzman superposition principle, creep and stress relaxation, modulus, method of viscoelastic behavior, distribution of relaxation time, molecular structure and viscoelasticity.

**3. Thermodynamics and Solution Behavior of Polymer:** Introduction, thermodynamics and solution properties of polymer-polymer dissolution, thermodynamics of polymer dissolution, criteria for polymer solubility, effect of molecular weight on polymer solubility, heat of dissolution and solubility parameters, Flory-Huggins theory of polymer solution, lower and upper critical solution temperatures.

**4. Controlled Polymer Structures:** General background, controlled radical and living radical polymerization (ATRP and RAFT), mechanism of atom transfer radical polymerization (ATRP) and radical addition fragmentation transfer (RAFT) and surface initiated radical polymerization, click chemistry.

**5. Analysis and Testing of Polymers:** Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study, microscopy. Thermal analysis and physical testing-tensile strength, fatigue, impact, and tear resistance, hardness and abrasion resistance.

**6. Polymers in Tissue Replacement:** Hard tissue: orthopedic implants (hip, knee), dental implants. Soft tissue: skin implant, burn (wound), dressings/synthetic skin, dialysis membranes, scaffolds, vascular implants, heart valve implants, artificial kidneys and livers. Biomaterials for gene delivery, Hydrogel as stimuli-sensitive biomaterials, biomaterials for drug delivery. Blood and tissue compatibility of biomaterials and their in vitro and in vivo assessment. Degradation of biomaterials in biological environments, toxicity of biomaterials.

**Books recommended**:


1. Principles of Polymerization : G. Odian
2. Polymer Science : Gowariker, Viswanathan & Sreedhur
3. The Chemistry of High Polymers : C.E.H. Bawn
4. Chemical Microstructure of Polymer Chain : J.L. Koening
5. Textile Chemistry (Vol. 1, 2 & 3) : R.H. Peters
6. Wood Chemistry Fundamentals and Applications : E. Sjostrom
7. Wood Structure and Composition : M. Lewin and I.S. Goldstein
8. Polymer Science & Technology of Plastics and Rubber : P. Ghosh
9. Text Book of Polymer Science : F.W. Billmeyer
10. Principles of Polymer Chemistry : P. Flory
11. Introduction to Polymer Chemistry : G.S. Misra
12. Dyeing of Cellulose Fibres and Related Processes : Cockett & Hilton
13. Chemical Technology of Fibrous Materials : F. Sadov, Korchagim and Matetsky

14. Dyeing and Chemical Technology of Textile Fibres : E.R. Trotman

15. Polymer Chemistry: an Introduction : M.P. Stevens
16. Biomaterial Science-an Introduction to Materials in Medicine : Ratner, Hoffman, Schoen
17. Biomaterials- Science and Engineering :Park .J.B.
18. Blood Compatible Materials and Devices : Sharma C.P., Szycher.M
19. Tucker Biopolymers : R.M.Johnson, R.M.Mwaikambo

# Course No. ACCE-505
# Textile Fibers and Dyeing Technology

Marks: 100 Time: 4 Hours

**Credit: 4** **Exam.-2022-2023**

**Rationale:** A rapid increase in global human population has increased the demand for commodities, including textiles. Thus, a sudden boom in the textile sector has been reported in several countries. The textile and dyestuff manufacturing waste water are extremely diverse and perhaps one of the most potential pollutants of aquatic environment. This course advances the knowledge of fibers and yarns and textile printing using pigments and various dyes.

**Objectives of the Course:** The course intends to

- Expose the student to the textile materials and processes used in composite applications and to introduce methods of analyzing and predicting the behavior of the resultant products.
- Learn about fiber architecture of textiles used for composites.
- Study of major industrial-fabric applications and constractions

**Intended Learning Outcomes (ILOs):** After studying this course, student should be able to:

- Give a broad range of knowledge in nonwoven manufacturing methods cost and end use applications and consumption.
- Develop a comprehensive understanding of the interrelationships of the fabric and product forming stages as related to their evaluation is developed.

## Course Content

**1. Fibre Technology:** (i) Natural fibres, animal based fibers and man-made fibers: Cellulose- sources and isolation, fibre structure- cellulose molecule, supermolecular structure and ultrastructure, cellulose allomorphs and their interconversion, mercerization of cellulose, cellulose derivatives, degradation reactions of cellulose, vegetable fibres. Protein polymers- silk and wool, composition and structure of mulberry silk, properties of silk. Jute- Constituents of jute fibre, Estimation of jute fibre constituents, Chemistry and technology of jute bleaching, Chemical modification of jute, tensile strength and tenacity of jute fibre. Future prospects of jute.

(ii) weaving principle: mechanisms of shedding, pickling and beating up, yarn preparation for weaving, (iii) knitting principle: Techniques of loop formation in weft and warp knitting, mechanisms of knitted fabric formation.

**2. Yarn Manufacturing & Numbering Systems:** Introduction to yarn manufacturing, principles of melt spinning, dry spinning and wet spinning, numbering systems, direct and indirect systems, British, Tex, Denier systems.

**3. Dyeing Technology:** Different types of textile dyes, chemistry and physics of dyes, qualities desirable for a dye, exhaustion and fixation of dyes, kinetics of dyeing, effect of dye concentration, electrolyte, temperature, pH, machine and agitation time on dye uptake, chemistry of reactive, direct, mordant and vat dyeing, dyeing operations with preparation of fiber and fabrics (mercerization, scouring, desizing, washing etc.), details of dyeing techniques, conditions and bath preparations.

**4. Finishing and Testing of Fibre:** Mechanical finishing of cotton, application of resins for finishing, properties imparted by finishing operation, single-bath dyeing and finishing, finishing of silk, wool and linen, special finishing operations, methods of determining wash, light and rubbing fastness, evaluation of fastness properties with the help of grey scale.

**5. Dyeing of Polymers:** Dyes and dyeing, modern concept of dyeing, dye-fibre bondings, mechanism and kinetics of dyeing, factors affecting dyeing, dye intermediates, preparation of some important dyes and dye intermediates.

**Books recommended**:

1. Textile Science : J. T. Marsh
2. An Introduction to Textile Finishing : J. T. Marsh
3. Textile Fibres, Finishes and Processes : H. L. Needle
4. Textile Science : E.P.J. Gohl and Valensky
5. Textile Chemistry : R. H. Peters (Vol 1, 2 & 3)
6. Textiles: Fibres to Fabric : B. P. Corbman

# Course No. ACCE-506
# Engineering of Nanotechnology

Marks: 75 Time: 4 Hours

**Credit: 3** **Exam.-2022 & 2023**

**Rationale:** Nanomedicine is the application of nanotechnology (the engineering of tiny machines) to the prevention and treatment of disease in the human body. The real time applicability of nanotechnology based biomedical interventions, including for the toxic responses against administration of nanomedicines. This discipline is still in its infancy. It has the potential to change medical science dramatically in the 21st century.

**Objectives of the course:** Objectives include

- Explore the biologically motivated discovery and development that will incorporate nanotechnology tools, devices and processes.
- Provide fundamental insights into cellular function and dysfunction, and leading to therapeutic interventions for disease.

**Intended Learning Outcomes (ILOs):** After studying this course, student should be able to:

- Explore the biological safety of inorganic nanoparticles, including the cell viability
- Synthesize the nano-sized liposomes containing both nuclear medicine molecules for modality and chemotherapeutics
- Perform the in vivo investigations employing both organic and inorganic nanoparticles for targeting delivery and controlled release
- Learn and appreciate the biomedical applications on diagnostic and therapeutic approaches in organ

## Course Content

**1. Fundamentals of Nanotechnology:** History of nanotechnology, properties of nanomaterials, Bulk vs Nano, influence of nanostructure on mechanical, optical, electrical and magnetic properties, surface to volume ratio, particle size, chemistry and physics of nanomaterials, Real-world application of nanomaterials, Health hazards and Ethical issues in nanoscience and nanotechnology.

**2. Nanomaterials**: Basic concept, synthesis, properties and applications of nanoparticles, nanocomposites, polymeric micelles, dendrimers, carbon nanotube, nanogel, nanomedicine, nanorods and quantum dots.

**3. Nanostructure Synthesis :** Top-down and bottom-up approaches for preparing nanomaterials, General synthesis techniques: Solid State Synthesis Methods; Melting and solidification, Microwave synthesis, Sol-Gel Methods; Precursor Methods; Hydrothermal Methods; Microemulsion, Self-assembly, Layer-by-layer assembly, PVD (physical vapor deposition); CVD (chemical vapor deposition); Lithography.

**4.Characterization of Nanostructured composite :**Characterization technique related to nanoscience such as XRD, SAXRD, XPS, SEM, EDX, TEM, AFM, Raman Spectroscopy, DLS, UV-vis-DRS, FTIR, and Photoluminescence spectroscopy.

5. Biosensor: Biosensor system, bioreceptors, surface attachment to the biological elements, biotransducer, applications.

**Books recommended**:


1. Nanocomposite Science and Technology : Pulikel M. Ajayan
2. Nanolithography and patterning techniques in microelectronics : David G. Bucknall
3. Micro and Nanofabrication : Zheng Cui
4. Nanostructured Materials : Jackie Y. Ying
5. Nanoengineering of Structural, Functional and Smart Materials : Mark J. Schulz
6. Textiles: Fibres to Fabric : B. P. Corbman
7. Nanomaterials: Risks and Benefits : I. Linkov and Jeffery Steevens


# Course No. ACCE-507
# Sustainable Energy Conversion Engineering

Marks: 75 Time: 4 Hours

**Credit: 3** **Exam.- 2022 & 2023**

**Rationale:** The world is becoming more energy intensive with rapid industrialization and urbanization. Knowledge of energy conversion and storage technologies are essential for designing and operating energy systems for a sustainable future.

**Objectives of the course:** Major objectives include

- To cover renewable energy technologies, energy storage, biomass conversion, power plant technology and computational methods.
- To develop unique expertise in the fundamentals of energy and the environment, their applications for the benefit of humankind, and the ability to stay abreast of the field of sustainable energy engineering.

**Intended Learning Outcome (ILOs):** At the successful completion of this course, the student is expected to have/be able to:

- List and generally explain the main sources of energy and their primary applications.
- Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
- Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources.

## Course Content

**1. Solar Energy and Photocatalysis:** Energy outlook of Bangladesh, present & future energy demand and supply, solar radiation and its measurement, solar thermal energy storage systems, solar water heating, solar distillation, solar production of hydrogen, solar photovoltaic (PV) system, efficiency of

solar cells, semiconductor materials for solar cells, applications of PV system, photocatalysis, mechanism of photocatalysis, factors affecting photocatalysis.

**2. Biomass and Hydrogen Energy:** Biomass conversion technologies, biomass production, classification of biomass plants, raw materials, fuel properties of biogas, biogas plant technology, problems involved in biogas production, biomass gasification, energy recovery from urban waste, power generation from liquid waste. Production methods of hydrogen, hydrogen storage, hydrogen transportation, utilization of hydrogen, hydrogen as an alternative fuel for motor vehicles.

**3. Nuclear Energy:** Nuclear processes, Neutron interactions: scattering, adsorption, fission, thermal & fast neutrons, reactor components, classification of reactors, nuclear fuel cycle: enrichment, fabrication, reprocessing, importance of heavy water, waste disposal, basic requirements for nuclear fusion, and possible routes to fusion power.

**Books recommended**:


1. Renewable Energy Resources : J. Twidell, T . Weir
2. Chemistry of Engineering Materials : Robert B. Leighou
3. Solar Energy, 2nd Ed. : S. P. Sukhatme
4. Solar-hydrogen Energy System : T. Ohta

# Course No. ACCE-508
# Lab-I: Chemical Process Technology-I/Internship

Marks: 75 Time: 9 Hours

**Credit: 3** **Exam.- 2022 & 2023**

**Rationale :** Chemical Process and Technology with commercial production of chemicals and related products from natural raw materials and their derivatives. When we apply chemistry in the transformation of materials and energy to make useable products, this results in growth and improvement in areas such as food production, health and hygiene, shelter and clothing.

**Objectives of this Course:** Major objectives will be to

- Answer to the changing needs of the chemical and related process industries such as petroleum, petrochemical, bituminous, pharmaceutical and health, agro and food, cosmetic and perfume, etc.
- Meet market demands for the survival in globalization of trade and competition.

**Intended Learning Outcome (ILOs):** Having completed this lab student should be able to

- Impart technological skills in energy, environmental, health and safety aspects to professionals for industrial development
- Develop major energy, environmental and health and safety technology training Centre in the country

## Course Content

1. Analysis and identification of chemical compounds from different samples (Industrial, textiles, cosmetics, etc.) using titrimetric or spectrophotometric methods
2. Multistep synthesis of biopolymers from natural resources (Starch, chitin, chitosan alginates, etc.)
3. Analysis of carbohydrates (glucose, sugar, starch) fats and oils.
4. Metallurgical analysis (titrimetric/spectrophometric)-Estimation of Cr/Ni/Mn in the given stainless steel compound.
5. Physical and chemical testing of cement.
6. Estimation of nitrogen ($N_2$) content in the supplied sample of urea.
7. Identification of functional groups in polymers/ organic samples.
8. Testing of pulp, paper, plastics and rubber.
9. Analysis of textile fibers (jute, cotton, rayon and silk etc).
10. Analysis of different parameters in the given fuel sample (solid, liquid and gases fuel)
11. Analysis of paints (physical and chemical tests).
12. Analysis of pharmaceuticals raw materials and finished products.
13. Determination of Calcium Gluconate in the given sample.

14. Determination of lactose contents in the milk.
15. Estimation of casein present in milk.
16. Estimation of acetic acid in the vinegar.
17. Estimation the amount of sugar in blood serum.
18. Creatinine estimation in blood serum.
19. Estimation of blood Cholesterol.
20. Measurements of enzymatic activity using spectrophotometer.
21. Draw a circulating magna crystallizer/ standard vertical type evaporator/ a spray dryer/ rotary dryer.
22. Measurements of fluid flow and viscosity of liquids.
23. Synthesis of nanomaterials from the given precursors.
24. Synthesis of nanocomposites.
25. Engineering drawing of reactors/heat exchangers/absorbers/distillation column/bimodal curve for ternary system/boiling point diagram/ pump/valve/fans/blowers etc.
26. Analysis of cellulosic materials of the supplied samples (bamboo, woods, jute, and bagasse).
27. Estimation of drying rate of the industrial products.
28. Determination of particle size by standard screen.
29. Determination of absorption rate during pollutants purification process.
30. Laboratory preparation of laundry soap, cold cream, vanishing cream, shaving cream, tooth paste, shampoo (liquid) and others.
31. In-plant tour/survey works in different chemical industries/institutes.
32. Some other experiments as designed by the course teacher(s).
33. All non-thesis group students will have to perform internship (about one month). It will be based upon different industries. It will be accomplished as group-work or individuals which are organized by concerned teachers/exam committee. Participation is compulsory for each student and they will submit a report and give a viva-voce/a power point presentation. The report and viva-voce/presentation will be examined by the internal/external examiners.

**Books recommended**:

1. Applied Chemistry Theory and Practice : Vermani and Narula
2. A Text Book of Inorganic Quantitative Analysis : A.I. Vogel
3. Practical Organic Chemistry : Clarke
4. বিশ্লেষনীয় ও ব্যবহারিক রসায়ন : হাজারী, দাস ও দে
5. Procedure Supplied from Dept.

# Course No. ACCE-509
# Lab-II: Chemical Process Technology-II/Internship

Marks: 75 Time: 9 Hours

**Credit: 3** **Exam.- 2022 & 2023Rationale:** An Environmental Engineer and Technologist are in charge of designing, planning and creating procedures and features aimed at controlling environmental damage and hazards. This can mean anything from water treatment plants to pollution control facilities.

**Objectives of this Course:**

- To develop research capabilities and effective training programmes in environmental, energy, and occupational safety and health technologies.
- To impart technological skills in energy, environmental, health and safety aspects to professionals for industrial development.

**Intended Learning Outcome (ILOs):** The expected outcome of this course will consist of the following

- Ability to define engineering problems, explore solutions, and critically analyze to achieve a practical solution.
- Ability and conduct laboratory experiments, as well as to analyze and interpret data.

**Course Content**

1. Analysis and identification of chemical compounds from different environmental samples (air, water, soil) using titrimetric or spectrophotometric methods
2. Analysis and estimation of acidity/alkalinity/preservatives in the supplied sample of juices and soft drink.
3. Analysis of water sample for total dissolved solid, chlorine, phosphate, nitrate, nitrite, ammonia and organic matter.
4. Analysis of industrial waste samples (textiles, pulp & paper, fertilizer, pharmaceuticals etc.)
5. Analysis of hazardous materials in the sample collected from the ship-breaking area.
6. Separation of individual compound from the organic mixtures using chromatographic methods.
7. Water and soil degradation test of polymers.
8. Determination of molecular weight of polymers by viscosity and osmotic pressure methods.
9. Estimation of amino acids and total-$N_2$ in a protein sample.

10. Extraction of useful compounds from medicinal plants and marine algae.
11. Determination of trace elements in waste water.
12. Determination of formalin in contaminated samples
13. Determination of toxic metals in biological samples.
14. Analysis of oil and grease in waste water samples.
15. Determination of moisture content, water holding capacity and pH of soil.
16. Estimation of total nitrogen and percentage of protein in a supplied fish fillet.
17. Estimation of calcium carbide and ethylene in fruit samples.
18. Identification of sugar in fruit juices using TLC.
19. Estimation of melamine in dairy products.
20. Survey/Field works in different industrial zone/polluted area/coastal zone etc.
21. Some other experiments as designed by the course teacher(s).
22. All non-thesis group students will have to perform internship (about one month). It will be based upon different industries. It will be accomplished as group-work or individuals which are organized by concerned teachers/exam committee. Participation is compulsory for each student and they will submit a report and give a viva-voce/a power point presentation. The report and viva-voce/presentation will be examined by the internal/external examiners.

**Books recommended**:

1. Applied Chemistry Theory and Practice : Vermani and Narula
2. A Text Book of Inorganic Quantitative Analysis : A.I. Vogel
3. বিশ্লেষনীয় ও ব্যবহারিক রসায়ন : হাজারী, দাস ও দে
4. Procedure Supplied from Dept.

**Course No. ACCE-510**
**Lab-III: Project Work**

Marks: 50

**Credit: 2** **Exam.- 2022 & 2023**

**Rationale:** A good report is one that presents students' project work concisely and effectively. It should contain various materials relevant to the work they have undertaken as a group; it should be organised into a logical framework; and it should be supported by written material that follows well-established academic conventions in a consistent fashion. The true value of the research may be assessed through a report since the written report may be the "only tangible product of hundreds of hours of work.

**Objectives of this course:**

- To reflect the focus of the degree programme students are enrolled in.
- Communicate information which has been compiled as a result of research and analysis of data and of issues.

**Intended Learning Outcomes (ILOs):**

- Be able to communicate effectively with clarity, organization and content.
- Be able to write scientific, technical and field report in standard format.

**Course Content**

All general group students will have to perform project work. Project work will be based upon different industries. It will be accomplished as group-work or individuals which are organized by concerned teachers. Participation is compulsory for each general group student and they will submit a report and give a viva-voce/a power point presentation. The report and viva-voce/presentation will be examined by the internal examiners.

**Course No. ACCE-511**
**Sessional+General Viva-Voce**

Marks: 100

**Credit: 4** **Exam.- 2022 & 2023**

**Rationale:** Viva voce is a verbal counterpart to students' written project or thesis. Report or thesis work demonstrate their skills at presenting research in writing. In the viva examination, they will demonstrate their ability to participate in academic discussion with research colleagues.

**Objectives of the course**

- Confirm that students understand what they have written and can defend it verbally.
- Investigate the awareness of students' work in relation to the wider research field.

**Intended Learning Outcomes (ILOs):**

- Justify their written arguments in their respective projects
- Be able to explain the wider research context in which the work has been undertaken

**Course Content**

All general group students will give a general viva-voce. The viva-voce will be conducted by the internal and external examiners. There is no specific particular syllabus for this. Students should possess comprehensive knowledge on their particular research area.

**Course No. ACCE-512**
**Thesis**

Marks: 150

**Credit: 6** **Exam.- 2022 & 2023Rationale:** Thesis provides students with added depth in the technical aspects of the field and breadth through technical electives. This degree prepares students for a variety of career paths.

**Objectives of this course:**

- Plan, conduct and evaluate scientific research.
- Follow developments in their field and apply research findings to their work.
- Determine and solve well-defined research problems.
- Report their findings.

**Intended Learning Outcomes (ILOs):** Upon completion of the course, the student is expected to be able to:

- Show considerable knowledge of a specific theoretical and empirical issue area. - compose, present and defend a scientific inquiry in the form of a master's thesis. –
- Critically scrutinize different theories and methods in political science as well as to apply these in the composition of a master's thesis.

**Course Content**

A thesis student is to be involved with a supervisor to carry out the specific research work. S/he will submit the thesis and give a viva-voce/power point presentation. The thesis viva-voce/power point presentation will be examined by the internal and external examiners.

**Course No. ACCE-513**
**Thesis Viva-Voce**

Marks: 50

**Credit: 2** **Exam.- 2022 & 2023**

**Rationale:** Viva voce is a verbal counterpart to students' written project or thesis. Report or thesis work demonstrate their skills at presenting research in writing. In the viva examination, they will demonstrate their ability to participate in academic discussion with research colleagues.

**Objectives of the course**

- Confirm that students understand what they have written and can defend it verbally.
- Investigate the awareness of students' work in relation to the wider research field.

**Intended Learning Outcomes (ILOs):**

- Justify their written arguments in their respective projects.
- Be able to explain the wider research context in which the work has been undertaken.

**Course Content**

Thesis students will give a viva-voce on thesis work. The viva-voce will be conducted by the internal and external examiners.

**The End**

**Ordinance**