Bachelor of Engineering

Chemical Engineering

Bachelor of Engineering Chemical Engineering

MISSION STATEMENT

*The **SRU Bachelor of Engineering in Chemical Engineering** is dedicated to advancing the frontiers of chemical science and engineering. Our program combines rigorous education, cutting-edge research, and industry collaboration. Through a comprehensive curriculum, hands-on experiences, and ethical training, we empower students to excel in designing sustainable processes, developing innovative materials, and solving complex challenges. As future leaders, our graduates contribute to a greener, safer, and more interconnected world.*

The mission of the chemical engineering program at SRU is to prepare students for a technical career, to be innovative and ethically responsible, and to provide leadership in chemical engineering and related disciplines. At Springfield Research University, our Bachelor of Engineering in Chemical Engineering program is designed to equip students with the knowledge and skills necessary for impactful careers in the field. Our mission is built upon three fundamental pillars:

1. **Academic Excellence**:
   - We maintain rigorous standards, fostering critical thinking and intellectual growth.
   - Through engaging coursework, practical training, and evidence-based practice, we empower students to excel in the complex world of chemical engineering.
   - Students gain a solid foundation in chemical processes, thermodynamics, and fundamental engineering principles.
2. **Cutting-Edge Research**:
   - Our faculty and students actively contribute to advancing chemical technology.
   - By addressing real-world challenges, exploring innovative process design concepts, and shaping industry practices, we drive positive change within the field.
   - Students engage in research projects, simulations, and analysis, enhancing their ability to provide innovative solutions.
3. **Societal Impact**:
   - We recognize our responsibility to society and the environment.
   - Our graduates are not only skilled engineers but also ethical leaders who advocate for safety, sustainability, and human well-being.
   - We empower them to make meaningful contributions to industrial processes, environmental protection, and public health.

Integrating Knowledge Seamlessly: Our program seamlessly integrates knowledge acquisition throughout the curriculum. Here's how we achieve this:

1. **Foundational Sciences**:
   - Students delve into core subjects such as chemical reactions, thermodynamics, and transport phenomena.
   - These foundational sciences provide the essential groundwork for understanding chemical processes, reactor design, and sustainable engineering principles.
2. **Applied Correlations**:
   - Lectures and practical sessions correlate theoretical knowledge with real-world chemical engineering scenarios.
   - For instance, students learn about unit operations and immediately apply this knowledge in designing efficient chemical processes.

3. **Case-Based Learning**:
   - Real-world chemical engineering cases serve as powerful teaching tools.
   - Students analyze process performance data, safety considerations, and environmental impact.
   - This approach bridges theory and practice, reinforcing chemical engineering concepts.
4. **Simulated Design Experiences**:
   - Simulation labs replicate actual chemical process conditions.
   - Students practice process modeling, optimization, and safety analysis, honing their skills before working on real projects.
5. **Industry Collaborations and Internships**:
   - During industry placements and internships, students work directly with chemical engineering professionals.
   - They apply theoretical knowledge in designing, evaluating, and optimizing chemical processes.
6. **Cutting-Edge Research and Innovation**:
   - Students critically evaluate research articles, explore emerging technologies, and contribute to advancements in chemical engineering.
   - Evidence-based practices ensure that knowledge acquisition aligns with current best practices in the field.

By seamlessly weaving theory, practical experiences, and evidence-based approaches, our program prepares graduates to contribute effectively to the dynamic field of chemical engineering.

Rationale for the Bachelor of Engineering in Chemical Engineering

At Springfield Research University, our Bachelor of Engineering in Chemical Engineering program is purposefully designed to prepare students for impactful careers in the field. Rooted in academic excellence, this program equips students with essential knowledge, practical skills, and hands-on experience. By emphasizing evidence-based practices and innovation, our graduates emerge as competent professionals poised to make a positive impact on the future of chemical processes, industrial applications, and environmental sustainability.

National Needs (Eswatini):

1. **Quantitative Expertise**:
   - Eswatini requires skilled chemical engineers who can navigate complex scenarios in process design, safety, and efficiency.
   - The program equips students with mathematical proficiency and critical thinking abilities to assess chemical conditions effectively.
2. **Cutting-Edge Practices**:
   - Graduates advocate for evidence-based decision-making, ensuring safety, efficiency, and equitable treatment in the chemical industry.
   - By enhancing their understanding of chemical reactions, materials, and energy-efficient systems, they contribute to better industrial outcomes.
3. **Policy and Innovation**:
   - The program fosters critical thinking, enabling graduates to engage in research, policy formulation, and informed decision-making at the national level.

Regional Needs (SADC):

1. **Harmonization of Practices**:
    - SADC member states share chemical engineering challenges related to industrial processes, environmental protection, and public health.
    - The program aligns with SADC's goal of harmonizing chemical engineering frameworks, promoting cooperation, and advancing sustainable practices.
2. **Human Capital Development**:
    - Chemical engineers play a pivotal role in regional development and community well-being.
    - The program contributes to building a skilled workforce capable of addressing cross-border chemical complexities.
3. **Technological Advancements**:
    - SADC's prosperity relies on informed chemical practices that balance industrial efficiency, safety, and environmental impact.
    - Our graduates contribute to maintaining chemical integrity, resolving process challenges, and fostering regional well-being.

Purpose of the Program:

1. **Technical Leadership**:
    - The program educates ethical leaders who champion evidence-based practices, fairness, and safety in chemical engineering.
    - Graduates not only assess technical data but also shape policies, regulations, and protocols that impact industrial processes.
2. **Innovative Research**:
    - Students engage in specialized chemical research, addressing contemporary challenges such as sustainable process design, resource utilization, and environmental stewardship.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

Our Bachelor of Engineering in Chemical Engineering program aims to produce graduates who demonstrate the following attributes:

1. **Technical Competence and Professional Success**:
    - Graduates will succeed in the chemical engineering profession by applying their technical knowledge effectively.
    - They will analyze complex problems, design innovative solutions, and contribute to industrial processes, safety, and sustainability.
    - Effective communication, teamwork, and leadership skills will enable them to collaborate with colleagues, clients, and stakeholders.
2. **Lifelong Learning and Personal Development**:
    - Graduates will maintain a lifelong interest in learning, adapting to evolving technologies and industry trends.
    - They will actively seek professional development opportunities, staying informed about advancements in chemical engineering.
    - Lifelong learning ensures their continued growth and relevance in a dynamic field.
3. **Ethical Responsibility and Social Awareness**:
    - Graduates will practice chemical engineering ethically, considering societal and environmental impacts.
    - They will adhere to regulatory standards, safety protocols, and ethical guidelines.
    - By addressing global challenges, they contribute to a sustainable and responsible future.

PROGRAM LEARNING OUTCOMES (PLOS)

Upon graduation, an SRU graduate in Chemical Engineering will demonstrate the following competencies:

1. **Application of Knowledge**:
   - Apply mathematical, scientific, and engineering principles to solve complex chemical engineering problems.
   - Utilize fundamental concepts to analyze and design chemical processes, unit operations, and systems.
2. **Experimental Design and Data Analysis**:
   - Design and conduct experiments, collecting relevant data and interpreting results.
   - Analyze experimental data to draw meaningful conclusions and inform engineering decisions.
3. **System Design and Constraints**:
   - Design chemical systems, components, or processes to meet specific needs while considering realistic constraints.
   - Address economic, environmental, social, ethical, health and safety, manufacturability, and sustainability factors.
4. **Multidisciplinary Collaboration**:
   - Function effectively as part of multidisciplinary teams, integrating diverse perspectives to solve engineering challenges.
   - Communicate and collaborate with professionals from various fields.
5. **Problem Identification and Solution**:
   - Identify and formulate engineering problems related to chemical processes, safety, and efficiency.
   - Develop innovative solutions using critical thinking and engineering principles.
6. **Professional and Ethical Responsibility**:
   - Understand and uphold ethical standards in chemical engineering practice.
   - Consider societal impact, safety, and environmental responsibility in decision-making.
7. **Effective Communication**:
   - Communicate technical information clearly and concisely to diverse audiences.
   - Present findings, proposals, and recommendations effectively.
8. **Global Context and Lifelong Learning**:
   - Recognize the impact of engineering solutions on a global scale, considering economic, environmental, and societal factors.
   - Commit to lifelong learning, staying informed about advancements in chemical engineering.
9. **Contemporary Issues and Awareness**:
   - Stay informed about current trends, challenges, and emerging technologies in chemical engineering.
   - Engage with contemporary issues related to sustainability, safety, and industrial practices.
10. **Engineering Tools and Techniques**:
    - Utilize modern engineering tools, software, and techniques to analyze, model, and optimize chemical processes.
    - Apply computational methods and simulations to solve engineering problems.

CAREER OPPORTUNITIES

A Chemical Engineering Bachelor’s degree will open doors in many fields in terms of work opportunities. Some of the most common jobs for Chemical Engineering graduates are:

1. Chemical Plant and System Operator

You can get hired by chemical manufacturing companies that make soaps, paint, coating, pesticide, and more. Main responsibilities for chemical plant operators:

- Ensure that all the equipment used in chemical plants works according to standards
- Instruct, evaluate, and inspect all personnel regarding the proper use of equipment
- Run tests, check for malfunctions, troubleshoot, and make or suggest adjustments
- Improve the overall quality, efficiency and safety of the chemical plant

2. Manufacturing Production Technician

Companies that manufacture chemical goods are the largest potential employer for students with a Chemical Engineering diploma. Main responsibilities for manufacturing production technicians:

- Work directly with machinery and equipment used in the process of manufacturing raw materials (e.g. oil, iron, coal) or goods (e.g. clothing, medication, pesticides).
- Set up the equipment and ensure all regulations and safety measures are met
- Run tests, monitor equipment, and adjust operations during the manufacturing process
- Inspect finished products, check their quality, and make other verifications to determine if they meet customer standards

3. Food Scientist

Not surprisingly, Chemical Engineering graduates are also pursued by food manufacturing companies, as well as universities, government organisations, and research institutes. Main responsibilities for food scientists:

- Evaluate the qualities of various food, such as nutritional value, colour, flavour and texture
- Test and compare food samples, look for harmful bacteria, create detailed reports
- Check if the processes used to manufacture food products meet the official regulations
- Research work: find new ways to manufacture food or new types of food to be produced

4. Biotechnologist

Such a position is of high importance for pharmaceutical companies and medical research institutes. Main responsibilities for biotechnologists:

- Develop new drugs, vaccines, experimental treatments, and even artificial organs
- Study, research and apply principles of human genetics to living cells and use biological techniques to create antibiotics, insulin, hormones, etc.
- Work in scientific research teams, support research ideas and directions, obtain funding for projects

5. Environmental Engineer

You will find positions at NGOs, environmental consulting firms, as well as waste management companies. Main responsibilities of environmental engineers:

- Use knowledge from various fields (engineering, chemistry, biology) to find solutions to environmental challenges, such as air and water pollution, soil degradation, deforestation, etc.
- Offer recommendations to local authorities in order to monitor and reduce the levels of pollution in that area and clean waste sites
- Work with architects and other engineers to design projects that are environmentally friendly and sustainable

ENTRY REQUIREMENTS

The student must have 6 credits and/or passes in SGCSE/GCE/IGCSE O' level including a pass with Grade C or better in English Language and at least four other subjects. Special: Mathematics and any other two from Chemistry, Combined Science, Physics, Physical Science. Faculty may set mature entry requirements subject to approval by Senate.

The Bachelor's Degree shall:

The Bachelor's degree program in Chemical Engineering at Springfield Research University is designed to equip students with the skills and knowledge necessary for a successful career in this dynamic field. Here are the key features of our program:

1. **Duration**:
    - The program spans **four years** for full-time students or **six years** for part-time students, including an industrial attachment or internship period.
2. **Semester Structure**:
    - Each academic year consists of **two semesters**.
    - **Semester Duration**: Each semester runs for **20 weeks**.
        - **Orientation Week**: One week dedicated to orientation.
        - **Teaching Weeks**: A minimum of **14 weeks** for instruction.
        - **Mid-Semester Break**: A one-week break for students.
        - **Examination Period**: Two weeks for final exams.
        - **Results Processing**: Two weeks allocated for marking and result processing.

Our program ensures a rigorous academic experience while allowing flexibility for part-time students. Students engage in hands-on learning, theoretical coursework, and practical projects, preparing them for the exciting challenges of the Chemical industry.

Special Departmental Regulations

1. **Course Completion Requirements**:
    - All **Core**, **Prerequisite**, **Required**, **General**, and **Elective** courses within the degree program are compulsory. Students must pass these courses with a minimum grade of **50%** to graduate.

   - However, during the third and fourth years, all courses must be passed with a minimum grade of **60%** (equivalent to a CGPA of **3.00**) to qualify for graduation.

2. **Optional Courses**:
   - Optional courses do not contribute to the final grade. Their marks are excluded from the computation of the overall grade.

3. **Externalization of Courses**:
   - All courses within the degree programs must be completed internally. Externalization is not permitted.

4. **Quality Control and Evaluation**:
   - Regular academic audits and reviews occur every four years, overseen by external moderators. Internal program evaluation is ongoing.

5. **Competence and Preparation**:
   - The courses offered in the Bachelor of Engineering in Chemical Engineering program provide adequate competences, preparing students for professional practice at the required academic level.

6. **Core and Prerequisite Courses**:
   - Students must pass all Core and Prerequisite courses with a minimum grade of **50%** before progressing to the next level or enrolling in additional courses.

Degree Award and Classification

- Upon successful completion of all **Core**, **Required**, and **Education** courses, as well as meeting the program requirements, a student will be awarded the degree of **Bachelor of Engineering in Chemical Engineering** at the end of the final year.
- The **normal classification** of a Bachelor's Degree is determined based on the academic performance during the third and fourth years of study.

Rationale to Course Numbering

At Springfield Research University, we meticulously design our Chemical Engineering curriculum to empower students with the knowledge and skills needed to thrive in this dynamic field. Our course numbering system serves as a roadmap, guiding students through their academic journey - ****100-level courses**** introduce foundational concepts. - ****200-level courses**** build on those foundations. - ****300-level courses**** explore more specialized topics. - ****400-level courses**** are advanced and often include research or project components. Let's delve into the reasons behind our thoughtful approach:

1. **Logical Progression**: Our course numbers reflect a logical progression. Foundational concepts begin with the "100" series, followed by deeper explorations in the "200" and "300" levels. Advanced topics and research opportunities reside in the "400" series.
2. **Prerequisites and Coherence**: Clear numbering helps students understand prerequisites and co-requisites. For instance, a 200-level course assumes knowledge from related 100-level courses, ensuring a coherent learning experience.

3. **Specialization and Depth**: As students advance, higher-level courses delve into specialized areas such as control systems, machine learning, and autonomous Biomedical. The numbering system communicates this depth of study.
4. **Alignment with Program Goals**: Each course number aligns with our program's learning outcomes. Whether it's mastering kinematics or diving into image processing, students can track their progress.
5. **Transferability**: Consistent numbering facilitates credit transfer between institutions, supporting seamless academic mobility.

In summary, our course numbering isn't just a sequence—it's a deliberate framework that enhances learning, fosters curiosity, and prepares our students for impactful careers in Chemical engineering. Chemical Engineering courses simplifies the course numbering system.

1. **100-Level Courses:**
    - **CHE 101:** Introduction to Chemical Engineering
    - **CHE 110**: Linear Algebra for Chemical Engineering
    - **CHE 120:** Mechanics and Dynamics in Chemical Systems
2. **200-Level Courses:**
    - **CHE 201:** Thermodynamics and Heat Transfer
    - **CHE 210:** Chemical Process Analysis
    - **CHE 220:** Materials Science for Chemical Engineering
3. **300-Level Courses:**
    - **CHE 301:** Mass Transfer and Separation Processes
    - **CHE 310:** Reaction Engineering
    - **CHE 320:** Process Control and Optimization
4. **400-Level Courses:**
    - **CHE 401:** Chemical Plant Design
    - **CHE 410:** Environmental Engineering
    - **CHE 420:** Advanced Topics in Chemical Engineering

The Bachelor of Engineering is a four (4) program. The student is expected to accumulate 576 credit points to be considered to have met the requirements of the Bachelor of Engineering in Chemical Engineering and must pass each module by at least 50%.

- Level 1 = minimum of credits 144 (1440 notional hours of study)
- Level 2 = minimum of credits 144 (1440 notional hours of study)
- Level 3 = minimum of credits 144 (1440 notional hours of study)
- Level 4 = minimum of credits 144 (1440 notional hours of study)

TOTAL credit points 576 (5760 notional hours of study)

Credit Transfer and Accumulation

1. Credits are derived from engagement of students in learning activities during lectures, seminars, tutorials, micro or macro field trips, directed and self-directed learning and writing examination tests and assignments.
2. Modules from the engineering faculty are worth 12 credit. Lecture attendance is compulsory. Students who attend less than 80% of lessons will not be allowed to sit for their sessional examinations.

Weighting

The degree class shall be based on weighting the results from part 1, 2, 3, and 4, the Degree weighting shall be as follows:

Level 1	20%
Level 2	20%
Level 3	30%
Level 4	30%

Distribution of Notional Hours

Module	Lecture Hrs	Tutorials/ Seminars	Self-Directed Study	Assignment Tests/Exams	Notional Hrs	Credits
CHE000	36	24	30	30	120	12
PROJECT	0	0	60	60	120	12

ASSESSMENT METHODS

1. **Formative Assessment (30%)**:
   - **Class Participation**: Actively engage in discussions, seminars, and practical activities related to chemical engineering.
   - **Quizzes and Short Tests**: Regular assessments on specific chemical engineering topics.
   - **Draft Assignments**: Receive feedback on early assignment drafts related to chemical engineering principles.
   - **Peer Review**: Collaborate with peers to review and improve each other's engineering project work.
2. **Summative Assessment (60%)**:
   - **Final Examinations**: Comprehensive exams covering course content specific to chemical engineering.
   - **End-of-Semester Projects**: Assess students' knowledge and problem-solving skills related to chemical engineering challenges.

- **Oral Presentations**: Evaluate communication abilities within the context of chemical engineering solutions.
- **Engineering Design Competitions**: Simulate real-world chemical engineering scenarios.

3. **Continuous Assessment (10%)**:
    - **Internships or Work Placements**: Engage in supervised chemical engineering placements, applying theoretical knowledge to practical projects.
    - **Assignments and Projects**: Regular tasks contribute to the overall grade, emphasizing practical skills in chemical engineering design and analysis.
    - **Research Papers**: Demonstrate research abilities related to chemical engineering innovations and advancements.
    - **Attendance and Active Participation**: Engage in lectures, workshops, and industry events specific to chemical engineering practices.

These adapted assessment methods align with Springfield Research University's commitment to academic excellence and the development of competent engineers.

Teaching Methods

At Springfield Research University (SRU), we are committed to employing a diverse array of teaching methods to ensure a comprehensive and engaging learning experience for our students. Our teaching methods are carefully selected to align with the programme's objectives and to meet the needs of our diverse student body. The following are the key teaching methods utilized across all SRU programmes:

1. Lectures:

- Lectures are used to introduce and explain key concepts, theories, and principles. They provide a structured and systematic approach to delivering content, allowing students to gain a solid foundation in their respective fields. Lectures are often supplemented with visual aids, multimedia presentations, and interactive elements to enhance understanding and engagement.

2. Seminars:

- Seminars are interactive sessions that promote critical thinking and in-depth discussion on specific topics. Students are encouraged to actively participate, share their perspectives, and engage in debates. Seminars provide an opportunity for students to develop their analytical and communication skills.

3. Workshops:

- Workshops are hands-on sessions that focus on practical skills and applications. These sessions allow students to engage in experiential learning, apply theoretical knowledge to real-world scenarios, and collaborate with peers on projects and activities. Workshops are designed to foster creativity, problem-solving, and teamwork.

4. Problem-Based Learning (PBL):

- Problem-Based Learning is a student-centered approach that involves presenting students with complex, real-world problems to solve. Students work in small groups to research, discuss, and propose solutions, developing critical thinking and collaborative skills in the process. PBL encourages independent learning and active engagement.

5. Case Studies:

- Case studies are used to analyze real-life situations and decision-making processes. Students examine and discuss case studies to understand the context, identify key issues, and evaluate possible solutions. This method helps students develop their analytical and problem-solving abilities while relating theoretical concepts to practical situations.

6. Clinical Practice:

- For programmes that include a clinical component, such as Health and Medical Sciences, clinical practice is an integral part of the curriculum. Students gain hands-on experience in clinical settings, working under the supervision of qualified professionals. This method provides valuable opportunities for students to apply their knowledge, develop clinical skills, and gain insights into professional practice.

7. Research Projects:

- Research projects are designed to cultivate a culture of inquiry and innovation. Students engage in independent or group research projects, exploring topics of interest and contributing to the body of knowledge in their field. Research projects develop students' research skills, critical thinking, and ability to communicate findings effectively.

8. Online Learning:

- Online learning is incorporated to provide flexible and accessible education. SRU utilizes online platforms to deliver lectures, conduct discussions, and facilitate collaborative projects. Online learning allows students to access course materials, participate in virtual classrooms, and engage with peers and instructors remotely.

9. Continuous Assessment:

- Continuous assessment methods, such as quizzes, assignments, and presentations, are used to monitor students' progress and provide ongoing feedback. These assessments help identify areas for improvement and ensure that students are meeting learning objectives throughout the course.

10. Peer Learning:

- Peer learning encourages students to collaborate and learn from each other. Group projects, study groups, and peer review sessions provide opportunities for students to share knowledge, offer feedback, and support each other's learning journey.

At SRU, our commitment to employing diverse and effective teaching methods ensures that our students receive a well-rounded education that prepares them for success in their chosen fields. We continuously review and enhance our teaching practices to provide the best possible learning experience for our students.

Delivery Methods

At Springfield Research University (SRU), we utilize a variety of delivery methods to ensure that our educational programmes are accessible, engaging, and effective. Our delivery methods are designed to cater to the diverse needs of our students and to provide flexible learning opportunities. The following are the key delivery methods employed across all SRU programmes:

1. In-Person Delivery:

- **Classroom Lectures:** Traditional classroom lectures provide a structured and interactive environment where students can engage with instructors and peers. These sessions often include discussions, presentations, and multimedia resources to enhance learning.
- **Laboratory Sessions:** For programmes that require practical and experimental learning, laboratory sessions are conducted in specialized labs equipped with the necessary tools and equipment. These hands-on sessions allow students to apply theoretical knowledge in a controlled environment.
- **Clinical Placements:** Health and Medical Sciences programmes include clinical placements in hospitals, clinics, and healthcare facilities. These placements provide students with real-world experience under the supervision of qualified professionals.

2. Online Delivery:

- **Virtual Classrooms:** Online platforms are used to deliver lectures, conduct discussions, and facilitate collaborative projects. Virtual classrooms enable students to access course materials, participate in live sessions, and engage with peers and instructors from remote locations.
- **Recorded Lectures:** Recorded lectures are made available for students to access at their convenience. This flexible approach allows students to review and revisit course content as needed.
- **Online Assessments:** Online assessments, including quizzes, assignments, and exams, are conducted through secure online platforms. These assessments provide timely feedback and help monitor students' progress.

3. Blended Learning:

- **Hybrid Courses:** Blended learning combines in-person and online delivery methods to provide a flexible and comprehensive learning experience. Hybrid courses may involve alternating between classroom sessions and online activities.
- **Flipped Classroom:** In the flipped classroom model, students access instructional content online before class and use in-person sessions for interactive, application-based activities. This approach encourages active learning and deeper engagement with the material.

4. Independent Study:

- **Self-Paced Learning:** Self-paced learning allows students to progress through course materials at their own speed. This method is ideal for students who prefer to learn independently and manage their own schedules.

- **Research Projects:** Independent research projects provide students with the opportunity to explore topics of interest, develop research skills, and contribute to the body of knowledge in their field. Faculty advisors provide guidance and support throughout the research process.

5. Collaborative Learning:

- **Group Projects:** Group projects foster teamwork and collaboration among students. These projects often involve problem-solving, research, and presentations, allowing students to learn from each other and develop interpersonal skills.

- **Peer Review:** Peer review sessions encourage students to provide and receive constructive feedback on each other's work. This method promotes critical thinking, reflection, and improvement.

6. Experiential Learning:

- **Internships and Work Placements:** Internships and work placements provide students with practical experience in their chosen field. These opportunities allow students to apply their knowledge in real-world settings, develop professional skills, and build industry connections.

- **Field Trips and Excursions:** Field trips and excursions offer experiential learning opportunities outside the classroom. These activities provide students with firsthand exposure to relevant sites, industries, and practices.

7. Continuous Assessment:

- **Formative Assessments:** Formative assessments, such as quizzes, assignments, and in-class activities, provide ongoing feedback to students and help track their progress. These assessments are designed to support learning and identify areas for improvement.

- **Summative Assessments:** Summative assessments, including final exams, projects, and presentations, evaluate students' overall performance and mastery of course content.

At SRU, our diverse delivery methods ensure that students receive a well-rounded and flexible education that caters to their individual learning preferences. We are committed to continuously enhancing our delivery methods to provide the best possible learning experience for our students.

Curriculum

Chemical Engineering, ESQF Level 8 BE-CHE degree, typical course sequence

YEAR 1: SEMESTER 1

Code	Course	Lectures	Practicals	Credits
CHE100	Principles of Chemistry	**100**	**20**	**12**
CHE101	Calculus for Scientists	**100**	**20**	**12**
CHE102	Design I	**100**	**20**	**12**
CHE103	Physics I – Mechanics	**60**	**60**	**12**
CHE104	Introduction to Computing for Scientists	**100**	**20**	**12**

CHE105	Introduction to Electrical and Electronic Engineering	**100**	**20**	**12**
TOTAL				72

YEAR 1: SEMESTER 2

Code	**Course**	**Lectures**	**Practicals**	**Credits**
CHE106	Fundamentals of Biology	**100**	**20**	**12**
CHE107	Principles of Chemistry II	**100**	**20**	**12**
CHE108	Engineering Science	**100**	**20**	**12**
CHE109	Calculus for Scientists II	**120**	**0**	**12**
CHE110	Introduction to Chemical Engineering Analysis Design	**60**	**60**	**12**
CHE111	Communication for Academic Purposes	**120**	**0**	**12**
TOTAL				72

YEAR 2: SEMESTER 3

Code	**Course**	**Lectures**	**Practicals**	**Credits**
CHE212	Introduction to Thermodynamics	**100**	**20**	**12**
CHE213	Organic Chemistry and Laboratory I	**100**	**20**	**12**
CHE214	Calculus for Scientists III	**100**	**20**	**12**
CHE215	Physics II – Electromagnetism and Optics	**120**	**0**	**12**
CHE216	Introduction to Material Science	**60**	**60**	**12**
CHE217	Differential Equations	**120**	**0**	**12**
TOTAL				72

YEAR 2: SEMESTER 4

Code	**Course**	**Lectures**	**Practicals**	**Credits**
CHE218	Computational Methods in Chemistry	**100**	**20**	**12**
CHE219	Material and Energy Balances	**100**	**20**	**12**
CHE220	Organic Chemistry and Laboratory II	**100**	**20**	**12**
CHE221	Principles of Economics	**120**	**0**	**12**
CHE222	Fuel Cell Science and Technology	**60**	**60**	**12**
CHE223	Numerical Analysis	**120**	**0**	**12**
TOTAL				72

YEAR 3: SEMESTER 5

Code	**Course**	**Lectures**	**Practicals**	**Credits**
CHE324	Fluid Mechanics	**100**	**20**	**12**
CHE325	Chemical Engineering Thermodynamics	**100**	**20**	**12**
CHE326	Physical Chemistry: A Molecular Perspective	**100**	**20**	**12**
CHE327	Bioprocessing Engineering	**100**	**20**	**12**
CHE328	Transport Phenomena	**100**	**20**	**12**
CHE329	Heat Transfer	**100**	**20**	**12**
TOTAL				72

YEAR 3: SEMESTER 6

Code	**Course**	**Lectures**	**Practicals**	**Credits**
CHE330	Research Methods	**100**	**20**	**12**
CHE331	Process Dynamics and Control	**100**	**20**	**12**
CHE332	Unit Operations and Laboratory	**100**	**20**	**12**
CHE333	Introduction to Electrochemical Engineering	**100**	**20**	**12**
CHE334	Chemical Engineering Flow Assurance	**100**	**20**	**12**

CHE335	Separations	**100**	**20**	**12**
TOTAL				**72**

YEAR 4: SEMESTER 7

Code	**Course**	**Lectures**	**Practicals**	**Credits**
CHE436	Chemical Engineering Design	**60**	**60**	**12**
CHE437	Chemical Process Safety	**100**	**20**	**12**
CHE438	Kinetics and Reaction Engineering	**60**	**60**	**12**
CHE439	Quantitative Human Biology	**100**	**20**	**12**
CHE440	Polymer Science and Technology	**60**	**60**	**12**
CHE441	Chemical Engineering Practice I	**0**	**120**	**12**
TOTAL				**72**

YEAR 4: SEMESTER 8

Code	**Course**	**Lectures**	**Practicals**	**Credits**
CHE442	Introduction to Energy Technologies	**120**	**0**	**12**
CHE443	Mathematical Methods in Chemistry	**120**	**0**	**12**
CHE444	Natural Gas Processing	**100**	**20**	**12**
CHE445	Petroleum Processes	**100**	**20**	**12**
CHE446	Chemical Engineering Practice II	**0**	**120**	**12**
CHE447	Research Project	**0**	**120**	**12**
TOTAL				**72**

COURSE DESCRIPTIONS

FUNDAMENTALS OF BIOLOGY I

Fundamentals of Biology with Laboratory I. This course will emphasize the fundamental concepts of biology and use illustrative examples and laboratory investigations that highlight the interface of biology with engineering. The focus will be on (1) the scientific method; (2) structural, molecular, and energetic basis of cellular activities; (3) mechanisms of storage and transfer of genetic information in biological organisms; (4) a laboratory 'toolbox' that will carry them forward in their laboratory-based courses. This core course in biology will be interdisciplinary in nature and will incorporate the major themes and mission of this school - earth, energy, and the environment.

FUNDAMENTALS OF BIOLOGY II

This is the continuation of Fundamentals of Biology I. Emphasis in the second semester is placed on an examination of organisms as the products of evolution and the diversity of life forms. Special attention will be given to how form fits function in animals and plants and the potential for biomimetic applications.

COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING

Fundamentals of mathematical methods and computer programming as applied to the solution of chemical engineering problems. Introduction to computational methods and algorithm development and implementation.

MATERIAL AND ENERGY BALANCES

Introduction to the formulation and solution of material and energy balances on chemical processes. Establishes the engineering approach to problem solving, the relations between known and unknown process variables, and appropriate computational methods.

CHEMICAL PROCESS PRINCIPLES LABORATORY

Laboratory measurements dealing with the first and second laws of thermodynamics, calculation and analysis of experimental results, professional report writing. Introduction to computer-aided process simulation.

INTRO TO THERMODYNAMICS

Introduction to the fundamental principles of classical engineering thermodynamics. Application of mass and energy balances to closed and open systems including systems undergoing transient processes. Entropy generation and the second law of thermodynamics for closed and open systems. Introduction to phase equilibrium and chemical reaction equilibria. Ideal solution behavior.

INTRODUCTION TO CHEMICAL ENGINEERING ANALYSIS AND DESIGN

Introduction to chemical process industries and how analysis and design concepts guide the development of new processes and products. Use of simple mathematical models to describe the performance of common process building blocks including pumps, heat exchangers, chemical reactors, and separators.

ANATOMY AND PHYSIOLOGY

This course will cover the basics of human anatomy and physiology of the cardiovascular system and blood, the immune system, the respiratory system, the digestive system, the endocrine system, the urinary system and the reproductive system. We will discuss the gross and microscopic anatomy and the physiology of these major systems. Where possible, we will integrate discussions of disease processes and introduce biomedical engineering concepts and problems.

ANATOMY AND PHYSIOLOGY LAB

In this course we explore the basic concepts of human anatomy and physiology using simulations of the physiology and a virtual human dissector program. These are supplemented as needed with animations, pictures and movies of cadaver dissection to provide the student with a practical experience discovering principles and structures associated with the anatomy and physiology.

FLUID MECHANICS

This course covers theory and application of momentum transfer and fluid flow. Fundamentals of microscopic phenomena and application to macroscopic systems are addressed. Course work also includes computational fluid dynamics.

HEAT TRANSFER

This course covers theory and applications of energy transfer: conduction, convection, and radiation. Fundamentals of microscopic phenomena and their application to macroscopic systems are addressed. Course work also includes application of relevant numerical methods to solve heat transfer problems.

INTRODUCTION TO BIOMEDICAL ENGINEERING

Introduction to the field of Biomedical Engineering including biomolecular, cellular, and physiological principles, and areas of specialty including biomolecular engineering, biomaterials, biomechanics, bioinstrumentation and bioimaging.

INTRODUCTION TO NEUROSCIENCE

This course is the general overview of brain anatomy, physiology, and function. It includes perception, motor, language, behavior, and executive function. This course will review what happens with injury and abnormalities of thought. It will discuss the overview of brain development throughout one's lifespan.

UNIT OPERATIONS LABORATORY

This course covers principles of mass, energy, and momentum transport as applied to laboratory-scale processing equipment. Written and oral communications skills, teamwork, and critical thinking are emphasized.

UNIT OPERATIONS LABORATORY

This course covers principles of mass, energy, and momentum transport as applied to laboratory-scale processing equipment. Written and oral communications skills, teamwork, and critical thinking are emphasized.

CHEMICAL ENGINEERING HEAT AND MASS TRANSFER

This course covers theory and applications of energy transfer: conduction, convection, and radiation and mass transfer: diffusion and convection. Fundamentals of microscopic phenomena and their application to macroscopic systems are addressed. Course work also includes application of relevant numerical methods to solve heat and mass transfer problems.

INTRODUCTION TO ELECTROCHEMICAL ENGINEERING

Introduction to the field of Electrochemical Engineering including basic electrochemical principles, electrode kinetics, ionic conduction, as applied to common devices such as fuel cells, electrolyzers, redox flow cells and batteries.

CELL BIOLOGY AND PHYSIOLOGY

An introduction to the morphological, biochemical, and biophysical properties of cells and their significance in the life processes.

INTRO TO GENETICS

A study of the mechanisms by which biological information is encoded, stored, and transmitted, including Mendelian genetics, molecular genetics, chromosome structure and rearrangement, cytogenetics, and population genetics.

BIOLOGICAL PSYCHOLOGY

This course relates the hard sciences of the brain and neuroscience to the psychology of human behavior. It covers such topics as decision making, learning, the brain's anatomy and physiology, psychopathology, addiction, the senses, sexuality, and brainwashing.

GENERAL BIOLOGY II LABORATORY

This Course provides students with laboratory exercises that complement lectures, the second semester introductory course in Biology. Emphasis is placed on an examination of organisms as the products of evolution. The diversity of life forms will be explored. Special attention will be given to the vertebrate body (organs, tissues and systems) and how it functions.

INTRODUCTION TO BREWING SCIENCE

Introduction to the field of Brewing Science including an overview of ingredients and the brewing process, the biochemistry of brewing, commercial brewing, quality control, and the economics of the brewing industry. Students will malt grain, brew their own beer, and analyze with modern analytical equipment.

COOPERATIVE EDUCATION

Cooperative work/education experience involving employment of a chemical engineering nature in an internship spanning at least one academic semester.

CHEMICAL ENGINEERING THERMODYNAMICS

Introduction to non-ideal behavior in thermodynamic systems and their applications. Phase and reaction equilibria are emphasized. Relevant aspects of computer-aided process simulation are incorporated.

CHEMICAL ENGINEERING THERMODYNAMICS LABORATORY

This course includes hands-on laboratory measurements of physical data from experiments based on the principles of chemical engineering thermodynamics. Methods and concepts explored include calculation and analysis of physical properties, phase equilibria, and reaction equilibria and the application of these concepts in chemical engineering.

BIOPROCESS ENGINEERING

The analysis and design of microbial reactions and biochemical unit operations, including processes used in conjunction with bioreactors, are investigated in this course. Industrial enzyme technologies are developed and explored. A strong focus is given to the basic processes for producing fermentation products and biofuels. Biochemical systems for organic oxidation and fermentation and inorganic oxidation and reduction are presented. Computer-aided process simulation is incorporated.

INTRODUCTION TO CHEMICAL ENGINEERING PRACTICE

Builds on the design process introduced in Design EPICS I, which focuses on open-ended problem solving approached in an integrated teamwork environment, and initial technical content specific to the Chemical Engineering degree program to solve a range of chemical process engineering problems. Technical content necessary for process analysis and design activity is presented. This course emphasizes steady-state design in areas such as fuels, food sciences, chemicals, and pharmaceuticals, wherein creative and critical thinking skills are necessary. Projects may involve computer-based optimization to obtain a solution.

INTRODUCTION TO BIOENERGY

In this course the student will gain an understanding about using biological sources and processes for energy uses, both electricity and fuels. There is an emphasis on using chemical engineering principles and tools to aid in the analysis of these bioenergy systems. Specific technologies will be addressed that have historical use and future potential, such as biochemical conversion routes to biofuels (chemical vs. enzymatic hydrolysis followed by fermentation), gasification followed by Fischer-Tropsch synthesis, application of anaerobic digestion, and others. Since products are to be used as energy carriers there will an emphasis on the energy efficiency of transformations and comparing the efficiencies of competing transformation pathways.

CHEMICAL ENGINEERING SEPARATIONS

This course covers fundamentals of stage-wise and diffusional mass transport with applications to chemical engineering systems and processes. Relevant aspects of computer-aided process simulation and computational methods are incorporated.

PROCESS OPTIMIZATION

This course introduces skills and knowledge required to develop conceptual designs of new processes and tools to analyze troubleshoot, and optimize existing processes.

CHEMICAL ENGINEERING DESIGN

This course covers simulation, synthesis, analysis, evaluation, as well as costing and economic evaluation of chemical processes. Computer-aided process simulation to plant and process design is applied.

PROCESS DYNAMICS AND CONTROL

Mathematical modeling and analysis of transient systems. Applications of control theory to response of dynamic chemical engineering systems and processes.

NATURAL GAS PROCESSING

Application of chemical engineering principles to the processing of natural gas. Emphasis on using thermodynamics and mass transfer operations to analyze existing plants. Relevant aspects of computer-aided process simulation.

PETROLEUM PROCESSES

Application of chemical engineering principles to petroleum refining. Thermodynamics and reaction engineering of complex hydro carbon systems. Relevant aspects of computer-aided process simulation for complex mixtures.

NEUROSCIENCE, MEMORY, AND LEARNING

This course relates the hard sciences of the brain and neuroscience to memory encoding and current learning theories.

INTRODUCTION TO PHARMACOLOGY

This course introduces the concepts of pharmacokinetics and biopharmaceuticals. It will discuss the delivery systems for pharmaceuticals and how they change with disease states. It will cover the modeling of drug delivery, absorption, excretion, and accumulation. The course will cover the different modeling systems for drug delivery and transport.

QUANTITATIVE HUMAN BIOLOGY

This course examines the bioelectric implications of the brain, heart, and muscles from a biomedical engineering view point. The course covers human brain, heart, and muscle anatomy as well as the devices currently in use to overcome abnormalities in function.

CHEMICAL PROCESS SAFETY

This course considers all aspects of chemical process safety and loss prevention. Students are trained for the identification of potential hazards and hazardous conditions associated with the processes and equipment involved in the chemical process industries, and methods of predicting the possible severity of these hazards and presenting, controlling or mitigating them. Quantitative engineering analysis; applications of mass and energy balances, fluid mechanics of liquid, gas, and two-phase flows, heat transfer, the conservation of energy, mass transfer, diffusion and dispersion under highly variable conditions, reaction kinetics, process control, and statistical analysis.

POLYMER SCIENCE AND TECHNOLOGY

Chemistry and thermodynamics of polymers and polymer solutions. Reaction engineering of polymerization. Characterization techniques based on solution properties. Materials science of polymers in varying physical states. Processing operations for polymeric materials and use in separations.

POLYMER ENGINEERING AND TECHNOLOGY

Polymer fluid mechanics, polymer rheological response, and polymer shape forming. Definition and measure ment of material properties. Interrelationships between response functions and correlation of data and material response. Theoretical approaches for prediction of polymer properties. Processing operations for polymeric materials; melt and flow instabilities.

KINETICS AND REACTION ENGINEERING

This course emphasizes applications of the fundamentals of thermodynamics, physical chemistry, organic chemistry, and material and energy balances to the engineering of reactive processes. Key topics include reactor design, acquisition and analysis of rate data, and heterogeneous catalysis. Computational methods as related to reactor and reaction modeling are incorporated.

MATHEMATICAL METHODS IN CHEMICAL ENGINEERING

Formulation and solution of chemical engineering problems using numerical solution methods within the Excel and MathCAD environments. Setup and numerical solution of ordinary and partial differential equations for typical chemical engineering systems and transport processes.

CHEMICAL ENGINEERING FLOW ASSURANCE

Chemical Engineering Flow Assurance will include the principles of the application of thermodynamics and mesocopic and microscopic tools that can be applied to the production of oil field fluids, including mitigation strategies for solids, including gas hydrates, waxes, and asphaltenes.

ADVANCED FUNCTIONAL POROUS MATERIALS

Nanomaterials synthesis, hierarchically ordered porous materials, functional applications, catalysis, separations, adsorption.

TRANSPORT PHENOMENA

This course covers theory and applications of momentum, energy, and mass transfer based on microscopic control volumes. Analytical and numerical solution methods are employed in this course.

IMMUNOLOGY FOR ENGINEERS AND SCIENTISTS

This course introduces the basic concepts of immunology and their applications in engineering and science. We will discuss the molecular, biochemical and cellular aspects of the immune system including structure and function of the innate and acquired immune systems. Building on this, we will discuss the immune response to infectious agents and the material science of introduced implants and materials such as heart valves, artificial joints, organ transplants and lenses. We will also discuss the role of the immune system in cancer, allergies, immune deficiencies, vaccination and other applications such as immunoassay and flow cytometry.

TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS

The goal of this course is to develop and analyze models of biological transport and reaction processes. We will apply the principles of mass, momentum, and energy conservation to describe mechanisms of physiology and pathology. We will explore the applications of transport phenomena in the design of drug delivery systems, engineered tissues, and biomedical diagnostics with an emphasis on the barriers to molecular transport in cardiovascular disease and cancer.

INTERDISCIPLINARY MICROELECTRONICS

Application of science and engineering principles to the design, fabrication, and testing of microelectronic devices. Emphasis on specific unit operations and the interrelation among processing steps.

MOLECULAR PERSPECTIVES IN CHEMICAL ENGINEERING

Applications of statistical and quantum mechanics to understanding and prediction of equilibrium and transport properties and processes. Relations between microscopic properties of materials and systems to macroscopic behavior.

APPLIED BIOINFORMATICS

In this course we will discuss the concepts and tools of bioinformatics. The molecular biology of genomics and proteomics will be presented and the techniques for collecting, storing, retrieving and processing such data will be discussed. Topics include analyzing DNA, RNA and protein sequences, gene recognition, gene expression, protein structure prediction, modeling evolution, utilizing BLAST and other online tools for the exploration of genome, proteome and other available databases. In parallel, there will be an introduction to the PERL programming language. Practical applications to biological research and disease will be presented and students given opportunities to use the tools discussed.

INTERNATIONAL GENETIC ENGINEERED MACHINE SEMINAR

iGEM allows for a hands-on experience in the emerging frontier of synthetic biology and genetic engineering while promoting an entrepreneurial spirit as students engage in teams with all aspects of the engineering design process. The design process starts with stakeholder engagement, and student identification of a problem they wish to solve using synthetic biology. A team will go through the design build test cycle multiple times in preparation for a culminating public presentation at an international symposium. Projects cover frontiers of science and engineering, such as new biochemical production, new materials, environmental projects (e.g., promoting enzymatic degradation of PET plastics), analysis, and health innovations.

BIOCHEMICAL PROCESS ENGINEERING

The analysis and design of microbial reactions and biochemical unit operations, including processes used in conjunction with bioreactors, are investigated in this course. Industrial enzyme technologies are developed and explored. A strong focus is given to the basic processes for producing fermentation products and biofuels. Biochemical systems for organic oxidation and fermentation and inorganic oxidation and reduction are presented.

BIOCHEMICAL PROCESS ENGINEERING LABORATORY

This course emphasizes bio-based product preparation, laboratory measurement, and calculation and analysis of bioprocesses including fermentation and bio-solids separations and their application to biochemical engineering. Computer-aided process simulation is incorporated.

FUEL CELL SCIENCE AND TECHNOLOGY

Investigate fundamentals of fuel-cell operation and electrochemistry from a chemical-thermodynamics and materials-science perspective. Review types of fuel cells, fuel-processing requirements and approaches, and fuel-cell system integration.

INTRODUCTION TO MICROFLUIDICS

This course introduces the basic principles and applications of microfluidic systems. Concepts related to microscale fluid mechanics, transport, physics, and biology are presented. To gain familiarity with small-scale systems, students are provided with the opportunity to design, fabricate, and test a simple microfluidic device.

INTRODUCTION TO ENERGY TECHNOLOGIES

In this course the student will gain an understanding about energy technologies including how they work, how they are quantitatively evaluated, what they cost, and what is their benefit or impact on the natural environment. There will be discussions about proposed energy systems and how they might become a part of the existing infrastructure. However, to truly understand the impact of proposed energy systems, the student must also have a grasp on the infrastructure of existing energy systems.

NATURAL GAS HYDRATES

The purpose of this class is to learn about clathrate hydrates, using two books, (1) Clathrate Hydrates of Natural Gases, Third Edition (2008) co-authored by C.A.Koh, and (2) Hydrate Engineering, (2000). Using a basis of these books, and accompanying programs, we have abundant resources to act as professionals who are always learning.

COURSE OUTLINES

Course Title: Principles of Chemistry

Course Description:

This course provides a foundational understanding of chemical principles relevant to engineering applications. Students will learn fundamental concepts in chemistry, including atomic structure, chemical bonding, thermodynamics, and reaction kinetics.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the basic principles of chemistry.
- Apply chemical concepts to engineering problems.
- Analyze chemical reactions and equilibria.

Topics Covered:

1. **Atomic Structure and Periodic Trends**
    - Atomic models.
    - Electronic configuration.
    - Periodic table and trends.
2. **Chemical Bonding**
    - Covalent, ionic, and metallic bonds.
    - Lewis structures.
    - Molecular geometry.

3. **Stoichiometry and Reaction Balancing**
   - Chemical equations.
   - Mole concept.
   - Limiting reactants.
4. **Thermodynamics**
   - Laws of thermodynamics.
   - Enthalpy, entropy, and Gibbs free energy.
   - Heat transfer in chemical processes.
5. **Chemical Kinetics**
   - Reaction rates.
   - Activation energy.
   - Rate laws.
6. **Equilibrium and Acid-Base Chemistry**
   - Equilibrium constants.
   - Le Chatelier's principle.
   - pH and acid-base reactions.
7. **Electrochemistry**
   - Redox reactions.
   - Electrochemical cells.
   - Corrosion and batteries.
8. **Applications in Chemical Engineering**
   - Chemical reactors.
   - Heat exchangers.
   - Separation processes.

Assessment:

- Quizzes and exams.
- Laboratory experiments.
- Problem-solving assignments.

Recommended Reading:

1. Chang, R. (2019). *Chemistry*. McGraw-Hill Education.
2. Atkins, P., & Jones, L. (2016). *Chemical Principles: The Quest for Insight*. W. H. Freeman.

Course Title: Calculus for Scientists

Course Description:

This course provides an introduction to calculus with exposure to applications in science, business, and economics. The main concepts covered are limits, derivatives, and integrals.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the fundamental principles of calculus.
- Apply calculus techniques to scientific problems.
- Analyze functions, rates of change, and areas under curves.

Topics Covered:

1. **Pre-Calculus Review**
    - Notation, absolute value, and inequalities.
    - Points and curves in the plane (Cartesian coordinates, circles, parabolas, ellipses, hyperbolas).
2. **Introduction to Calculus**
    - Limits and continuity.
    - Differentiation (derivatives).
    - Applications of derivatives.
3. **Representing Functions**
    - Introduction to functions.
    - Vertical line test.
    - Piecewise defined functions.
4. **Sequences**
    - Convergence and divergence.
    - Series and summation.
5. **A Catalog of Essential Functions**
    - Common functions (polynomials, exponential, logarithmic, trigonometric).
    - Techniques of integration.
6. **Applications in Science**
    - Modeling physical phenomena.
    - Optimization problems.
    - Differential equations.

Course Title: Design I

Course Description:

Design I is an introductory course that explores fundamental design principles, creative problem-solving, and visual communication. Students will learn to apply design thinking to various contexts and develop practical skills for effective design.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the basics of design theory.
- Apply design principles to real-world scenarios.
- Create visually appealing and functional designs.

Topics and Activities:

1. **Introduction to Design**
    - What is design?
    - Elements of design (line, shape, color).
    - Historical context and influential designers.
    - Activity: Analyzing everyday objects.
2. **Design Process and Ideation**
    - Design thinking process.
    - Brainstorming techniques.
    - Sketching and prototyping.
    - Activity: Ideation sessions and rough sketches.
3. **Visual Communication**

- Typography and layout.
    - Color theory.
    - Visual hierarchy.
    - Activity: Design a poster or infographic.
4. **User-Centered Design**
    - User personas.
    - User experience (UX) design.
    - Usability testing.
    - Activity: Conduct user interviews and create wireframes.
5. **Materials and Form**
    - Material selection.
    - Form and function.
    - Sustainability in design.
    - Activity: Explore materials and design a functional object.
6. **Design Ethics and Social Impact**
    - Ethical considerations in design.
    - Cultural sensitivity.
    - Design for social change.
    - Activity: Research and present socially impactful design projects.
7. **Design Presentation and Critique**
    - Effective presentation skills.
    - Constructive critique.
    - Iterative design process.
    - Activity: Present final design projects and receive peer feedback.

Assessment:

- Design project (individual or group).
- Quizzes on design principles.
- Participation in class discussions.

Course Title: Physics I (Mechanics)

Course Description:

Physics I (Mechanics) is an introductory course that explores the fundamental principles of classical mechanics. Students will study motion, forces, energy, and momentum, building a solid foundation for further studies in physics and engineering.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the basic laws of motion.
- Apply mathematical concepts to analyze physical systems.
- Solve problems related to mechanics.

Topics Covered:

1. **Introduction to Mechanics**
    - Overview of classical mechanics.

- Units and scientific notation.
    - Measurement conversions.
2. **Kinematics in One Dimension**
    - Motion along a straight line.
    - Velocity, acceleration, and displacement.
    - Equations of motion.
3. **Kinematics in Two Dimensions**
    - Curved paths and projectile motion.
    - Vector representation.
    - Relative motion.
4. **Forces and Dynamics**
    - Newton's laws of motion.
    - Friction and tension.
    - Circular motion.
5. **Work, Energy, and Conservation Laws**
    - Work done by forces.
    - Kinetic and potential energy.
    - Conservation of mechanical energy.
6. **Linear Momentum and Collisions**
    - Impulse and momentum.
    - Elastic and inelastic collisions.
    - Center of mass.
7. **Rotational Motion**
    - Angular velocity and acceleration.
    - Torque and rotational dynamics.
    - Moment of inertia.
8. **Angular Momentum and Rigid Bodies**
    - Conservation of angular momentum.
    - Rolling motion.
    - Gyroscopic effects.

Assessment:

- Problem-solving exercises.
- Quizzes and exams.
- Laboratory experiments (if applicable).

Course Title: Introduction to Computing for Scientists

Course Description:

This course provides an introduction to computational methods and programming for scientists, with a focus on chemical engineering applications. Students will learn fundamental programming concepts, numerical computation, and data analysis using relevant tools and languages.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the basics of programming and algorithmic thinking.
- Apply computational techniques to solve scientific problems.

- Manipulate data and visualize results.

Topics Covered:

1. **Introduction to Programming**
    - Basics of programming languages (Python, MATLAB, or similar).
    - Variables, data types, and control structures.
    - Writing and executing simple programs.
2. **Numerical Computation**
    - Floating-point arithmetic.
    - Solving equations numerically.
    - Root-finding algorithms.
3. **Data Structures and Algorithms**
    - Lists, arrays, and dictionaries.
    - Iteration and recursion.
    - Sorting and searching algorithms.
4. **Scientific Computing Libraries**
    - Introduction to NumPy (Python) or equivalent.
    - Vectorized operations.
    - Plotting data (Matplotlib or similar).
5. **File I/O and Data Manipulation**
    - Reading and writing data files.
    - Data preprocessing and cleaning.
    - Basic statistical analysis.
6. **Applications in Chemical Engineering**
    - Solving mass and energy balances.
    - Simulating chemical processes.
    - Analyzing experimental data.
7. **Project Work**
    - Small programming projects related to chemical engineering problems.
    - Collaborative coding and debugging.

Assessment:

- Programming assignments.
- Quizzes on programming concepts.
- Final project applying computational methods to a chemical engineering scenario.

Course Title: Fundamentals of Biology I

Course Description:

Fundamentals of Biology I introduces chemical engineering students to essential biological concepts relevant to their field. The course covers foundational principles of biology, cellular processes, and their applications in chemical engineering.

Learning Objectives:

By the end of this course, students should be able to:

- Understand key biological concepts.

- Apply biological knowledge to chemical engineering problems.
- Appreciate the interdisciplinary nature of biology and engineering.

Topics Covered:

1. **Introduction to Biological Systems**
    - Overview of biological hierarchy (cells, tissues, organs, organisms).
    - Biomolecules (proteins, nucleic acids, lipids, carbohydrates).
2. **Cell Structure and Function**
    - Cell organelles (nucleus, mitochondria, endoplasmic reticulum).
    - Cellular metabolism (glycolysis, Krebs cycle).
    - Membrane transport and signaling.
3. **Genetics and Molecular Biology**
    - DNA structure and replication.
    - Gene expression (transcription, translation).
    - Genetic variation and mutations.
4. **Enzymes and Enzyme Kinetics**
    - Enzyme function and specificity.
    - Michaelis-Menten kinetics.
    - Enzyme inhibition.
5. **Microbial Growth and Bioreactors**
    - Microbial growth phases (lag, exponential, stationary).
    - Chemostats and batch reactors.
    - Biomass production.
6. **Biological Applications in Chemical Engineering**
    - Bioprocess engineering.
    - Bioremediation.
    - Biofuels and bioproducts.
7. **Ethics and Safety in Biological Research**
    - Biosafety protocols.
    - Ethical considerations in biotechnology.
    - Responsible conduct in research.

Assessment:

- Quizzes and exams on biological concepts.
- Laboratory experiments related to microbial growth and enzyme kinetics.
- Group projects applying biological principles to chemical engineering problems.

Course Title: Principles of Chemistry II

Course Description:

Principles of Chemistry II builds upon the foundational concepts introduced in Principles of Chemistry I. This course delves deeper into chemical principles, equipping students with essential knowledge for further studies in chemistry and related fields. Topics covered include kinetics, equilibrium, acid-base theories, electrochemistry, thermodynamics, nuclear chemistry, and an introduction to organic chemistry.

Topics Covered:

1. **Chemical Kinetics**

- Reaction rates and mechanisms.
- Catalysis.
- Rate laws and order of reactions.

2. **Chemical Equilibrium**
   - Homogeneous and heterogeneous equilibria.
   - Le Chatelier's principle.
   - Relationship between chemical equilibria and kinetics.
3. **Acids and Bases**
   - Bronsted-Lowry and Lewis acid-base theory.
   - Strong and weak acids/bases.
   - pH and titrations.
4. **Electrochemistry**
   - Galvanic and voltaic cells.
   - Cell potential and EMF.
   - Electrolysis and corrosion.
5. **Thermodynamics**
   - Spontaneity and entropy.
   - Enthalpy and Gibbs free energy.
   - Thermodynamic relationships to equilibrium constants.
6. **Nuclear Chemistry**
   - Radioactive decay and transmutation.
   - Fission and fusion.
   - Biological effects of radiation.
7. **Introduction to Organic Chemistry**
   - Basics of organic compounds.
   - Functional groups.
   - Isomerism.

Assessment:

- Quizzes and exams on the covered topics.
- Laboratory experiments related to electrochemistry and kinetics.
- Application of principles to chemical engineering scenarios.

Course Title: Calculus for Scientists II

Course Description:

Calculus for Scientists II builds upon the foundational concepts introduced in Calculus for Scientists I. This course delves deeper into advanced calculus topics, equipping students with essential mathematical tools for scientific and engineering applications. Topics covered include integration techniques, differential equations, multivariable calculus, and power series.

Topics Covered:

1. **Integration Techniques**
   - Integration by parts.
   - Trigonometric integrals.
   - Trigonometric substitutions.
   - Partial fraction decomposition.
   - Numerical integration methods (Midpoint, Trapezoid, Simpson's rule).
2. **Improper Integrals**

    - Evaluating improper integrals.
    - Convergence and divergence.
3. **Differential Equations**
    - Introduction to differential equations.
    - Direction fields and numerical methods.
    - Separable differential equations.
    - First-order linear differential equations.
4. **Taylor and Maclaurin Series**
    - Power series and functions.
    - Properties of power series.
    - Taylor series expansions.
    - Applications of Taylor series.
5. **Multivariable Calculus**
    - Functions of several variables.
    - Limits and continuity in multivariable functions.
    - Partial derivatives.
    - Gradient vectors and directional derivatives.
6. **Double and Triple Integrals**
    - Double integrals over rectangular and general regions.
    - Polar coordinates.
    - Applications in physics and engineering.

Assessment:

- Quizzes and exams on the covered topics.
- Problem-solving assignments.
- Application of calculus techniques to scientific scenarios.

Course Title: Engineering Science

Course Description:

Engineering Science encompasses a wide range of subjects, from microelectronics to offshore oil platforms. This semester-based course involves the application of creative reasoning, science, mathematics, and experience to real-world problems. Undergraduate teaching is based on a unified course in Engineering Science, integrating study across traditional boundaries of engineering disciplines.

Learning Objectives:

By the end of this semester, students should be able to:

- Understand fundamental engineering principles.
- Apply interdisciplinary knowledge to solve complex problems.
- Prepare for specialized engineering branches.

Topics Covered:

1. **Foundational Topics**
    - Mathematics and physics fundamentals.
    - Materials science.

- Thermodynamics and fluid mechanics.
- Electrical circuits and systems.

2. **Specialization**
   - Chemical Engineering
   - In-depth study of specialized topics related to the chosen branch.
3. **Industrial Experience**
   - Encouragement to obtain industrial experience through sponsorship or internships.
   - Practical application of engineering principles.

Assessment:

- Quizzes, exams, and coursework related to foundational topics.
- Specialization projects and assignments.
- Integration of theoretical knowledge with practical applications.

Course Title: Introduction to Chemical Engineering Analysis and Design

Course Description:

Introduction to Chemical Engineering Analysis and Design provides fundamental knowledge and skills necessary for chemical engineering practice. The course emphasizes problem-solving, process analysis, and design principles. Students will explore mass and energy balances, process modeling, and learn how to apply engineering concepts to real-world chemical processes.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the role of chemical engineers in process design and optimization.
- Apply mass and energy balances to chemical systems.
- Analyze chemical processes using mathematical and graphical methods.
- Develop a foundation for subsequent chemical engineering courses.

Topics Covered:

1. **Introduction to Chemical Engineering**
   - Historical context and current trends.
   - Role of chemical engineers in industry.
   - Ethical considerations.
2. **Mass and Energy Balances**
   - Conservation of mass and energy.
   - Steady-state vs. unsteady-state systems.
   - Material and energy flow diagrams.
3. **Process Modeling and Simulation**
   - Mathematical models for chemical processes.
   - Use of software tools (e.g., Aspen Plus, MATLAB).
   - Sensitivity analysis.
4. **Chemical Reactor Design**
   - Types of reactors (batch, continuous, catalytic).

- Reaction kinetics and rate equations.
- Reactor sizing and optimization.

5. **Separation Processes**
    - Distillation, absorption, extraction.
    - Mass transfer principles.
    - Design of separation units.
6. **Process Safety and Hazards**
    - Risk assessment.
    - Safety protocols.
    - Case studies of chemical accidents.
7. **Design Projects**
    - Small-scale process design projects.
    - Integration of theoretical concepts into practical applications.

Assessment:

- Quizzes and exams on fundamental concepts.
- Process analysis assignments.
- Group design projects.

Course Title: Introduction to Thermodynamics

Course Description:

Introduction to Thermodynamics provides foundational knowledge in the study of energy transfer, heat, and work. This course is essential for understanding the behavior of physical systems and their applications in engineering, physics, and chemistry.

Learning Objectives:

By the end of this course, students should be able to:

- Define and apply the First Law of Thermodynamics.
- Analyze energy exchange processes in various systems.
- Understand the concepts of reversibility, irreversibility, and path dependence.
- Apply ideal cycle analysis to heat engine cycles.

Topics Covered:

1. **Thermodynamics Concepts**
    - Definition and significance of thermodynamics.
    - Brief history and evolution of thermodynamic theories.
    - Overview of classical, statistical, and chemical thermodynamics.
2. **First Law of Thermodynamics**
    - Heat, work, and energy.
    - Energy balance in closed systems.
    - Analysis of cycles.

3. **Energy Exchange Processes**
    - Forms of energy (heat and work).
    - Heat engines (e.g., refrigerators, internal combustion engines, jet engines).
    - Reversible and irreversible processes.
4. **Ideal Cycle Analysis**
    - Estimating thermal efficiency and work in heat engine cycles.
    - Pressure and temperature variations during the cycle.

Assessment:

- Quizzes, homework, and self-assessment on thermodynamics concepts.
- Application of steady-flow energy equations to thermodynamic components.
- Understanding the impact of reversibility and irreversibility on system performance.

Course Title: Organic Chemistry I

Course Description:

Organic Chemistry I introduces students to the fundamental principles of organic chemistry. This course focuses on the structure, properties, and reactions of organic compounds. Students will explore topics such as nomenclature, functional groups, stereochemistry, and reaction mechanisms.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the electronic structure of organic molecules.
- Identify and name organic compounds.
- Analyze reaction mechanisms and predict products.
- Apply organic chemistry concepts to real-world scenarios.

Topics Covered:

1. **Introduction to Organic Chemistry**
    - Definition and scope of organic chemistry.
    - Historical context and contributions of key chemists.
    - Electronic structure of carbon atoms.
2. **Hydrocarbons and Functional Groups**
    - Alkanes, alkenes, and alkynes.
    - Aromatic compounds.
    - Alcohols, ethers, and amines.
3. **Isomerism and Stereochemistry**
    - Structural isomers.
    - Geometric (cis-trans) isomers.
    - Chirality and enantiomers.
4. **Nomenclature and Conformational Analysis**
    - IUPAC rules for naming organic compounds.
    - Newman projections and chair conformations.
    - Cycloalkanes and ring strain.
5. **Reaction Mechanisms**

- Electrophilic and nucleophilic reactions.
    - Substitution, elimination, and addition reactions.
    - Reaction intermediates (carbocations, carbanions).
6. **Spectroscopy and Spectrometry**
    - Infrared (IR) spectroscopy.
    - Nuclear magnetic resonance (NMR) spectroscopy.
    - Mass spectrometry (MS).
7. **Organic Synthesis and Retrosynthesis**
    - Designing synthetic routes.
    - Protecting groups.
    - Retrosynthetic analysis.

Assessment:

- Quizzes and exams on organic chemistry concepts.
- Problem-solving assignments related to reaction mechanisms and synthesis.
- Laboratory experiments involving organic reactions and spectroscopic techniques.

Course Title: Calculus for Scientists III

Course Description:

Calculus for Scientists III extends the study of calculus to more advanced topics. This course focuses on multivariable calculus, vector calculus, and applications in science and engineering. Students will explore functions of several variables, line integrals, surface integrals, and gradient fields.

Learning Objectives:

By the end of this course, students should be able to:

- Understand multivariable calculus concepts.
- Apply vector calculus techniques to physical problems.
- Analyze functions and surfaces in three-dimensional space.

Topics Covered:

1. **Functions of Several Variables**
    - Partial derivatives.
    - Gradient vectors.
    - Chain rule for multivariable functions.
2. **Multiple Integrals**
    - Double integrals over rectangular and general regions.
    - Iterated integrals.
    - Applications in physics and engineering.
3. **Vector Calculus**
    - Vector fields.
    - Line integrals.
    - Green’s theorem.
4. **Surface Integrals**
    - Flux and divergence.

    - Parametric surfaces.
    - Stokes' theorem.
5. **Applications in Science and Engineering**
    - Work and circulation.
    - Conservative fields.
    - Applications to fluid flow and electromagnetism.

Assessment:

- Quizzes and exams on multivariable calculus concepts.
- Problem-solving assignments related to vector calculus.
- Application of calculus techniques to physical scenarios.

Course Title: Organic Chemistry Lab

Course Description:

Organic Chemistry Lab provides hands-on experience in organic synthesis, purification, and characterization techniques. Students will apply theoretical knowledge from organic chemistry lectures to practical laboratory experiments. The course emphasizes safety, precision, and critical thinking in the context of organic reactions.

Learning Objectives:

By the end of this course, students should be able to:

- Perform organic reactions following established protocols.
- Safely handle chemicals and laboratory equipment.
- Analyze and interpret experimental data.
- Communicate results effectively.

Topics Covered:

1. **Laboratory Safety and Techniques**
    - Proper use of lab equipment (glassware, fume hoods, balances).
    - Handling hazardous chemicals.
    - Emergency procedures.
2. **Extraction and Purification**
    - Extraction of organic compounds.
    - Recrystallization techniques.
    - Thin-layer chromatography (TLC).
3. **Synthesis of Organic Compounds**
    - Preparation of alcohols, aldehydes, ketones, and esters.
    - Multistep syntheses.
    - Isolation and purification of reaction products.
4. **Spectroscopic Analysis**
    - Infrared (IR) spectroscopy.
    - Nuclear magnetic resonance (NMR) spectroscopy.
    - Mass spectrometry (MS).
5. **Reaction Mechanisms and Stereochemistry**
    - Mechanistic studies of organic reactions.

    - Determination of reaction pathways.
    - Chirality and enantiomers.
6. **Laboratory Reports and Communication**
    - Writing clear and concise lab reports.
    - Data analysis and error propagation.
    - Presenting findings to peers.

Assessment:

- Laboratory performance and technique.
- Lab reports and notebooks.
- Participation in group discussions and presentations.

Course Title: Physics II (Electromagnetism and Optics)

Course Description:

Physics II (Electromagnetism and Optics) builds upon the foundational concepts introduced in Physics I. This course focuses on the principles of electromagnetism and the behavior of light. Students will explore electric and magnetic fields, electromagnetic waves, and optical phenomena.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the behavior of electric and magnetic fields.
- Analyze electromagnetic waves and their properties.
- Apply optics principles to real-world scenarios.

Topics Covered:

1. **Electric Fields and Gauss's Law**
    - Coulomb's law and electric force.
    - Electric field lines.
    - Gauss's law and its applications.
2. **Electric Potential and Capacitance**
    - Electric potential energy.
    - Voltage and potential difference.
    - Capacitors and dielectrics.
3. **Magnetic Fields and Ampere's Law**
    - Magnetic force on moving charges.
    - Magnetic field lines.
    - Ampere's law and magnetic flux.
4. **Faraday's Law and Inductance**
    - Faraday's law of electromagnetic induction.
    - Self-inductance and mutual inductance.
    - Applications in transformers and inductors.
5. **Electromagnetic Waves and Optics**
    - Electromagnetic spectrum.
    - Reflection and refraction of light.

- Interference and diffraction.

6. **Geometric Optics and Lens Systems**
   - Ray tracing.
   - Thin lenses and lens formulas.
   - Aberrations and lens design.
7. **Wave Optics and Polarization**
   - Interference of light waves.
   - Diffraction patterns.
   - Polarization of light.

Assessment:

- Quizzes and exams on electromagnetism and optics concepts.
- Problem-solving assignments related to electromagnetic fields and optical phenomena.
- Laboratory experiments involving optics and electromagnetic waves.

Course Title: Computational Methods in Chemical Engineering

Course Description:

Computational Methods in Chemical Engineering introduces students to numerical techniques and computer-based tools commonly used in chemical engineering practice. This course focuses on solving engineering problems, simulating processes, and analyzing data using computational methods. Students will gain proficiency in programming, data analysis, and modeling.

Learning Objectives:

By the end of this course, students should be able to:

- Apply numerical methods to solve chemical engineering problems.
- Use software tools for data analysis and process simulation.
- Develop and implement algorithms for engineering applications.

Topics Covered:

1. **Introduction to Computational Methods**
   - Role of computation in chemical engineering.
   - Overview of numerical techniques.
   - Error analysis and convergence.
2. **Programming Fundamentals**
   - Introduction to a programming language (e.g., Python, MATLAB).
   - Variables, loops, and conditional statements.
   - Functions and modular programming.
3. **Numerical Methods for Equations**
   - Root-finding algorithms (Newton-Raphson, bisection).
   - Solving linear and nonlinear equations.
   - Interpolation and curve fitting.
4. **Numerical Integration and Differentiation**
   - Trapezoidal rule, Simpson’s rule.

    - Numerical differentiation.
    - Error estimation.
5. **Process Simulation and Modeling**
    - Introduction to process simulators (e.g., Aspen Plus, COMSOL).
    - Dynamic simulations.
    - Sensitivity analysis.
6. **Data Analysis and Visualization**
    - Statistical methods (mean, variance, regression).
    - Plotting data (scatter plots, histograms).
    - Data preprocessing.
7. **Project Work and Case Studies**
    - Application of computational methods to chemical engineering scenarios.
    - Modeling transport phenomena, reaction kinetics, and process optimization.

Assessment:

- Quizzes and exams on numerical techniques and programming concepts.
- Problem-solving assignments.
- Final project applying computational methods to a chemical engineering problem.

Course Title: Materials and Energy Balances

Course Description:

Materials and Energy Balances is a fundamental course in chemical engineering that focuses on the principles of mass and energy conservation. Students will learn how to analyze and quantify the flow of materials and energy in chemical processes. The course emphasizes problem-solving, process analysis, and the development of systematic approaches.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the fundamental laws of mass and energy conservation.
- Apply material balance equations to analyze chemical processes.
- Quantify energy use and losses in production systems.
- Develop problem-solving skills for engineering applications.

Topics Covered:

1. **Introduction to Material and Energy Balances**
    - Role of mass and energy balances in chemical engineering.
    - Classification of processes (steady state, transient, continuous, batch).
    - Differential and integral balances.
2. **Material Balances**
    - Input, output, and accumulation terms.
    - Degrees of freedom and solving mass balance problems.
    - Flowchart development.
3. **Energy Balances**
    - Different forms of energy (kinetic, potential, internal, etc.).
    - Heat balances and energy use in closed and open systems.

    - Sankey diagrams for energy conservation.
4. **Applications in Chemical Processes**
    - Solving material and energy balance equations for reactors, separators, and other unit operations.
    - Optimization of energy costs.
    - Environmental impact assessment.

Assessment:

- Quizzes and exams on mass and energy balance concepts.
- Problem-solving assignments related to chemical processes.
- Case studies analyzing real-world systems.

Course Title: Organic Chemistry II

Course Description:

Organic Chemistry II builds upon the foundational concepts introduced in Organic Chemistry I. This course delves deeper into the study of organic compounds, their reactions, and functional groups. Students will explore advanced topics in stereochemistry, spectroscopy, and synthesis.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the behavior of organic molecules.
- Analyze reaction mechanisms and predict products.
- Apply spectroscopic techniques to identify organic compounds.

Topics Covered:

1. **Stereochemistry**
    - Chirality and enantiomers.
    - Diastereomers and meso compounds.
    - Optical activity and specific rotation.
2. **Spectroscopy and Spectrometry**
    - Infrared (IR) spectroscopy.
    - Nuclear magnetic resonance (NMR) spectroscopy.
    - Mass spectrometry (MS).
3. **Reactions of Functional Groups**
    - Alcohols, ethers, and epoxides.
    - Aldehydes and ketones.
    - Carboxylic acids and derivatives.
4. **Aromatic Compounds and Heterocycles**
    - Benzene and its derivatives.
    - Aromatic electrophilic substitution.
    - Heterocyclic compounds.
5. **Multi-Step Synthesis**
    - Designing synthetic routes.
    - Protecting groups.

    - Retrosynthetic analysis.
6. **Laboratory Techniques**
    - Purification methods (distillation, recrystallization).
    - Characterization of organic compounds.

Assessment:

- Quizzes and exams on organic reactions and spectroscopy.
- Problem-solving assignments related to synthesis and mechanisms.
- Laboratory experiments involving organic synthesis and analysis.

Course Title: Principles of Economics

Course Description:

Principles of Economics introduces students to fundamental economic concepts and their applications. This course provides a solid foundation for understanding economic behavior, market dynamics, and decision-making. Students will explore microeconomics and macroeconomics topics relevant to engineering and industry.

Learning Objectives:

By the end of this course, students should be able to:

- Understand basic economic principles.
- Analyze supply and demand in various markets.
- Apply economic reasoning to engineering and business scenarios.

Topics Covered:

1. **Introduction to Economics**
    - Definition and scope of economics.
    - Economic agents (consumers, firms, government).
    - Opportunity cost and trade-offs.
2. **Microeconomics**
    - Supply and demand.
    - Elasticity of demand and supply.
    - Consumer behavior and utility theory.
3. **Market Structures**
    - Perfect competition, monopoly, oligopoly.
    - Price determination and market power.
    - Game theory and strategic behavior.
4. **Macroeconomics**
    - National income and output.
    - Inflation and unemployment.
    - Fiscal and monetary policy.
5. **Engineering Applications**
    - Cost-benefit analysis.
    - Project evaluation and investment decisions.
    - Environmental economics.
6. **Case Studies and Industry Examples**

    - Energy markets.
    - Technological innovation and economic growth.
    - Global economic trends.

Assessment:

- Quizzes and exams on economic concepts.
- Problem-solving assignments related to engineering scenarios.
- Group discussions and presentations on economic issues.

Course Title: Differential Equations

Course Description:

This course introduces chemical engineering students to ordinary differential equations (ODEs) and their applications in various engineering contexts. Students will explore mathematical techniques commonly used to solve chemical engineering problems, including modeling chemical reactions, heat transfer, mass transfer, fluid flow, and reaction kinetics. Topics covered include first-order ODEs, separable equations, linear ODEs, numerical methods, linear algebra, and optimization techniques.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the fundamental concepts of ordinary differential equations.
- Apply mathematical techniques to solve ODEs relevant to chemical engineering.
- Analyze and model chemical processes using differential equations.
- Interpret the physical significance of solutions to ODEs in chemical engineering contexts.

Topics Covered:

1. **Introduction to Differential Equations**
    - Definition of ODEs
    - First-order ODEs
    - Separable equations
    - Linear ODEs
2. **Mathematical Techniques for Solving ODEs**
    - Numerical methods (e.g., Euler's method)
    - Linear algebra
    - Optimization techniques
    - Methods for solving process dynamics
3. **Applications in Chemical Engineering**
    - Modeling chemical reactions
    - Heat transfer and mass transfer
    - Fluid flow and transport phenomena
    - Reaction kinetics

Assessment:

- Marked laboratory and project work
- Written examinations at the end of the year

Recommended Reading:

1. Boyce, W. E., & DiPrima, R. C. (2012). *Elementary Differential Equations and Boundary Value Problems*. Wiley.
2. Levenspiel, O. (1999). *Chemical Reaction Engineering*. Wiley.

Course Title: Fluid Mechanics

Course Description:

This course provides an introduction to the fundamental concepts and methods of fluid mechanics. Students will explore the behavior of fluids, including pressure, hydrostatics, buoyancy, and flow through pipes. The course covers both theoretical principles and practical applications relevant to mechanical engineering.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the physical properties of fluids.
- Apply equations of motion for incompressible ideal flow.
- Analyze continuity, energy, and momentum principles.
- Perform control volume analysis for fluid systems.
- Differentiate between laminar and turbulent flows.
- Apply fluid mechanics principles to engineering applications.

Topics Covered:

1. **Fluid Properties and Behavior**
   - Pressure, hydrostatics, and buoyancy
   - Fluid kinematics (Lagrangian and Eulerian views)
2. **Equations of Motion and Flow Analysis**
   - Incompressible ideal flow
   - Control volume analysis
   - Laminar and turbulent flows
3. **Engineering Applications**
   - Flow through pipes
   - Open channels
   - Boundary-layer theory elements

Assessment:

- Assignments and problem sets
- Examinations (midterm and final)

Recommended Reading:

1. Cengel, Y. A., & Cimbala, J. M. (2014). *Fluid Mechanics: Fundamentals and Applications*. McGraw-Hill Education.
2. White, F. M. (2016). *Fluid Mechanics*. McGraw-Hill Education.

Course Title: Chemical Engineering Thermodynamics

Course Description:

Chemical Engineering Thermodynamics deals with the macroscopic relationships between thermal energy (heat transfer) and work (useful energy) in steady-state and uniform systems. This course explores fundamental concepts, laws, and properties related to thermodynamics and their applications in chemical engineering.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the basic principles of thermodynamics.
- Apply thermodynamic laws to chemical processes.
- Analyze thermodynamic properties and relations.
- Solve problems related to vapor-liquid equilibrium (VLE) and solution theory.

Topics Covered:

1. **Introduction to Thermodynamics**
   - Basic concepts and laws of thermodynamics
   - Equilibrium types and criteria
2. **Thermodynamic Properties and Relations**
   - PVT behaviors and equation of state
   - Free energy and property relations
   - Residual properties
3. **Vapor-Liquid Equilibrium (VLE)**
   - One-component VLE and Raoult's law
   - Multicomponent VLE calculations
   - General mixture behavior (Pxy)
4. **Solution Theory and Thermodynamic Properties of Mixtures**
   - Partial properties and chemical potential
   - Ideal-gas mixture
   - Fugacity
   - Ideal and non-ideal solutions (activity and excess properties)
5. **Thermodynamics of Mixtures and Mixing**

Assessment:

- Assignments, problem sets, and laboratory work
- Written examinations (midterm and final)

Recommended Reading:

1. Smith, J. M., Van Ness, H. C., & Abbott, M. M. (2005). *Introduction to Chemical Engineering Thermodynamics*. McGraw-Hill Education.

2. Prausnitz, J. M., Lichtenthaler, R. N., & de Azevedo, E. G. (1998). *Molecular Thermodynamics of Fluid-Phase Equilibria*. Prentice Hall.

Course Title: Physical Chemistry: A Molecular Perspective

Course Description:

Physical Chemistry explores the macroscopic, atomic, subatomic, and particulate phenomena in chemical systems using principles and concepts from physics. In this course, we focus on the molecular aspects of physical chemistry, emphasizing the behavior of molecules and their interactions.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the fundamental principles of physical chemistry.
- Apply thermodynamics, quantum physics, and statistical mechanics to chemical systems.
- Analyze equilibrium, kinetics, and molecular properties.

Topics Covered:

1. **Introduction to Physical Chemistry**
    - Definition and scope
    - Role of physics in chemical systems
2. **Thermodynamics and Energy**
    - Laws of thermodynamics
    - Enthalpy, entropy, and Gibbs free energy
    - Chemical equilibrium
3. **Quantum Mechanics and Molecular Structure**
    - Wave functions and Schrödinger equation
    - Molecular orbitals and electronic structure
    - Spectroscopy
4. **Statistical Mechanics and Kinetics**
    - Boltzmann distribution
    - Reaction rates and transition states
    - Molecular dynamics

Assessment:

- Problem-solving assignments
- Examinations (midterm and final)

Recommended Textbook:

- D.A. McQuarrie, J.D. Simon, *Physical Chemistry: A Molecular Approach*. University Science Books (1997).

Course Title: Chemical Engineering Thermodynamics Lab

Course Description:

The Chemical Engineering Thermodynamics Lab provides hands-on experience in applying thermodynamic principles to real-world chemical engineering scenarios. Students will engage in practical experiments, measurements, and data analysis related to thermodynamic properties, phase equilibria, and energy transfer.

Learning Objectives:

By the end of this course, students should be able to:

- Conduct laboratory experiments to verify thermodynamic concepts.
- Measure properties such as pressure, temperature, and volume.
- Analyze vapor-liquid equilibrium (VLE) behavior.
- Understand the impact of thermodynamics on chemical processes.

Topics Covered:

1. **Introduction to Thermodynamics Lab**
    - Safety protocols and lab equipment
    - Data collection techniques
2. **Measurement of Thermodynamic Properties**
    - Pressure measurement using manometers
    - Temperature measurement using thermocouples
    - Volume measurement using burettes
3. **Vapor-Liquid Equilibrium Experiments**
    - Bubble point and dew point calculations
    - Raoult's law and binary VLE
    - Constructing Pxy diagrams
4. **Heat Transfer and Energy Balance**
    - Calorimetry experiments
    - Heat exchanger performance analysis

Assessment:

- Lab reports and data analysis
- Practical exams based on experimental setups

Recommended Reading:

1. Smith, J. M., Van Ness, H. C., & Abbott, M. M. (2005). *Introduction to Chemical Engineering Thermodynamics*. McGraw-Hill Education.

Course Title: Bioprocessing Engineering

Course Description:

Bioprocessing engineering focuses on the role of living organisms in manufacturing processes. This course explores fundamental concepts related to biocatalysis, fermentation, and downstream operations. Students will learn to apply principles of mass and energy balances in integrated bioprocesses.

Learning Objectives:

By the end of this course, students should be able to:

- Understand biocatalysis and metabolic engineering.
- Explore advanced bioreactor design and scale-up.
- Analyze downstream operations for recovery and purification of biologics.

Topics Covered:

1. **Introduction to Bioprocessing**
    - Biocatalysis and metabolic engineering
    - Advanced bioreactor design and scaling
2. **Downstream Operations**
    - General purification strategy
    - Properties of biomolecules
    - Cell disruption and flocculation
    - Sedimentation, centrifugation, and filtration
    - Liquid chromatography

Assessment:

- Assignments, practical experiments, and case studies
- Written examinations (midterm and final)

Recommended Reading:

1. Smith, J. M., Van Ness, H. C., & Abbott, M. M. (2005). *Introduction to Chemical Engineering Thermodynamics*. McGraw-Hill Education.

Course Title: Heat and Mass Transfer

Course Description:

Heat and Mass Transfer is a fundamental course in chemical engineering that explores the transfer of energy (heat) and matter (mass) within various systems. Students will learn about the principles governing these processes and their applications in industrial settings.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the mechanisms of heat transfer (conduction, convection, and radiation).
- Analyze mass transfer phenomena (diffusion and convection).
- Apply mathematical models to solve heat and mass transfer problems.

Topics Covered:

1. **Conduction Heat Transfer**
   - Fourier's law
   - Steady-state and transient conduction
   - Thermal resistance networks
2. **Convective Heat Transfer**
   - Forced convection
   - Natural convection
   - Heat exchangers
3. **Radiation Heat Transfer**
   - Stefan-Boltzmann law
   - Blackbody radiation
   - View factors
4. **Mass Transfer**
   - Fick's law of diffusion
   - Mass transfer coefficients
   - Binary and multicomponent systems

Assessment:

- Assignments, problem-solving exercises, and laboratory experiments
- Written examinations (midterm and final)

Recommended Textbooks:

1. Incropera, F. P., & DeWitt, D. P. (2007). *Fundamentals of Heat and Mass Transfer*. Wiley.
2. Cussler, E. L. (2009). *Diffusion: Mass Transfer in Fluid Systems*. Cambridge University Press.

Course Title: Chemical Engineering Separations

Course Description:

This course covers the principles and design of large-scale diffusional separation processes. Emphasis is placed on developing quantitative problem-solving skills essential for practicing graduates. Topics include various separation processes, equilibrium-stage operations, continuous-contact operations, and mass transfer.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the principles for designing selected separation units, including:
  - Distillation columns (flash, binary, and multicomponent)
  - Gas absorption/stripping

    - Liquid-liquid extraction
    - Membrane separation processes
    - Sorption processes (adsorption, ion exchange, and chromatography)

Topics Covered:

1. **Distillation**
    - Flash distillation
    - Binary distillation
    - Multicomponent distillation
2. **Gas Absorption and Stripping**
    - Equilibrium-based modeling
    - Design of absorption and stripping columns
3. **Liquid-Liquid Extraction**
    - Solvent extraction
    - Counterflow extraction
4. **Membrane Separation Processes**
    - Reverse osmosis
    - Ultrafiltration
5. **Sorption Processes**
    - Adsorption columns
    - Ion exchange
    - Chromatography

Assessment:

- Problem-solving assignments
- Examinations (midterm and final)

Recommended Textbook:

1. Seader, J. D., & Henley, E. J. (2006). *Separation Process Principles*. Wiley.

Course Title: Process Dynamics and Control

Course Description:

Process Dynamics and Control is a fundamental course in chemical engineering that explores the mathematical theory, modern practice, and industrial technology of process control. The course combines theoretical and computational approaches to illustrate how dynamic mass and heat balances govern the response of unit operations and plants to setpoint changes and external disturbances.

Learning Objectives:

By the end of this course, students will be able to:

- Recognize and classify dynamic variables of chemical processes.
- Develop simple process unit dynamic models from balances.

- Apply Laplace and Inverse Laplace Transforms to obtain s-domain transfer functions and dynamic responses.
- Solve dynamic models using MATLAB.

Topics Covered:

1. **Introduction to Process Control**
   - Control architecture design, notation, and implementation
   - Mathematical modeling and analysis of open-loop and closed-loop process dynamics
2. **Dynamics of Simple Systems**
   - Formulation of transient mass and energy balances
   - Linearization relative to steady state (setpoint)
   - Laplace Transforms: Definition, properties, and solution of linear dynamic problems
3. **Feedback Control**
   - Open and closed loops
   - PID Control: Proportional, Integral, and Derivative components
   - Tuning of PID controllers
4. **Experimental Determination of Transfer Functions**
   - Routh-Hurwitz stability
   - Examples and synthesis of control loops in chemical engineering
5. **Advanced Process Control Techniques**
   - Introduction to feedback, feedforward, ratio control, cascade control, and Model Predictive Control (MPC)

Prerequisites:

- Recommended prerequisites include Chemical Engineering Kinetics and Catalysis, Chemical Engineering Unit Operations, Solids Processing, and Computational Methods for Chemical Engineers.

Course Title: Unit Operations Laboratory

Course Description:

The **Unit Operations Laboratory** provides practical and theoretical experience in essential chemical and pharmaceutical engineering unit operations. Students gain a thorough understanding of unit operation principles and material selection. The course covers experimental design, execution, data analysis, oral presentation skills, technical report writing, and team-building.

Learning Outcomes:

By the end of this course, students will be able to:

- Apply theoretical knowledge to practical experiments.

- Analyze data and draw conclusions.
- Communicate effectively through reports and presentations.

Key Topics and Experiments:

1. **Fluid and Particle Mechanics:**
    - Principles of fluid flow and particle behavior
    - Measurement techniques (e.g., flow rates, pressure drops)
2. **Separation Processes:**
    - Distillation (flash, binary, and multicomponent)
    - Gas absorption and stripping
    - Liquid-liquid extraction
3. **Heat Transfer:**
    - Heat exchangers
    - Conductive and convective heat transfer
4. **Microbial Growth and Protein Separation:**
    - Bioreactor experiments
    - Protein purification techniques
5. **Chemical Reactor Engineering:**
    - Reactor design and kinetics
    - Safety considerations

Course Title: Introduction to Electrochemical Engineering

Course Description:

This course provides a broad introduction to electrochemistry and electrochemical technology. It covers the principles of electrochemistry and their application in various areas, including synthesis, energy systems, materials, surface engineering, and water treatment. Special emphasis is placed on the design and engineering aspects behind electrochemical technology.

Topics Covered:

1. **Introduction to Electrochemistry and Electrochemical Engineering**
    - Overview of electrochemical processes
    - Applications and relevance
2. **Basic Principles of Electrochemistry**
    - Redox reactions
    - Electrode potentials
    - Nernst equation
3. **Potential and Thermodynamics of Electrochemical Cells**
    - Cell potential
    - Gibbs free energy
    - Electrochemical equilibrium
4. **Kinetics of Electrode Processes**
    - Butler-Volmer equation
    - Tafel slopes
    - Charge transfer reactions
5. **Transport Phenomena in Electrochemical Systems**
    - Mass transport (diffusion and convection)
    - Charge transport (ionic conductivity)

6. **Electroanalytical Methods**
    - Voltammetry
    - Potentiostatic techniques
    - Impedance spectroscopy
7. **Electrochemical Reactors and Applications**
    - Design considerations
    - Electrolysis cells
    - Fuel cells and batteries
8. **Materials and Surface Engineering**
    - Corrosion prevention
    - Coatings and surface modifications

Assessment:

- Written exam (100%)

Recommended Textbooks:

1. Pletcher, D., & Walsh, F. C. (1990). *Industrial Electrochemistry* (2nd Edition). London: Blackie Academic & Professional.
2. Fuller, T. F., & Harb, J. N. (2018). *Electrochemical Engineering* (1st Edition). Hoboken: John Wiley & Sons.

Course Title: Chemical Engineering Design

Course Description:

Chemical Engineering Design focuses on the application of engineering principles to design and optimize chemical processes and equipment. Students learn how to conceptualize, analyze, and synthesize chemical systems, considering safety, economics, and environmental impact.

Learning Objectives:

By the end of this course, students should be able to:

- Understand the design process and its stages.
- Apply mass and energy balances to process design.
- Evaluate equipment selection and sizing.
- Consider safety, sustainability, and economic factors in design.

Topics Covered:

1. **Introduction to Process Design**
    - Design stages: conceptual, preliminary, detailed
    - Feasibility studies and project scope
2. **Process Flowsheet Development**
    - Block flow diagrams (BFDs)
    - Process flow diagrams (PFDs)
    - Heat and material balances
3. **Equipment Design and Sizing**

   - Reactors, distillation columns, heat exchangers
   - Pumps, compressors, separators
   - Pressure vessels, piping, instrumentation
4. **Safety and Environmental Considerations**
   - Hazard identification and risk assessment
   - Process safety management
   - Environmental impact assessment
5. **Economic Analysis and Optimization**
   - Cost estimation
   - Profitability analysis
   - Trade-offs and sensitivity analysis

Assessment:

- Design projects (individual or team-based)
- Written reports and presentations

Recommended Textbooks:

1. Towler, G., & Sinnott, R. (2013). *Chemical Engineering Design: Principles, Practice, and Economics of Plant and Process Design*. Elsevier.
2. Peters, M. S., Timmerhaus, K. D., & West, R. E. (2003). *Plant Design and Economics for Chemical Engineers*. McGraw-Hill Education.

Course Title: Chemical Process Safety

Course Description:

Chemical Process Safety focuses on preventing and mitigating hazards associated with chemical processes. Students learn about risk assessment, safety management, and emergency response. The course emphasizes the importance of safety culture and compliance with regulations.

Learning Outcomes:

By the end of the course, students will understand:

- The key principles of process safety and its management.
- The consequences of poor process safety on human health, the environment, and business.
- Hazard identification techniques and risk control measures.
- Safety requirements throughout the life cycle of a process plant.

Topics Covered:

1. **Introduction to Process Safety**
   - Importance of process safety
   - Legal and regulatory frameworks
2. **Hazard Identification and Evaluation**
   - Identifying potential hazards
   - Risk assessment techniques (e.g., HAZOP, LOPA)

3. **Consequences of Process Incidents**
    - Toxicity and fires
    - Explosions and chemical reactions
4. **Design Safety and Risk Assessment**
    - Designing for safety
    - Quantitative risk analysis
5. **Operations and Asset Integrity**
    - Safe operating procedures
    - Maintenance and inspection
6. **Management of Change**
    - Handling modifications
    - Impact on safety
7. **Human Factors and Safety Culture**
    - Human error prevention
    - Building a safety-conscious culture
8. **Emergency Response and Preparedness**
    - Crisis management
    - Evacuation procedures

Assessment:

- Written exams
- Case studies and practical exercises

Course Title: Kinetics and Reaction Engineering

Course Description:

Kinetics and Reaction Engineering focuses on understanding the rates of chemical reactions and their applications in chemical processes. Students learn about reaction mechanisms, rate laws, reactor design, and optimization.

Learning Objectives:

By the end of this course, students should be able to:

1. **Understand Reaction Kinetics:**
    - Define reaction rates and rate expressions.
    - Derive rate laws from experimental data.
    - Identify elementary steps and reaction pathways.
2. **Analyze Reactor Behavior:**
    - Describe steady-state and transient behavior in batch reactors, continuous stirred tank reactors (CSTRs), and plug flow reactors (PFRs).
    - Apply mass and energy balances to reactor design.
3. **Design and Optimize Reactors:**
    - Select appropriate reactor types based on reaction kinetics.
    - Size reactors for specific applications.
    - Consider isothermal and non-isothermal conditions.
4. **Explore Catalysis and Surface Reactions:**
    - Understand the role of catalysts in chemical reactions.
    - Discuss catalytic surfaces and deactivation.
5. **Address Mass Transfer Effects:**

- Recognize the impact of internal and external diffusion on reaction rates.

Assessment:

- Written exams
- Design projects and problem-solving exercises

Course Title: Quantitative Human Biology

Course Description:

Quantitative Human Biology explores the intersection of biology, mathematics, and data analysis to understand human physiological processes. Students learn to apply quantitative methods to study biological systems, analyze data, and model complex interactions.

Learning Objectives:

By the end of this course, students should be able to:

1. **Understand Biological Systems:**
   - Explore human anatomy, physiology, and cellular processes.
   - Investigate how biological systems function and adapt.
2. **Quantitative Methods:**
   - Learn mathematical techniques (e.g., calculus, statistics) relevant to biological modeling.
   - Apply quantitative reasoning to biological problems.
3. **Data Analysis and Visualization:**
   - Collect and analyze biological data.
   - Use software tools (e.g., R, Python) for data visualization.
4. **Biological Modeling:**
   - Develop mathematical models for biological processes (e.g., enzyme kinetics, population dynamics).
   - Simulate and interpret model outcomes.

Topics Covered:

1. **Introduction to Human Physiology:**
   - Overview of organ systems
   - Homeostasis and feedback mechanisms
2. **Mathematical Foundations:**
   - Differential equations in biology
   - Probability and statistical analysis
3. **Biological Data Collection and Analysis:**
   - Experimental design
   - Hypothesis testing
   - Regression analysis
4. **Modeling Biological Processes:**
   - Enzyme kinetics
   - Pharmacokinetics
   - Population growth models
5. **Bioinformatics and Genomics:**

    - DNA sequencing
    - Gene expression analysis
    - Systems biology

Assessment:

- Written exams
- Data analysis projects
- Presentations

Recommended Reading:

1. Keener, J. P., & Sneyd, J. (2009). *Mathematical Physiology: I: Cellular Physiology*. Springer.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular Biology of the Cell* (6th ed.). Garland Science.

Course Title: Polymer Science and Technology

Course Description:

Polymer Science and Technology provides an in-depth understanding of polymers, their properties, processing techniques, and applications. Students explore the chemistry of polymers, their behavior under various conditions, and practical aspects of polymer engineering.

Learning Objectives:

By the end of this course, students should be able to:

1. **Understand Polymer Chemistry:**
    - Explore the structure and bonding of polymers.
    - Relate polymer properties to their chemical composition.
2. **Polymer Processing Techniques:**
    - Learn about extrusion, injection molding, and other shaping methods.
    - Understand the impact of processing on polymer properties.
3. **Polymer Characterization:**
    - Analyze molecular weight, crystallinity, and thermal behavior.
    - Use techniques such as spectroscopy and microscopy.
4. **Applications and Material Selection:**
    - Study polymer applications in various industries (e.g., packaging, automotive, biomedical).
    - Select appropriate polymers for specific uses.

Topics Covered:

1. **Introduction to Polymers:**
    - Overview of polymer science and historical context.
    - Types of polymers and their significance.
2. **Polymer Structure and Properties:**
    - Polymerization mechanisms (e.g., addition, condensation).

    - Amorphous vs. crystalline structures.
3. **Polymer Processing Methods:**
    - Extrusion, injection molding, blow molding.
    - Thermoforming and rotational molding.
4. **Polymer Characterization Techniques:**
    - Fourier-transform infrared spectroscopy (FTIR).
    - Differential scanning calorimetry (DSC).
5. **Polymer Applications:**
    - Packaging materials (films, bottles).
    - Elastomers, fibers, and coatings.

Assessment:

- Written exams
- Laboratory work (hands-on polymer processing)
- Project assignments (material selection and design)

Recommended Reading:

1. Odian, G. (2004). *Principles of Polymerization*. Wiley.
2. Callister, W. D., & Rethwisch, D. G. (2018). *Materials Science and Engineering: An Introduction*. Wiley.

Course Title: Introduction to Energy Technologies

Course Description:

The course “Introduction to Energy Technologies” provides a foundational understanding of various energy sources, their conversion methods, and their impact on society. Students explore the principles behind energy production, distribution, and utilization. The course emphasizes sustainable and efficient energy practices.

Learning Objectives:

By the end of this course, students should be able to:

1. **Comprehend Energy Systems:**
    - Understand the global energy landscape.
    - Identify different energy sources (renewable and non-renewable).
2. **Energy Conversion Technologies:**
    - Explore methods for converting energy (e.g., combustion, nuclear, solar, wind).
    - Analyze efficiency and environmental implications.
3. **Energy Storage and Distribution:**
    - Study energy storage technologies (e.g., batteries, pumped hydro).
    - Investigate grid systems and transmission.
4. **Sustainable Energy Practices:**
    - Evaluate the role of energy efficiency and conservation.
    - Discuss policy and regulatory aspects.

Topics Covered:

1. **Introduction to Energy Systems:**
    - Overview of global energy demand and supply.
    - Energy security and environmental challenges.
2. **Non-Renewable Energy Sources:**
    - Fossil fuels (coal, oil, natural gas).
    - Nuclear energy (fission).
3. **Renewable Energy Technologies:**
    - Solar energy (photovoltaics, solar thermal).
    - Wind energy.
    - Hydropower.
4. **Energy Storage and Grid Integration:**
    - Battery technologies.
    - Smart grids and demand-side management.

Assessment:

- Written exams
- Case studies and projects
- Class participation

Recommended Reading:

1. Boyle, G., Everett, B., & Ramage, J. (2012). *Energy Systems and Sustainability: Power for a Sustainable Future*. Oxford University Press.
2. Turner, J. A. (2017). *Renewable Energy: Physics, Engineering, Environmental Impacts, Economics & Planning*. Springer.

Course Title: Mathematical Methods in Chemical Engineering

Course Description:

Mathematical Methods in Chemical Engineering provides essential tools for solving complex problems encountered in chemical engineering. Students learn mathematical techniques relevant to modeling, analysis, and optimization of chemical processes.

Learning Objectives:

By the end of this course, students should be able to:

1. **Apply Mathematical Concepts:**
    - Understand fundamental mathematical concepts (e.g., calculus, linear algebra).
    - Apply these concepts to chemical engineering problems.
2. **Numerical Methods:**
    - Learn numerical techniques for solving equations.
    - Implement and test these methods using practical computer exercises.
3. **Differential Equations:**
    - Solve linear and nonlinear ordinary differential equations.
    - Analyze systems with variable coefficients.
4. **Process Dynamics and Control:**
    - Apply mathematical modeling principles to process dynamics.

- Understand control system design.

Topics Covered:

1. **Introduction to Mathematical Techniques:**
    - Review of calculus and algebra.
    - Numerical methods for solving equations.
2. **Linear Algebra and Optimization:**
    - Matrix operations and eigenvalues.
    - Optimization techniques (e.g., linear programming).
3. **Differential Equations:**
    - First-order and higher-order ODEs.
    - Systems of differential equations.
4. **Process Dynamics and Control:**
    - Transfer functions and Laplace transforms.
    - Stability analysis and control strategies.

Assessment:

- Written exams
- Practical computer exercises
- Problem-solving assignments

Recommended Reading:

1. Kreyszig, E. (2018). *Advanced Engineering Mathematics*. Wiley.
2. Seborg, D. E., Edgar, T. F., & Mellichamp, D. A. (2010). *Process Dynamics and Control*. Wiley.

Course Title: Natural Gas Processing

Course Description:

Natural Gas Processing provides an in-depth understanding of the techniques and technologies used to extract, purify, and transport natural gas. Students explore the entire natural gas value chain, from production to distribution, and learn about safety, environmental considerations, and economic aspects.

Learning Objectives:

By the end of this course, students should be able to:

1. **Understand Natural Gas Composition:**
    - Explore the chemical composition of natural gas.
    - Identify impurities and contaminants.
2. **Gas Processing Techniques:**
    - Learn methods for separating natural gas components (e.g., methane, ethane, propane).
    - Understand processes such as sweetening, dehydration, and fractionation.
3. **Gas Compression and Transportation:**
    - Study compression stations and pipelines.

        - Analyze flow rates, pressure, and capacity.
4. **Safety and Environmental Considerations:**
    - Evaluate safety protocols in gas processing plants.
    - Address environmental impact and emissions.

Topics Covered:

1. **Introduction to Natural Gas:**
    - Overview of natural gas reserves and production.
    - Gas reservoirs and exploration.
2. **Gas Separation and Purification:**
    - Sweetening (removing hydrogen sulfide).
    - Dehydration (removing water vapor).
    - Fractionation (separating natural gas liquids).
3. **Gas Compression and Transmission:**
    - Compressor stations and pipeline networks.
    - Flow calculations and capacity planning.
4. **Economic and Regulatory Aspects:**
    - Cost analysis and project economics.
    - Compliance with safety regulations.

Assessment:

- Written exams
- Case studies and process simulations
- Group projects on gas processing facilities

Recommended Reading:

1. Speight, J. G. (2014). *Natural Gas: A Basic Handbook*. Gulf Professional Publishing.
2. Campbell, J. M. (2017). *Gas Conditioning and Processing: The Equipment Modules*. Gulf Professional Publishing.

Course Title: Chemical Research Project

Course Description:

The Chemical Research Project course provides students with an opportunity to engage in independent research within the field of chemical engineering. Students work on a substantial research project, applying their knowledge and skills to address real-world challenges. The course emphasizes critical thinking, experimental design, data analysis, and effective communication.

Learning Objectives:

By the end of this course, students should be able to:

1. **Formulate Research Objectives:**
    - Define clear research goals and scope.
    - Identify relevant literature and existing knowledge gaps.
2. **Conduct Independent Research:**
    - Design experiments or simulations.
    - Collect and analyze data using appropriate techniques.
3. **Interpret Results and Draw Conclusions:**
    - Evaluate research outcomes.
    - Address limitations and uncertainties.
4. **Effective Communication:**
    - Prepare written reports or research papers.
    - Present findings to peers and faculty.

Topics Covered:

1. **Project Proposal and Planning:**
    - Defining research questions.
    - Developing a research plan and timeline.
2. **Literature Review:**
    - Surveying relevant scientific literature.
    - Identifying key concepts and methodologies.
3. **Experimental Work or Simulation:**
    - Conducting experiments or simulations.
    - Collecting data and maintaining records.
4. **Data Analysis and Interpretation:**
    - Statistical analysis.
    - Drawing meaningful conclusions.
5. **Research Presentation and Reporting:**
    - Preparing oral presentations.
    - Writing research reports or papers.

Assessment:

- Research proposal and project plan.
- Progress reports.
- Final research paper or thesis.
- Oral presentation.

Recommended Reading:

1. Day, R. A., & Gastel, B. (2012). *How to Write and Publish a Scientific Paper*. Greenwood.
2. Booth, W. C., Colomb, G. G., & Williams, J. M. (2008). *The Craft of Research*. University of Chicago Press.

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