Bachelor of Engineering

Mechanical Engineering

Bachelor of Engineering: Mechanical Engineering

MISSION

*The **Bachelor of Engineering in Mechanical Engineering** at Springfield Research University (SRU) is committed to shaping adaptable engineers who drive technological progress, solve complex challenges, and contribute to a sustainable future. Our mission encompasses technical mastery, interdisciplinary collaboration, research-driven exploration, sustainable engineering practices, and ethical leadership.*

At Springfield Research University, our Bachelor of Engineering in Mechanical 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 mechanical engineering.
    - Students gain a solid foundation in mechanics, thermodynamics, and fundamental engineering principles.
2. **Cutting-Edge Research**:
    - Our faculty and students actively contribute to advancing mechanical technology.
    - By addressing real-world challenges, exploring innovative 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, energy efficiency, and technological advancement.

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 mechanics, thermodynamics, and materials science.
    - These foundational sciences provide the essential groundwork for understanding mechanical systems, design principles, and sustainable engineering practices.
2. **Applied Correlations**:
    - Lectures and practical sessions correlate theoretical knowledge with real-world mechanical engineering scenarios.
    - For instance, students learn about stress analysis and immediately apply this knowledge in designing efficient mechanical components.
3. **Case-Based Learning**:

- Real-world mechanical engineering cases serve as powerful teaching tools.
- Students analyze system performance data, safety considerations, and environmental impact.
- This approach bridges theory and practice, reinforcing mechanical engineering concepts.

4. **Simulated Design Experiences**:

- Simulation labs replicate actual mechanical conditions.
- Students practice 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 mechanical engineering professionals.
- They apply theoretical knowledge in designing, evaluating, and optimizing mechanical systems.

6. **Cutting-Edge Research and Innovation**:

- Students critically evaluate research articles, explore emerging technologies, and contribute to advancements in mechanical 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 mechanical engineering. We provide students with a robust foundation in mechanical principles, materials science, and design, encouraging creative thinking and visionary problem-solving. Graduates engage in cutting-edge research, investigating areas such as advanced materials, renewable energy systems, and robotics. They champion responsible manufacturing, uphold professional ethics, and address global challenges through innovative engineering.

Rationale for the Bachelor of Engineering in Mechanical Engineering

At Springfield Research University, our Bachelor of Engineering in Mechanical 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 mechanical systems, industrial applications, and technological advancement.

National Needs (Eswatini):

1. **Quantitative Expertise**:
    - Eswatini requires skilled mechanical engineers who can navigate complex scenarios in system design, safety, and efficiency.
    - The program equips students with mathematical proficiency and critical thinking abilities to assess mechanical conditions effectively.
2. **Cutting-Edge Practices**:
    - Graduates advocate for evidence-based decision-making, ensuring safety, efficiency, and equitable treatment in the mechanical industry.

- By enhancing their understanding of mechanics, 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 mechanical engineering challenges related to industrial processes, infrastructure, and economic development.
    - The program aligns with SADC's goal of harmonizing mechanical engineering frameworks, promoting cooperation, and advancing sustainable practices.
2. **Human Capital Development**:
    - Mechanical 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 mechanical complexities.
3. **Technological Advancements**:
    - SADC's prosperity relies on informed mechanical practices that balance industrial efficiency, safety, and environmental impact.
    - Our graduates contribute to maintaining mechanical integrity, resolving design 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 mechanical 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 mechanical research, addressing contemporary challenges such as sustainable system design, energy utilization, and technological innovation.

Program Objectives

The Mechanical Engineering Program is designed to prepare students for successful careers having positive societal impact in industry, government, academia, and consulting. Our graduates are expected to:

1. **Apply Their Engineering Knowledge and Skills with Integrity**:

- **Technical Competence**: Apply fundamental engineering principles to solve real-world problems. Understand mechanical systems, thermodynamics, fluid dynamics, and materials science.
- **Critical Thinking**: Analyze complex engineering challenges, considering ethical implications and societal context.
- **Creativity and Innovation**: Develop innovative solutions, whether designing mechanical components, optimizing processes, or improving energy efficiency.

2. **Continue Their Intellectual Development Through Lifelong Learning**:
    - **Graduate Education**: Pursue advanced degrees (master's or doctoral) to deepen their expertise and contribute to cutting-edge research.
    - **Professional Development**: Attend workshops, conferences, and industry seminars to stay informed about emerging technologies and best practices.
    - **Self-Directed Investigation**: Engage in self-study, explore new topics, and adapt to evolving engineering trends.
3. **Embrace Leadership and Collaborative Roles in Their Careers**:
    - **Leadership Skills**: Assume leadership positions, whether managing projects, teams, or departments.
    - **Effective Communication**: Communicate technical information clearly to diverse audiences, bridging the gap between engineers, stakeholders, and the public.
    - **Collaboration and Teamwork**: Work effectively in multidisciplinary teams, leveraging diverse perspectives to tackle complex problems.

Our graduates will contribute to sustainable development, technological advancement, and societal well-being. They will shape the future by designing efficient systems, ensuring safety, and promoting ethical practices.

Program Learning Outcomes (PLOs)

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

1. **Complex Problem Solving**:
    - Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
    - Analyze intricate mechanical challenges, considering multiple factors such as safety, efficiency, and environmental impact.
2. **Engineering Design and Innovation**:
    - Apply engineering design principles to create solutions that meet specified needs.
    - Consider public health, safety, welfare, cultural context, and economic factors when designing mechanical systems.

3. **Effective Communication**:
    - Communicate effectively with diverse audiences, whether presenting technical information, collaborating with colleagues, or explaining engineering concepts to non-experts.
4. **Ethical and Professional Responsibility**:
    - Recognize ethical dilemmas in engineering situations and make informed judgments.
    - Consider the global impact, economic implications, and societal context of engineering solutions.
5. **Collaboration and Leadership**:
    - Function effectively within multidisciplinary teams, providing leadership and fostering a collaborative, inclusive environment.
    - Establish goals, plan tasks, and work collectively to achieve objectives.
6. **Experimental Skills and Data Analysis**:
    - Develop and conduct appropriate experiments, collecting data and interpreting results.
    - Use engineering judgment to draw meaningful conclusions from experimental findings.
7. **Lifelong Learning and Adaptability**:
    - Acquire and apply new knowledge as needed, using appropriate learning strategies.
    - Stay informed about emerging technologies, industry trends, and advancements in mechanical engineering.

By achieving these outcomes, our graduates will contribute to technological advancement, sustainable practices, and societal well-being.

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 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.

CAREER OPPORTUNITIES

Mechanical engineering offers a wide range of career opportunities across various industries. Here are some examples of roles and areas where mechanical engineers can make a significant impact:

1. **Automotive Industry**:
    - Design, manufacture, and testing of motor vehicles.

- Vehicle dynamics, safety, and emissions control.

2. **HVAC (Heating, Ventilation, and Air Conditioning)**:
   - Specification and installation of large air conditioning and heating systems.
   - Energy-efficient HVAC design for buildings.
3. **Materials Handling and Mining**:
   - Design of materials handling systems in packaging, mining, and material processing industries.
   - Conveyor systems, bulk material handling, and equipment design.
4. **Railway and Transportation**:
   - Design of trains, locomotives, and rail systems.
   - Infrastructure planning and maintenance.
5. **Power Generation and Renewable Energy**:
   - Power plant design, operation, and maintenance.
   - Renewable energy systems (solar, wind, hydro, etc.).
6. **Petrochemical Industry**:
   - Construction, maintenance, and safety in petrochemical plants.
   - Process optimization and equipment design.
7. **Pharmaceutical Industry**:
   - Computerized control systems for pharmaceutical manufacturing.
   - Compliance with safety and regulatory standards.
8. **Aeronautical and Aerospace Engineering**:
   - Aircraft design, propulsion systems, and aerodynamics.
   - Space exploration and satellite technology.
9. **Manufacturing and Process Improvement**:
   - Implementation of new manufacturing methods and automation.
   - Lean manufacturing, quality control, and production optimization.
10. **Research and Development**:
    - Innovations in product design, materials, and technologies.
    - Collaborating on cutting-edge projects.
11. **Technical Sales and Marketing**:
    - Communicating technical information to clients and customers.
    - Promoting engineering solutions and products.
12. **Engineering Management**:

- Leading teams, project management, and strategic planning.
- Balancing technical expertise with organizational goals.

13. **Software Development and Simulation**:
    - Developing engineering software tools and simulations.
    - Computational modeling and analysis.

Mechanical engineering is a versatile field, and graduates can adapt their skills to various domains. Whether it's designing efficient systems, improving safety, or contributing to sustainable practices, mechanical engineers play a crucial role in shaping our world.

The Bachelor's Degree shall:

The Bachelor's degree program in Mechanical 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 Mechanical 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 Mechanical 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 Mechanical 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 Mechanical 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 systems. 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 Mechanical engineering. Mechanical Engineering courses simplifies the course numbering system.

1. **100-Level Courses:**
   - **ME 101:** Introduction to Mechanical Engineering
   - **ME 110:** Linear Algebra for Mechanical Engineering
   - **ME 120:** Mechanics and Dynamics in Mechanical Systems
2. **200-Level Courses:**
   - **ME 201:** Thermodynamics and Heat Transfer
   - **ME 210:** Fluid Mechanics
   - **ME 220:** Materials Science for Mechanical Engineering
3. **300-Level Courses:**
   - **ME 301:** Machine Design and Kinematics
   - **ME 310:** Control Systems in Mechanical Engineering
   - **ME 320:** Mechanical Vibrations and Acoustics
4. **400-Level Courses:**
   - **ME 401:** Advanced Solid Mechanics
   - **ME 410:** Robotics and Automation
   - **ME 420:** Finite Element Analysis

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 Mechanical 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
ME100	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 mechanical engineering.
   - **Quizzes and Short Tests**: Regular assessments on specific mechanical engineering topics.
   - **Draft Assignments**: Receive feedback on early assignment drafts related to mechanical 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 mechanical engineering.
   - **End-of-Semester Projects**: Assess students' knowledge and problem-solving skills related to mechanical engineering challenges.

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

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

COURSE STRUCTURE

YEAR 1: SEMESTER 1

Code	Course	Lectures	Practicals	Credits
ME100	General Chemistry	**100**	**20**	**12**
ME101	Physics (Mechanics/Newtonian)	**100**	**20**	**12**
ME102	Electrical and Electronic Engineering	**100**	**20**	**12**
ME103	Engineering Mathematics I	**100**	**20**	**12**
ME104	Computing for Engineers and Scientists	**20**	**100**	**12**
ME105	Design I	**100**	**20**	**12**
TOTAL				**72**

YEAR 1: SEMESTER 2

Code	Course	Lectures	Practicals	Credits
ME106	Statics	**120**	**0**	**12**
ME107	Engineering Mathematics 2	**120**	**0**	**12**
ME108	Introduction Mechanical and Automotive Engineering	**60**	**60**	**12**
ME109	Communication for Academic Purposes	**120**	**0**	**12**
ME110	Creative Engineering CAD	**20**	**100**	**12**
ME111	Engineering Science	**100**	**20**	**12**
TOTAL				**72**

YEAR 2: SEMESTER 3

Code	Course	Lectures	Practicals	Credits
ME212	Engineering Mathematics 3	**120**	**0**	**12**
ME213	Engineering Dynamics	**120**	**0**	**12**
ME214	Differential Equations	**120**	**0**	**12**
ME215	Principles of Mechatronics	**100**	**20**	**12**
ME216	Fluid Mechanics of Mechanical Systems	**100**	**20**	**12**
ME217	Introduction to Material Science	**100**	**20**	**12**
TOTAL				**72**

YEAR 2: SEMESTER 4

Code	Course	Lectures	Practicals	Credits
ME218	Foundations of Artificial Intelligence for STEM	**120**	**0**	**12**
ME219	Numerical Analysis	**120**	**0**	**12**
ME220	Applied Thermodynamics	**100**	**20**	**12**
ME221	Mechanics and Materials 2	**100**	**20**	**12**
ME222	Mechanical Design I	**100**	**20**	**12**
ME223	Structural Mechanics	**100**	**20**	**12**
TOTAL				**72**

YEAR 3: SEMESTER 5

Code	Course	Lectures	Practicals	Credits
ME324	Solid Mechanics 3	**100**	**20**	**12**
ME325	Heat Transfer	**100**	**20**	**12**
ME326	Numerical Methods and Statistics	**100**	**20**	**12**
ME327	Thermal – Fluid Systems Design	**100**	**20**	**12**
ME328	Mechanical Vibrations	**100**	**20**	**12**
ME329	Mechanical Design II	**100**	**20**	**12**
TOTAL				**72**

YEAR 3: SEMESTER 6

Code	Course	Lectures	Practicals	Credits
ME330	Research Methods	**120**	**0**	**12**
ME331	Applied Heat and Mass Transfer	**100**	**20**	**12**
ME332	Computational Fluid Dynamics	**100**	**20**	**12**
ME333	Mechanics of Machines	**100**	**20**	**12**
ME334	Finite Element Analysis (FEA)	**100**	**20**	**12**
ME335	Mechanical Design III	**100**	**20**	**12**
TOTAL				**72**

YEAR 4: SEMESTER 7

Code	Course	Lectures	Practicals	Credits
ME436	Engineering Capstone Project A	**0**	**120**	**12**
ME437	Renewable Energy Systems	**100**	**20**	**12**
ME438	Automotive Control	**100**	**20**	**12**
ME439	Engineering and Enterprise	**100**	**20**	**12**
ME440	Mechanical Design Optimization	**100**	**20**	**12**
ME441	Manufacturing Processes and Automation	**100**	**20**	**12**
TOTAL				72

YEAR 4: SEMESTER 8

Code	Course	Lectures	Practicals	Credits
ME442	Engineering Capstone Project B	**0**	**120**	**12**
ME443	Robotics and Automation	**100**	**20**	**12**
ME444	Engineering Project Management	**100**	**20**	**12**
ME445	Advanced Materials Science and Engineering	**100**	**20**	**12**
ME446	Mechatronics and Control Systems	**100**	**20**	**12**
ME447	Product Design and Development	**100**	**20**	**12**
TOTAL				72

COURSE DESCRIPTIONS

INTRODUCTION TO PROFESSIONAL ENGINEERING

Introduction to Professional Engineering Practice provides a foundation for your ongoing professional development, first as a student engineer, and later as a professional engineer. The course caters around learning and applying engineering design, while developing the complimentary skills required to practice competently, ethically, and safely. Course topics will be learnt through lectures, briefings and tutorials as well as self-guided learning. The course will prepare you for subsequent, discipline-specific courses in engineering design, research, management and sustainability.

DIGITAL FUNDAMENTALS

This course is focused on digital literature for engineers and will equip you with the ability to apply a problem-solving methodology to common engineering problems. Using a problems-based approach, students will develop the skills to design, write, test and debug programs that improve the world we live in. You will be presented with various types of engineering problems which you will then work through from problem identification and algorithm design through to the implementation phase. As part of the course you will also be introduced to the syntax and development environment of engineering software tool MATLAB/Simulink.

INTRODUCTION TO ELECTRICAL AND ELECTRONIC ENGINEERING

The aim of this course is to make you competent in analyzing electrical circuits and performing basic electrical measurements to verify circuit concepts experimentally. In this course, you will be introduced to the concepts and definition of charges, currents, voltages, power and energy. You will learn the voltage-current relationships of basic circuit elements-resistors, inductors, capacitors, dependent and independent voltage and current sources; apply Kirchhoff's current and voltage laws to circuits in order to determine voltage, current and power branches of any circuit excited by DC voltage and current sources. Applying simplifying techniques to solve DC circuit problems using basic circuit theorems and structured methods like node voltage and mesh current analysis. The goal also includes derivation of the transient responses of RC and RL circuits, steady state response of circuits to sinusoidal excitation in time domain, application of phasors to circuit analysis, introduction to non-liners electronic devices such as diodes.

ENGINEERING MATHEMATICS

This course provides a broad introduction to the fundamental mathematical tools used by engineers. These include mathematical techniques such as single variable differentiation or integration and mathematical objects such as vectors, complex numbers, and differential equations. The course builds on the foundations laid in secondary school mathematics and in turn helps to prepare students from more advanced mathematics in later study, and to give students the skills needed to understand the application of mathematics to engineering in real time. Topics include vectors, complex numbers, differentiation with applications, functions and their derivations methods of integration and their application.

ENGINEERING SCIENCE

Through a multidisciplinary approach, this course aims to introduce and contextualize the fundamental science that underpins engineering. This comprises three key areas of introductory physical chemistry, kinematics, and electronic circuits. Introducing physical chemistry will cover nomenclature, molecular structure and stoichiometric reactions. In kinematics you will develop an understanding of work and of conservation energy. Electronic circuits will introduce you to Ohm's Law, hence the consideration of electrical potential, current, resistance and capacitance.

CREATIVE ENGINEERING CAD

Computer Aided Design (CAD) is a significant contributor in transforming a concept into a tangible reality in order to test-with confidence tangible realities by simulating real world conditions. In this course you will develop fundamental CAD skills in both the 2D realm (e.g. building plans or circuit design) and 3D realm (e.g. using fully manipulable animated models that are invaluable tools for visualizing complex mechanisms. You will also improve your skills and knowledge in drawing techniques, learn to use specific tools and learn about the design process. You will learn about how international standards define the common language of graphic communication. These graphically presented virtual realities will also extend to the realm of augmented reality, in which simulations and real-world combine for totally immersive design,

ADVANCED MANUFACTURING AND MECHATRONICS

In this course you will learn about the operating principles, advantages, limitations and physical applications of various manufacturing process including:

- Solidification processes (casting, injection moulding) material removal processes (conventional and non-traditional machining) deformation process (forging, rolling, extension) as well as additive manufacturing techniques (3D printing).

You will also learn about key principles which support effective manufacturing systems including:

- Manufacturing Economics
- Quality Control Techniques and:
- Basic Principle of Manufacturing process automations through an introduction to G-code Computer Numerical Control (CNC) programming.

Furthermore, the course will cover the principles of mechatronic systems design in hands-on design classes, focusing on the following topics:

- Basic Mechatronics
- Embedded Programming
- Repetition and Digital processing
- Selection and Analog Processing
- Function and Pulse Width Modulation

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE STEM

This course introduces the foundation of Artificial Intelligence (AI) tailored to students from a range of health, science, technology, engineering, and math disciplines. AI is a branch of Computer Science devoted to devoted to developing intelligent hardware and Software Systems. Applications of AI are now widespread in the world of work. It is therefore increasingly important for all health, science, technology, engineering, and math disciplines graduate to understand the foundations and applications of the field of AI relevant to their own discipline. This course will also challenge you to consider the impact and ethics of AI on your future profession and society.

MATHEMATICS FOR ELECTRICAL AND COMPUTER ENGINEERING

Mathematics for Electrical and Computer Engineering is a core component of the Electrical and Computer Engineering Bachelors degrees. It provides an opportunity to develop the requisite range skills relevant to a wide range of sub-discipline existing within the field of Electrical and Computer Engineering. In this course you will be introduce to a range of mathematical concepts identified as fundamental to enhance your progress in studying related

Engineering Courses. You will develop the mathematical maturity required to become a well-grounded engineer.

INTRODUCTION TO MECHANICAL AND AUTOMOTIVE ENGINEERING

This course introduces essential mechanical engineering fundamentals, relevant to those considering a pathway in the broad discipline of mechanical engineering. Appropriate material properties are introduced, so that the Newtonian mechanics and conservation of energy introduced in Engineering Science can be further developed in an authentic mechanical engineering context. Relevant theories concerning material behavior under load (such as in a bridge or an aircraft wing), and heat transfer (such as in a refrigerator, or a cars radiator) are explored through a variety of real- world problems that a practicing engineer may face.

FLUID MECHANICS OF MECHANICAL SYSTEMS

This course provides an introduction to the principles of fluid mechanics of mechanical systems. The focus is to illustrate practical engineering applications of theses principles in relation tom simple fluid systems. The learning approach is to apply engineering principles to performance analysis and prediction of simple fluid systems. This will provide a basis for understanding how performance can be improved. You will acquire an understanding of the essential theoretical basis of the fluid mechanic science and their application to a range of problems of relevance to practical engineering.

ENGINEERING DYNAMICS

In this course you will study the state of rest or motion bodies under the action of a single or multiple force. Therefore, this course deals with Newtons Second Law of motion which is the foundation for the design and analysis of various structural, mechanical and electronic devices found in a wide range of engineering applications. You will study kinematics and kinetics of particles and rigid bodies using force and acceleration, work and energy, and impulse and momentum principles.

MECHATRONIC PRINCIPLES

This course will introduce you to Mechatronics as a multidisciplinary engineering discipline that includes electronics, electrical, mechanical computer systems engineering, together with information technology, theory lectures will introduce the core components of mechatronic systems, electrical and electronic components and circuits, sensors and actuators. In the laboratory work, you will work on putting theory into practice in the context of a challenging project that is at the core of a national design and build competition. This course significantly develops the generic skills of teamwork, planning, leadership and communication. Lectures will be given on the theoretical aspects of these graduate capabilities. You will then apply these skills in the completion of specific learning activities such as design project, report, testing and prototyping. The dry run testing of the prototype mechatronics mechanisms will provide an opportunity for you to receive feedback.

ADVANCED MATHEMATICS FOR ENGINEERS

Advanced Mathematics for Engineering is a single semester course consisting of five main mathematics topics namely:

- Transforms (Laplace/ Fourier),
- Vector Calculus
- Matrices
- Power Series and Numerical Analysis.

The course content has been selected, in consultation with Engineering, to provide the necessary mathematical training that will assist and expand your learning experience.

MECHANICS AND MATERIALS 2

This course further develops your capabilities in mechanic and materials. You will analyze combined shear, axial and bending loads, and design for strength in both tension and compression. Design for deflection will be covered, and various techniques will be used to calculate deflections including energy methods. You will examine the underlying assumption used in mechanics of solid analysis and recognize the environments under which engineering materials do not behave according to these assumptions. Situations of high and low temperatures and loading rates, fatigue loading and loads exceeding the yield strength will be examined.

APPLIED THERMODYNAMICS

This course provides an introduction to the essential theoretical basis of engineering thermodynamics and its application to a range of problems of relevance to practical engineering. The course aims to equip you with basic tools and methodologies for carrying out the thermodynamic analyses of engineering systems. Key topics are:

- Thermodynamic properties of working fluids including enthalpy and entropy
- First Law of Thermodynamics applied to common engineering situations
- Second Law of Thermodynamics applied to heart engines and refrigeration systems; common practical heart engine and refrigeration cycles.

MECHANICAL DESIGN I

This course is a part of a sequence of Project Based Learning (PBL) courses and concentrates on the study of machine elements and their incorporation into simple machines. Within this course the following topics will be dealt with:

- Rolling contact bearing and seals
- Belt drives and chain drives
- Design for different types of loading shaft design
- Keys, set screws, spur gears, helical gears, bevel gears and worm gears
- Plain surface bearings
- Couplings
- Motion Control; clutches and brakes
- Bolted and welded joints
- Tolerance and fits

SOLID MECHANICS 3

This course is designed to expand your knowledge in the field of non- linear mechanics of solids and its application to structural analysis, machine design and material processing. Through this course you will be able to understand the influence of non-linearities on the behavior of structures. The course aims to equip you with essential analytical skills which have a particular bearing on your professional practice as mechanical engineers. On completion of this course you should have sufficient knowledge of the mechanics of solids to enable you to solve advance practical problems.

MECHANICAL VIBRATIONS

This course deals with the study of vibration in the system which is concerned with the oscillatory motions of bodies and the forces associated with them. This course aims to provide you with an understanding of the nature and behavior of dynamic engineering systems and capability of applying knowledge of mathematics, science and engineering to solve engineering vibration problems.

THERMAL-FLUID SYSTEM DESIGN

The course is a continuation from the fundamental courses on the thermodynamics, fluid mechanics. The course aims to equip you with tools and methods to design real-world thermal/fluid systems. Topics include:

- Energy Analysis
- Thermo-economic analysis
- Rotodynamic machinery
- Energy storage system
- Engineering ethics and design decisions and engineering economics and its application in real-world

HEAT TRANSFER

This is the fourth part of a four-part series of core courses (Applied Thermodynamics, Fluid Mechanics of Mechanical Systems, Thermal-fluid System Design and Heat Transfer) designed to provide core knowledge of the fundamental principles and engineering applications of thermodynamics, heat transfer and fluid mechanics. These three arears collectively make up the field of Thermo Fluid Mechanics or Thermo Fluid Sciences but are traditionally thought as separate courses. However, in this course, knowledge from the pre-requisite courses are presented in a more integrated manner, emphasizing the connectivity between these areas in theoretical treatment and through the use of practical and real-world examples of thermal fluid systems. The fundamentals and principles of thermal fluid mechanics will be reviewed through the use of the real-world examples and be advanced to analyze the practical thermo-fluid systems for engineering design applications.

MECHANICAL DESIGN 2

This course is part of a sequence of design courses and aims to give practice in this design project situation in the use of knowledge gained from a wide range of other courses previously or concurrently studied. It has two parts addressing two design approaches: design by code and design by performance. The design by code part combines theoretical approaches to aspects of stress analysis with practical application of this knowledge in a design project situation of designing the air storage pressure vessel. The second part is more orientated towards product development and innovation experienced in technology start-up firms. This part will offer students opportunity to apply appropriate tools and structured methods to their own products and develop prototypes. Some of the tools and methods will include customer research, concept creation, product design, prototype development and market validation. Learning is problem-based for the project duration.

MECHANICS OF MACHINES

In this course you will study advanced concepts of kinematics and dynamic modelling and analysis of mechanisms and machines, including linkage mechanism and cam mechanism reciprocating and rotating machinery. The course enables you to explore in depth core mechanical engineering concepts by integrating and applying contemporary analytical, computational and experimental methods. It relates kinematics and dynamics of mechanisms and machines to their design and allows you to relate theory and practice using a problem-based approach in which you develop project management skills.

FINITE ELEMENT ANALYSIS

The course introduces you to the theoretical basics and practical application of the finite element method as well as to related numerical modelling techniques. It is designed to enable you to solve practical problems related to solid mechanics, machines and structures.

RENEWABLE ENERGY SYSTEMS

The use of renewable energy for power generation and heating is growing rapidly, the main drives being fear of depletion of present world energy resources, security of energy supplies, reduction of pollution and CO2 emission of conventional power plants and the need of supply of electricity in remote areas. Additionally, alternative energy systems based on emerging technologies and relevant within the future energy targets of many OECD countries requiring a high share of renewable energy in the energy mix. In this course you will learn about the operation and performance of three renewable energy technologies: grid-connected wind turbines, photovoltaic systems; and solar thermal systems and energy storage. The emphasis will be on the sizing, design, selection and performance evaluation of renewable energy equipment for given applications.

ENGINEERING AND ENTERPRISE

The key topics in this course include: organizational strategic modelling, some finance concepts, business plan development, organizational behaviour, leadership and risk management.

AUTOMATIC CONTROL

This course deals with the application of control theory in general engineering applications. Analysis of automatic control systems using transfer fabrication, block diagram, time response and frequency response are discussed and applied to control system evaluation and design.

MECHANICAL DESIGN 3

This is a final year course in the mechanical engineering specialist design stream involving advanced design concepts and techniques. It aims to engage you in systems design and robust design problems through experiential problem-based learning and project-based learning. You will work on real world industry relevant design projects from the stage of identifying the design requirements, through detailed design to the final stage of virtual prototyping, validating and developing technical documentation using contemporary computational and experimental techniques. This involves team-based discussions, workshops and consultations emulating professional engineering design practice. All projects involve students undergoing a complete systems design process involving complex mechanical systems and including a significant level of advanced engineering analysis and design optimization.

APPLIED HEAT AND MASS TRANSFER

This course is a final year elective course building on earlier core thermo-fluid courses. Within this course there are extended topics to the heat transfer knowledge attained from the previous studies. The topics will have applications with HVAC, refrigeration and air conditioning, and other industrial heating and coding applications.

- Revision of basic modes of heat transfer; vapor compression refrigeration cycle.
- The role of heat exchangers in a thermodynamic cycle and associated environmental and economic issues
- Boiling and Condensation
- Fouling of heat exchangers; overall heat difference; parallel flow, counter flow and cross flow configurations of heat exchangers; heat exchangers effectiveness and number of transfer units (NTU); pressure drop and flow considerations.
- Further conduction problems: Fins, Insulations, Transient, Numerical Computations
- Wetted Surface heat and mass transfer including evaporative cooling and cooling towers.

COMPUTATIONAL FLUID DYNAMICS

This course gives you an introduction to computational fluids dynamics (CFD) and numerical heat transfer (NHT) modelling technology for thermo-fluid related applications. It also gives you a proper background for intelligent and appropriate use for commercial CFD packages.

The course provides core knowledge of the fundamentals of CFD for engineers, and an introduction to the methods and analysis techniques used in CFD. It also provides an introduction to the use of commercial CFD codes to analyze flow and heat transfer in problems of practical engineering intertest. The emphasis of the course is on the use of CFD as a virtual fluid laboratory. At the end of the course you will understand the process of developing a geometrical model of the flow, applying appropriate boundary conditions, specifying solution parameters, and visualizing and analyzing the results. Through the course study, you will also become conscious of the limitations of CFD and develop an appreciation for factors limiting the accuracy of CFD solutions.

COURSE OUTLINES

Course Title: General Chemistry

Course Description:

General Chemistry provides foundational knowledge in chemical principles and their applications. Students will explore topics related to matter, atomic structure, chemical reactions, and more, with a focus on relevance to mechanical engineering.

Learning Objectives:

1. Understand the nature of matter and its properties.
2. Learn about atomic theory, the periodic table, and chemical bonding.
3. Apply chemistry concepts to engineering materials and processes.
4. Develop critical thinking skills for solving engineering challenges.

Topics Covered:

1. **Introduction to Chemistry**:
    - Scientific measurement and units.
    - States of matter (solid, liquid, gas).
2. **Atomic Structure and Bonding**:
    - Subatomic particles (protons, neutrons, electrons).
    - Chemical bonding (ionic, covalent).
3. **Chemical Reactions and Stoichiometry**:
    - Types of reactions (acid-base, redox).
    - Balancing chemical equations.
    - Reaction stoichiometry.
4. **Materials and Processes**:
    - Corrosion prevention.
    - Material selection criteria (strength, weight, thermal properties).
    - Chemical processes in manufacturing.

Assessment and Grading:

- Regular assignments, quizzes, and exams.
- Lab experiments related to materials characterization (if applicable).

Recommended Resources:

- No specific textbook required, but consider supplementary materials on chemistry and materials science.

Course Title: Physics (Mechanics/Newtonian)

Course Description:

Physics (Mechanics/Newtonian) introduces fundamental principles of classical mechanics, emphasizing the behavior of physical systems in motion. Students will explore topics essential for understanding mechanical systems, dynamics, and engineering applications.

Learning Objectives:

1. Develop a solid foundation in Newtonian mechanics.
2. Apply physics concepts to mechanical modeling and analysis.
3. Enhance problem-solving skills for engineering challenges.
4. Understand the principles governing motion, forces, and energy.

Topics Covered:

1. **Kinematics**:
   - Position, velocity, and acceleration.
   - Projectile motion and circular motion.
   - Relative motion in accelerated reference frames.
2. **Dynamics**:
   - Newton's laws of motion.
   - Work, energy, and conservation laws.
   - Impulse and momentum.
   - Rotational dynamics.
3. **Applications in Mechanical Engineering**:
   - Static equilibrium and free-body diagrams.
   - Friction and inclined planes.
   - Vibrations and oscillations.
   - Introduction to orbital mechanics (relevant for aerospace applications).

Assessment and Grading:

- Regular problem sets and quizzes.
- Midterm exams covering theoretical concepts.
- Final exam assessing overall understanding.

Recommended Resources:

- "University Physics" by Young and Freedman.
- Lecture notes and supplementary materials.

Course Title: Introduction to Electrical and Electronic Engineering

Course Description:

Introduction to Electrical and Electronic Engineering provides foundational knowledge in electrical systems, electronic devices, and their applications. Students will explore topics relevant to engineering practice, circuit analysis, and practical design.

Learning Objectives:

1. Understand basic electrical concepts (voltage, current, resistance, power).
2. Analyze simple DC and AC electrical circuits.
3. Explore semiconductor devices (diodes, transistors) and their applications.
4. Introduce digital logic, microcontrollers, and sensors.
5. Apply this knowledge to solve real-world engineering problems.

Topics Covered:

1. **Electric Circuit Fundamentals**:
    - Voltage, current, and Ohm's law.
    - Circuit analysis techniques (Kirchhoff's laws).
    - Basic circuit quantities (resistors, capacitors, inductors).
2. **Semiconductor Devices**:
    - Diodes: Rectification, switching, and applications.
    - Transistors: Amplification, switching, and logic gates.
    - Operational amplifiers (op-amps).
3. **Digital Logic and Microcontrollers**:
    - Binary representation.
    - Logic gates and truth tables.
    - Introduction to microcontrollers (architecture, programming).
4. **Electrical Energy, Machines, and Power Systems**:
    - Electric power generation and transmission.
    - Introduction to electric machines (motors, generators).
    - Power system components (transformers, circuit breakers).

Assessment and Grading:

- Regular assignments, quizzes, and exams.
- Practical circuit design and analysis.

Recommended Resources:

- No specific textbook required, but consider supplementary materials on electrical and electronic engineering.

Course Title: Engineering Mathematics I

Course Description:

Engineering Mathematics I provides foundational knowledge in mathematical concepts relevant to engineering. Students will explore topics essential for solving engineering problems and understanding mathematical principles.

Learning Objectives:

1. Develop proficiency in calculus and differential equations.
2. Apply mathematical techniques to model and analyze engineering systems.
3. Enhance problem-solving skills specific to engineering applications.

Topics Covered:

1. **Introduction to Differential Equations**:
    - First-order differential equations.
    - Separable equations and exact equations.
    - Applications in engineering.
2. **Higher-Order Differential Equations**:
    - Second-order linear differential equations.

- Homogeneous and nonhomogeneous equations.
    - Vibrations and oscillations.
3. **The Laplace Transform**:
    - Definition and properties of the Laplace transform.
    - Inverse Laplace transform.
    - Solving differential equations using Laplace transforms.
4. **Series Solutions of Linear Equations**:
    - Power series solutions.
    - Frobenius method.
    - Bessel functions and Legendre polynomials.
5. **Numerical Solutions of Ordinary Differential Equations**:
    - Euler's method and Runge-Kutta methods.
    - Stability and convergence.
    - Applications in engineering simulations.

Assessment and Grading:

- Regular assignments and problem-solving exercises.
- Midterm exams covering theoretical concepts.
- Final exam assessing overall understanding.

Recommended Resources:

- Textbook: D.G. Zill, "Advanced Engineering Mathematics," 7th Ed., Jones and Bartlett Publishers, Boston.
- Additional references: F.B. Hildebrand, E. Kreyszig, C.R. Wylie, D.U. von Rosenberg.

Course Title: Introduction to Computing for Engineers and Scientists

Course Description:

Introduction to Computing for Engineers and Scientists is an interdisciplinary course intended for first-year engineering students (but open to students from all schools). The course provides a practical introduction to computer science, emphasizing computational thinking, algorithmic problem-solving, and Python programming. We'll focus on science and engineering applications, exploring case studies in physics, statistics, electrical engineering, biology, and other relevant topics.

Learning Objectives:

1. Understand the basics of computer programming concepts.
2. Apply Python programming skills to solve engineering and scientific problems.
3. Develop computational thinking and algorithmic reasoning.
4. Collaborate effectively in interdisciplinary contexts.

Topics Covered:

1. **Introduction to Python**:
    - Python syntax and basic programming constructs.
    - Variables, data types, and control structures.
    - Writing and executing Python scripts.

2. **Computational Thinking and Problem Solving**:
   - Algorithm design and pseudocode.
   - Iteration and decision-making.
   - Debugging and error handling.
3. **Scientific Computing and Data Analysis**:
   - Numerical computing with Python libraries (NumPy, SciPy).
   - Data visualization using Matplotlib.
   - Basic statistical analysis.
4. **Applications in Engineering and Science**:
   - Physics simulations and modeling.
   - Electrical circuit analysis.
   - Data processing for scientific experiments.

Assessment and Grading:

- Regular assignments and coding exercises.
- Quizzes assessing theoretical knowledge.
- Collaborative projects related to real-world applications.

Recommended Resources:

- No specific textbook required, but consider reference books like:
  - "Introduction to Computation and Programming Using Python" by John Guttag.
  - "The Practice of Computing using Python" by William Punch and Richard Enbody.
  - "Python for Everyone" by Cay Horstmann and Rance Necaise.

Course Title: Design I

Course Description:

Design I introduces students to fundamental principles of design thinking, creativity, and problem-solving. Through hands-on projects and collaborative activities, students will develop skills necessary for designing innovative solutions.

Learning Objectives:

1. Understand the design process from ideation to implementation.
2. Apply design thinking techniques to real-world challenges.
3. Develop creativity and critical thinking skills.
4. Collaborate effectively in interdisciplinary teams.

Topics Covered:

1. **Introduction to Design Thinking**:
   - Overview of design principles.
   - User-centered design.
   - Brainstorming and ideation.
2. **Problem Definition and Research**:
   - Identifying design problems.
   - Conducting user research.

    - Defining design criteria.
3. **Concept Development and Prototyping**:
    - Sketching and visualization.
    - Creating design concepts.
    - Rapid prototyping techniques.
4. **Materials and Manufacturing Processes**:
    - Understanding materials (metals, plastics, composites).
    - Manufacturing methods (3D printing, CNC machining).
5. **Design Evaluation and Iteration**:
    - Usability testing.
    - Feedback and refinement.
    - Iterative design cycles.

Assessment and Grading:

- Design projects (individual and group).
- Design journals documenting the design process.
- Peer evaluations.
- Final design presentation.

Recommended Resources:

- No specific textbook required, but consider design literature and case studies.

Course Title: Statics

Course Description:

Statics is the study of methods for quantifying the forces between bodies. Forces are responsible for maintaining balance and causing motion of bodies or changes in their shape. Motion and changes in shape are critical to the functionality of artifacts in the man-made world and to phenomena in the natural world. This course introduces fundamental principles of statics, emphasizing equilibrium, force analysis, and structural stability.

Learning Objectives:

1. Understand the concept of equilibrium.
2. Analyze forces acting on rigid bodies.
3. Apply static equilibrium principles to solve engineering problems.
4. Explore applications in mechanical, civil, and aerospace engineering.

Topics Covered:

1. **Introduction to Statics**:
    - Overview of statics and units.
    - Problem-solving techniques.
2. **Forces and Vectors**:
    - Vector representation of forces.
    - Resultant forces and moments.
    - Free-body diagrams.
3. **Equilibrium of Particles and Rigid Bodies**:

    - Equilibrium conditions.
    - Analysis of concurrent and non-concurrent force systems.
    - Moment of a force.
4. **Structural Analysis**:
    - Trusses and frames.
    - Internal forces in structures.
    - Stability and determinacy.

Assessment and Grading:

- Regular problem sets and quizzes.
- Midterm exams covering theoretical concepts.
- Final exam assessing overall understanding.

Recommended Resources:

- Textbook: “Engineering Mechanics: Statics” by R.C. Hibbeler.
- Lecture notes and supplementary materials.

Course Title: Engineering Mathematics II

Course Description:

Engineering Mathematics II builds upon foundational mathematical concepts, emphasizing their applications in solving engineering problems. Students will explore topics related to differential equations, numerical methods, and probability theory.

Learning Objectives:

1. Master numerical methods for solving partial differential equations (PDEs).
2. Develop proficiency in numerical software (e.g., Python) for engineering computations.
3. Understand analytical methods for solving PDEs and linear systems.
4. Explore probability theory and statistical methods relevant to engineering.

Topics Covered:

1. **Numerical Methods for PDEs**:
    - Finite differences: Formulas for first and second order derivatives.
    - Schemes for one and two-dimensional elliptic boundary value problems (e.g., Poisson’s equation).
    - Solving linear equations using LU factorization, Jacobi, and Gauss-Seidel methods.
2. **Numerical Software**:
    - Basic syntax and commands in Python.
    - Reading documentation for relevant functions.
    - Computation of Fourier coefficients, function values, and series solutions of ODEs and PDEs.
3. **Analytical Methods for PDEs**:
    - Fourier series: Representation of periodic functions.

    - Convergence of Fourier series.
    - Solution techniques for Laplace’s equation.
4. **Probability and Statistical Methods**:
    - Random variables and probability distributions.
    - Bayes’ theorem and continuous/discrete distributions.
    - Estimation, confidence intervals, and hypothesis testing.

Assessment and Grading:

- Regular assignments, quizzes, and practical exercises.
- Comprehensive final exam.

Recommended Resources:

- No specific textbook required, but consider reference materials on numerical methods and mathematical software.

Course Title: Introduction to Mechanical and Automotive Engineering

Course Description:

Introduction to Mechanical and Automotive Engineering provides foundational knowledge in mechanical systems, automotive technology, and engineering principles. Students will explore topics relevant to both fields, emphasizing practical applications and interdisciplinary connections.

Learning Objectives:

1. Understand the fundamental principles of mechanical engineering.
2. Explore automotive systems, components, and design.
3. Develop problem-solving skills specific to mechanical and automotive contexts.
4. Gain insights into the broader field of engineering.

Topics Covered:

1. **Introduction to Mechanical Engineering**:
    - Overview of mechanical systems and applications.
    - Engineering ethics and professional responsibilities.
    - Interdisciplinary connections (e.g., materials science, thermodynamics).
2. **Statics and Dynamics**:
    - Equilibrium of particles and rigid bodies.
    - Forces, moments, and free-body diagrams.
    - Kinematics and dynamics of mechanical systems.
3. **Materials and Manufacturing Processes**:
    - Properties of engineering materials (metals, polymers, ceramics).
    - Manufacturing methods (casting, machining, forming).
4. **Automotive Technology**:
    - Vehicle components (engine, transmission, suspension, brakes).
    - Automotive safety and emissions.
    - Electric and hybrid vehicles.
5. **Engineering Design and Projects**:

    - Introduction to design thinking.
    - Collaborative projects related to mechanical and automotive systems.
    - Prototyping and testing.

Assessment and Grading:

- Regular assignments, quizzes, and exams.
- Practical projects and design challenges.

Recommended Resources:

- No specific textbook required, but consider supplementary materials on mechanical engineering and automotive technology.

Course Title: Academic Communication Skills

Course Description:

Academic Communication Skills equips students with essential communication abilities for success in university studies. The course focuses on core values, expectations of academic culture, and practical strategies applicable to various academic contexts.

Learning Objectives:

1. Recognize the importance of communication within university communities.
2. Understand communication contexts at university and associated expectations.
3. Adapt communicative styles appropriately for different audiences.
4. Demonstrate effective communication through spoken, written, visual, and conversational modes.
5. Formulate arguments and communicate research findings confidently.

Topics Covered:

1. **Introduction to Academic Communication**:
    - Understanding academic culture.
    - Core values and expectations.
2. **Written Communication**:
    - Academic writing skills.
    - Researching, composing, and editing.
    - Formulating arguments.
3. **Oral Communication**:
    - Public speaking and oral presentation skills.
    - Effective dialogue and respectful engagement.
4. **Functional Writing Skills**:
    - Writing for specific purposes (reports, summaries, emails).
    - Adapting writing styles.

Assessment and Grading:

- Regular assignments, quizzes, and practical exercises.
- Participation in discussions and group activities.

Recommended Resources:

- No specific textbook required, but consider supplementary materials on academic writing and communication.

Course Title: Creative Engineering CAD

Course Description:

Creative Engineering CAD focuses on the intersection of creativity, design, and engineering within the context of computer-aided design (CAD). Students will explore techniques for creating innovative and aesthetically pleasing designs using CAD software. The course emphasizes practical skills, critical thinking, and interdisciplinary collaboration.

Learning Objectives:

1. Develop proficiency in CAD software tools.
2. Apply design principles to engineering projects.
3. Cultivate creativity and problem-solving skills.
4. Understand the impact of design choices on functionality and aesthetics.

Topics Covered:

1. **Introduction to CAD**:
   - Overview of CAD software (e.g., AutoCAD, SolidWorks).
   - User interface and basic commands.
   - Drawing and modeling techniques.
2. **2D Drafting and Detailing**:
   - Creating technical drawings (orthographic, isometric).
   - Dimensioning and annotations.
   - Standards and conventions.
3. **3D Modeling and Visualization**:
   - Constructing 3D models.
   - Parametric modeling and assemblies.
   - Rendering and visualization techniques.
4. **Design Projects**:
   - Applying CAD skills to real-world engineering challenges.
   - Iterative design process.
   - Collaborative design reviews.

Assessment and Grading:

- Regular CAD assignments and projects.
- Design critiques and presentations.

Recommended Resources:

- No specific textbook required, but consider supplementary materials on CAD software and design principles.

Course Title: Engineering Science

Course Description:

Engineering Science provides a foundational understanding of the principles and techniques that underpin modern engineering practice. Students will develop analytical, design, and computing skills necessary for successful engineering careers. The course covers a broad range of topics, including mechanics, thermodynamics, fluid dynamics, and materials science.

Learning Objectives:

- Understand fundamental engineering concepts and theories.
- Apply mathematical and computational tools to solve engineering problems.
- Develop critical thinking and problem-solving skills.
- Gain practical knowledge through hands-on experiments and projects.

Topics Covered:

1. **Engineering Mechanics:**
    - Statics and dynamics
    - Forces, moments, and equilibrium
    - Kinematics and kinetics
2. **Thermodynamics and Heat Transfer:**
    - Laws of thermodynamics
    - Heat transfer mechanisms (conduction, convection, radiation)
    - Energy conversion processes
3. **Fluid Mechanics:**
    - Fluid properties
    - Fluid statics and dynamics
    - Bernoulli's equation
4. **Materials Science and Machine Element Design:**
    - Material properties and behavior
    - Stress and strain analysis
    - Design of machine components (gears, bearings, shafts)
5. **Measurement and Control:**
    - Sensors and instrumentation
    - Feedback control systems
    - Data acquisition and analysis
6. **Engineering Design:**
    - Design methodologies
    - CAD (Computer-Aided Design) tools
    - Prototyping and testing

Assessment and Grading:

- Regular quizzes and assignments: 30%
- Midterm examinations: 20%
- Final project or design challenge: 25%

Recommended Reading:

1. Hibbeler, R. C. (2016). *Engineering Mechanics: Statics & Dynamics* (14th ed.). Pearson.

2. Cengel, Y. A., & Boles, M. A. (2014). *Thermodynamics: An Engineering Approach* (8th ed.). McGraw-Hill.
3. Munson, B. R., Young, D. F., & Okiishi, T. H. (2013). *Fundamentals of Fluid Mechanics* (7th ed.). Wiley.

Course Title: Engineering Mathematics III

Course Description:

Engineering Mathematics III builds upon foundational mathematical concepts and techniques relevant to mechanical engineering. Students will delve into advanced topics necessary for solving complex engineering problems. The course covers both theoretical principles and practical applications.

Learning Objectives:

- Develop proficiency in complex analysis and its applications.
- Understand mathematical tools for solving engineering problems.
- Apply mathematical techniques to real-world scenarios.

Topics Covered:

1. **Complex Analysis:**
    - Complex numbers and elementary properties
    - Complex functions: limits, continuity, and differentiation
    - Cauchy-Riemann equations
    - Analytic and harmonic functions
    - Cauchy’s integral formula
    - Residues and contour integrals
2. **Power Series and Taylor Series:**
    - Zeros of analytic functions
    - Singularities and Laurent series
    - Rouche’s theorem and argument principle
3. **Applications:**
    - Mobius transformations
    - Use of complex analysis in engineering problems

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Final project or application of complex analysis: 25%

Recommended Reading:

1. Churchill, R. V., & Brown, J. W. (2003). *Complex Variables and Applications* (7th ed.). McGraw-Hill.
2. Marsden, J. E., & Hoffman, M. J. (1999). *Elementary Classical Analysis* (2nd ed.). W. H. Freeman.

Course Title: Engineering Dynamics

Course Description:

Engineering Dynamics introduces the study of motion and forces in mechanical systems. Students will explore the behavior of particles and rigid bodies, analyze kinematics, and understand the principles governing dynamic systems. The course emphasizes practical applications and problem-solving techniques.

Learning Objectives:

- Understand the kinematics of particles and rigid bodies.
- Apply force-momentum formulations to analyze motion.
- Explore work-energy concepts and virtual displacements.

Topics Covered:

1. **Kinematics:**
    - Particle motion in 1D, 2D, and 3D
    - Rigid body motion: translation, rotation, and general motion
    - Relative motion analysis
2. **Force-Momentum Formulation:**
    - Newton's second law
    - Equations of motion for particles and rigid bodies
    - Impulse and momentum
3. **Work-Energy Concepts:**
    - Work done by forces
    - Kinetic and potential energy
    - Conservation of mechanical energy
4. **Virtual Displacements and Virtual Work:**
    - Virtual displacements and constraints
    - Principle of virtual work
    - Applications in engineering systems

Assessment and Grading:

- Regular problem sets and assignments: 30%
- Midterm examinations: 20%
- Dynamics simulations or practical projects: 25%

Recommended Reading:

1. Hibbeler, R. C. (2015). *Engineering Mechanics: Dynamics* (14th ed.). Pearson.
2. Beer, F. P., Johnston, E. R., & Cornwell, P. J. (2015). *Vector Mechanics for Engineers: Dynamics* (11th ed.). McGraw-Hill.

Course Title: Differential Equations

Course Description:

Differential Equations explores mathematical models for dynamic systems encountered in engineering. Students will learn techniques to solve ordinary differential equations (ODEs) and gain insights into their applications. The course emphasizes both theory and practical problem-solving.

Learning Objectives:

- Understand the fundamentals of ODEs.
- Apply differential equations to real-world engineering scenarios.
- Develop computational skills for solving ODEs.

Topics Covered:

1. **First-Order ODEs:**
    - Separable equations
    - Linear equations
    - Exact equations
    - Integrating factors
2. **Higher-Order ODEs:**
    - Homogeneous and nonhomogeneous equations
    - Constant coefficient equations
    - Undetermined coefficients
    - Variation of parameters
3. **Applications:**
    - Vibrations and oscillations
    - Electrical circuits
    - Heat conduction
    - Fluid flow

Assessment and Grading:

- Regular problem sets and assignments: 30%
- Midterm examinations: 20%
- Modeling and solving engineering problems using ODEs: 25%

Recommended Reading:

1. Boyce, W. E., & DiPrima, R. C. (2017). *Elementary Differential Equations and Boundary Value Problems* (11th ed.). Wiley.
2. Tenenbaum, M., & Pollard, H. (1985). *Ordinary Differential Equations* (Dover Books on Mathematics). Dover Publications.

Course Title: Principles of Mechatronics

Course Description:

Principles of Mechatronics introduces the interdisciplinary field that combines mechanical engineering, electronics, control systems, and computer science. Students will gain insights into designing and analyzing mechatronic systems, emphasizing practical applications and hands-on experience.

Learning Objectives:

- Understand the fundamental principles of mechatronics.
- Apply knowledge of sensors, actuators, and control systems.
- Develop skills in designing and integrating mechatronic components.

Topics Covered:

1. **Introduction to Mechatronics:**
    - Definition and scope
    - Historical context
    - Importance in modern engineering
2. **Sensors and Actuators:**
    - Types of sensors (temperature, pressure, proximity, etc.)
    - Actuators (electro-pneumatic, hydraulic, electric motors)
    - Signal conditioning and interfacing
3. **Control Systems:**
    - Feedback and feedforward control
    - PID controllers
    - Digital control algorithms
4. **Mechatronic Design:**
    - System modeling and simulation
    - Integration of mechanical and electronic components
    - Case studies (robotics, automation, automotive systems)

Assessment and Grading:

- Regular assignments and practical projects: 30%
- Midterm examinations: 20%
- Mechatronic system design project: 25%

Recommended Reading:

1. Bolton, W. (2015). *Mechatronics: Principles and Applications* (5th ed.). Pearson.
2. Silva, C. A., & Silva, M. F. (2018). *Mechatronics: Principles, Technologies and Applications*. Springer.

Course Title: Fluid Mechanics of Mechanical Systems

Course Description:

Fluid Mechanics of Mechanical Systems explores the behavior of fluids (liquids and gases) in mechanical systems. Students will learn fundamental principles related to fluid flow, pressure, and energy conservation. The course emphasizes both theory and practical applications.

Learning Objectives:

- Understand fluid properties and behavior.
- Apply fluid mechanics concepts to engineering problems.
- Develop skills in analyzing and designing fluid systems.

Topics Covered:

1. **Fluid Properties and Statics:**
    - Density, viscosity, and surface tension
    - Hydrostatic pressure and buoyancy
    - Manometry and pressure measurement
2. **Fluid Dynamics:**
    - Conservation of mass and momentum
    - Bernoulli's equation
    - Flow through pipes and channels
3. **Viscous Flows and Boundary Layers:**
    - Laminar and turbulent flow
    - Reynolds number
    - Drag and lift forces
4. **Applications in Mechanical Systems:**
    - Pump and fan design
    - Heat exchangers
    - Hydraulic systems

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Fluid system design project: 25%
- End-of-semester examination: 25%

Recommended Reading:

1. White, F. M. (2017). *Fluid Mechanics* (8th ed.). McGraw-Hill.
2. Munson, B. R., Young, D. F., & Okiishi, T. H. (2013). *Fundamentals of Fluid Mechanics* (7th ed.). Wiley.

Course Title: Introduction to Materials Science

Course Description:

Introduction to Materials Science provides fundamental knowledge about materials and their behavior. Students will explore the properties, classification, testing, and selection of materials for various engineering applications. The course emphasizes both theory and practical aspects.

Learning Objectives:

- Understand material classification and properties.
- Learn about material testing techniques.
- Apply materials science principles to engineering problems.

Topics Covered:

1. **Fundamental Principles:**
    - Atomic structure and bonding
    - Crystallography
    - Phase diagrams
2. **Mechanical Properties:**
    - Stress and strain
    - Elasticity, plasticity, and fracture
    - Hardness and toughness
3. **Thermal Properties:**
    - Heat capacity and thermal conductivity
    - Thermal expansion
    - Phase transformations
4. **Electrical and Magnetic Properties:**
    - Conductivity and resistivity
    - Dielectric materials
    - Magnetic behavior
5. **Materials Selection:**
    - Material selection criteria
    - Case studies (metals, ceramics, polymers)

Assessment and Grading:

- Regular assignments and quizzes: 30%
- Midterm examinations: 20%
- Materials testing lab projects: 25%
- End-of-semester examination: 25%

Recommended Reading:

1. Callister, W. D., & Rethwisch, D. G. (2018). *Materials Science and Engineering: An Introduction* (10th ed.). Wiley.
2. Ashby, M. F., & Jones, D. R. H. (2019). *Engineering Materials 1: An Introduction to Properties, Applications, and Design* (5th ed.). Butterworth-Heinemann.

Course Title: Foundations of Artificial Intelligence for STEM

Course Description:

Foundations of Artificial Intelligence introduces fundamental concepts related to AI and machine learning. Students will explore various learning schemes, including supervised and unsupervised algorithms. The course emphasizes practical applications and ethical considerations.

Learning Objectives:

- Understand the basic concepts in Artificial Intelligence and their relation to Machine Learning.
- Learn how to choose the right learning technique for a given problem.
- Differentiate between shallow and deep learning.
- Verify the learning capabilities of different techniques.
- Gain experience in running experiments and validating/comparing algorithms.
- Develop research skills for writing scientific papers.

Topics Covered:

1. **Introduction to AI:**
    - What is Intelligence?
    - Terminology
    - A Brief History of AI/ML
2. **Dealing with Data and Experiments:**
    - Data Compression: PCA and t-SNE
    - K-Fold Cross Validation
    - Decision Trees
3. **Classification and Clustering:**
    - K-Means and Fuzzy C-Means
    - Support Vector Machines
    - Self-Organizing Maps
4. **Learning Algorithms:**
    - Perceptrons, MLPs, and Backpropagation
    - Deep Learning: Autoencoders, CNNs
5. **Special Topics:**
    - Medical Imaging
    - Privacy-preserving ML and Federated Learning
    - Uncertain and Vague Knowledge (Evolving Fuzzy Inference Systems, Evolutionary Algorithms)

Assessment and Grading:

- Quizzes (9%)
- Assignments (3 assignments, 30% total)
- Project Paper (33%)

Course Title: Numerical Analysis

Course Description:

Numerical Analysis introduces students to the formulation, methodology, and techniques for numerical solution of engineering problems. The course covers fundamental principles of digital computing, algorithm accuracy, stability, error propagation, and stability analysis. Topics include:

1. **Linear Systems:**
    - Direct and iterative techniques for solving systems of linear equations.
    - Error analysis in numerical solutions.
2. **Roots of Equations:**
    - Methods for finding roots of algebraic and transcendental equations.
    - Bisection, Newton-Raphson, and secant methods.
3. **Interpolation and Approximation:**
    - Polynomial interpolation (Lagrange, Newton).
    - Least squares approximation.
4. **Numerical Differentiation and Integration:**
    - Finite-difference approximations.
    - Trapezoidal and Simpson's rules.
5. **Ordinary Differential Equations (ODEs):**
    - Finite-difference methods for ODEs.
    - Error and convergence analysis.

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Numerical simulations and practical projects: 25%

Recommended Reading:

1. Burden, R. L., & Faires, J. D. (2015). *Numerical Analysis* (10th ed.). Cengage Learning.
2. Chapra, S. C., & Canale, R. P. (2014). *Numerical Methods for Engineers* (7th ed.). McGraw-Hill.

Course Title: Applied Thermodynamics

Course Description:

Applied Thermodynamics explores the principles governing energy transfer and conversion in mechanical systems. Students will learn about thermodynamic processes, cycles, and heat transfer. The course emphasizes practical applications and engineering analysis.

Learning Objectives:

- Interpret questions and problems related to engineering thermodynamics.
- Define systems, energy types, substance states, and properties.
- Apply ideal gas equations and retrieve data from thermodynamic property tables.
- Analyze simple systems using the First and Second Laws of Thermodynamics.

- Understand the social and environmental impact of typical thermodynamic systems.

Topics Covered:

1. **First and Second Laws of Thermodynamics:**
    - Thermodynamic processes, cycles, and heat transfer.
    - Steady-state processes and energy flow analysis.
2. **Ideal Gas Equations:**
    - Limitations and applications.
    - Retrieving data from property tables and charts.
3. **Energy Systems:**
    - Energy balance and efficiency.
    - Application of finite elements in solid modeling.
4. **Structural Integrity and Sustainability:**
    - Social and environmental considerations.
    - Energy conservation and renewable resources.

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Thermodynamic system analysis project: 25%

Course Title: Mechanics and Materials II

Course Description:

Mechanics and Materials II provides Mechanical Engineering students with an awareness of various responses exhibited by solid engineering materials when subjected to mechanical and thermal loadings. The course covers the physical mechanisms associated with design-limiting behavior of engineering materials, including stiffness, strength, toughness, and durability. Students will gain an understanding of basic mechanical properties of engineering materials, testing procedures used to quantify these properties, and ways in which these properties characterize material response. The course equips students with quantitative skills to address materials-limiting problems in engineering design and serves as a basis for materials selection in mechanical design.

Topics Covered:

1. **Elasticity and Solid Mechanics:**
    - Material behavior under uniaxial loading
    - Displacement and strain
    - Stress and equilibrium
    - Applications: Beam bending, buckling, and vibration
2. **Mechanisms of Elasticity and Viscoelasticity:**
    - 3-D linear thermo-elasticity
    - Simple states of elastic stress, strain, and displacement
    - Engineering polymers: Viscoelasticity, strength, and ductility
3. **Limits to Elasticity: Strength and Multi-axial Yield Condition:**
    - Plasticity and creep
    - Uniaxial elastic-plastic behavior
    - Ideal shear strength and dislocations

4. **Fracture and Fatigue:**
    - Ideal cleavage strength
    - Crack-tip stress intensity factors
    - Linear elastic fracture mechanics (LEFM)
    - Fatigue crack propagation and defect-tolerant design
5. **Material Selection for Design:**
    - Principles for material selection
    - Material indices of merit
    - Optimization

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Lab projects and practical applications: 25%

Course Title: Mechanical Design I

Course Description:

Mechanical Design I introduces fundamental principles and techniques related to engineering design. Students will learn how to conceptualize, analyze, and create mechanical systems and components. The course emphasizes practical applications, creativity, and problem-solving skills.

Topics Covered:

1. **Engineering Design Process:**
    - Problem definition and requirements
    - Concept generation and evaluation
    - Decision-making criteria
2. **Materials Selection and Properties:**
    - Material properties (strength, stiffness, toughness)
    - Material selection for specific applications
    - Environmental considerations
3. **Static and Dynamic Loading:**
    - Stress and strain analysis
    - Factor of safety
    - Fatigue and durability
4. **Machine Elements:**
    - Bearings, gears, shafts, and couplings
    - Fasteners (bolts, screws, rivets)
    - Springs and dampers
5. **Design for Manufacturing and Assembly:**
    - Tolerances and fits
    - Assembly processes
    - Cost-effective design

Assessment and Grading:

- Regular assignments and design projects: 30%
- Midterm examinations: 20%

- Prototyping and testing: 25%

Course Title: Structural Mechanics

Course Description:

Structural Mechanics explores the behavior of solid materials and structures under load and stress. Students will learn fundamental concepts related to analyzing and designing mechanical and civil structures. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Small Deflections of Beams:**
   - Analysis of beams under small deflections
   - Stress and strain distribution
   - Bending moments and shear forces
2. **Moderately Large Deflections:**
   - Columns, cables, and shafts
   - Elastic and plastic buckling
   - Thin-walled sections and plates
3. **Energy Methods and Virtual Work:**
   - Principle of virtual work
   - Exact and approximate methods
   - Failure analysis of structures
4. **Introduction to Failure Analysis:**
   - Material failure modes
   - Fracture mechanics
   - Fatigue and durability

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Lab projects and practical applications: 25%

Course Title: Solid Mechanics III

Course Description:

Solid Mechanics III builds upon foundational knowledge of mechanics and materials. Students will delve into advanced topics related to deformable bodies, stress analysis, and structural behavior. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Advanced Stress Analysis:**
   - Bending of beams and plates
   - Torsion of non-circular sections

    - Combined loading
2. **Unsymmetric Bending and Shear Stresses:**
    - Singularity functions in bending moment equations
    - Calculation of stresses and deflections for skew loading bending problems
    - Position of principal axes in an unsymmetric cross-section
3. **Energy Methods and Stability:**
    - Principle of virtual work
    - Buckling and stability analysis
    - Application of finite elements in solid modeling
4. **Failure Analysis and Fracture Mechanics:**
    - Material failure modes
    - Linear elastic fracture mechanics (LEFM)
    - Fatigue and durability considerations

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Lab projects and practical applications: 25%

Course Title: Heat Transfer

Course Description:

Heat Transfer introduces fundamental concepts related to the transfer of thermal energy. Students will explore various modes of heat transfer, including conduction, convection, and radiation. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Conduction:**
    - Fourier's law
    - Heat conduction equation
    - Steady-state and transient conduction
2. **Convection:**
    - Fundamentals of convection
    - Forced convection (external and internal flows)
    - Natural convection
3. **Radiation:**
    - Stefan-Boltzmann law
    - Blackbody radiation
    - Radiative heat transfer
4. **Heat Exchangers:**
    - Types of heat exchangers
    - Design considerations
    - Performance analysis

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Lab projects and practical applications: 25%

Course Title: Numerical Methods and Statistics

Course Description:

Numerical Methods and Statistics introduces essential mathematical techniques for solving engineering problems and analyzing data. Students will learn numerical approximation methods, statistical analysis, and their applications in mechanical engineering. The course emphasizes both theory and practical implementation.

Topics Covered:

1. **Numerical Methods:**
    - Root finding (e.g., Newton-Raphson, bisection)
    - Interpolation and curve fitting
    - Numerical integration (e.g., trapezoidal rule, Simpson's rule)
    - Solution of linear and nonlinear equations
    - Ordinary differential equations (ODEs)
2. **Statistical Analysis:**
    - Descriptive statistics (mean, variance, standard deviation)
    - Probability distributions (normal, binomial, Poisson)
    - Hypothesis testing and confidence intervals
    - Regression analysis
3. **Applications in Mechanical Engineering:**
    - Finite element analysis (FEM)
    - Heat transfer simulations
    - Structural mechanics modeling
    - Experimental design and data analysis

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Numerical simulations and practical projects: 25%

Course Title: Mechanical Design II

Course Description:

Mechanical Design II builds upon foundational knowledge from previous courses and focuses on advanced topics related to engineering design. Students will delve into more specialized areas, gaining expertise in designing mechanical systems and components. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Advanced Machine Elements:**
    - Gear design and analysis
    - Bearing selection and lubrication
    - Couplings and clutches
2. **Finite Element Analysis (FEA):**
    - Introduction to FEA

    - Modeling techniques
    - Stress analysis and optimization
3. **Design for Manufacturing and Assembly (DFMA):**
    - Tolerances and fits
    - Assembly processes and cost considerations
    - Concurrent engineering
4. **Materials Selection and Failure Analysis:**
    - Material properties and selection criteria
    - Fatigue, fracture, and wear analysis
    - Case studies

Assessment and Grading:

- Regular assignments and design projects: 30%
- Midterm examinations: 20%
- FEA simulations and practical applications: 25%

Course Title: Thermal Fluid Systems Design

Course Description:

Thermal Fluid Systems Design focuses on the integration of thermodynamics, fluid mechanics, and heat transfer principles to design efficient and effective thermal systems. Students will learn how to analyze, model, and optimize systems related to energy transfer, HVAC, and industrial processes. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Thermodynamics:**
    - Laws of thermodynamics
    - Energy conversion cycles (e.g., Rankine, Brayton)
    - Heat engines and refrigeration systems
2. **Fluid Mechanics:**
    - Fluid properties and behavior
    - Flow in pipes and channels
    - Pump and fan selection
3. **Heat Transfer:**
    - Conduction, convection, and radiation
    - Heat exchangers
    - Insulation and thermal resistance
4. **System Design and Optimization:**
    - System modeling and simulation
    - Component selection
    - Efficiency and sustainability considerations

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Design projects (e.g., HVAC system, power plant): 25%

Course Title: Mechanical Vibrations

Course Description:

Mechanical Vibrations introduces fundamental concepts related to the dynamic behavior of mechanical systems. Students will explore various aspects of vibration analysis, including single and multi-degree-of-freedom systems, harmonic motion, resonance, and transient excitation. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Single Degree of Freedom (SDOF) Vibrations:**
   - Free and forced vibration
   - Harmonic response
   - Periodic and non-sinusoidal signals
2. **Multi-Degree of Freedom (MDOF) Systems:**
   - Modeling via Newton's second law
   - Modal analysis and modal summation
   - Torsional systems
3. **Continuous Systems:**
   - Introduction to vibration of continuous structures
   - Applications to critical speeds
4. **Vibration Measurement and Control:**
   - Vibration measuring instruments
   - Vibration isolation
   - Tuned mass vibration absorbers

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Lab projects and practical applications: 25%

Course Title: Research Methods

Course Description:

The "Research Methods" course equips engineering students with essential skills and knowledge necessary for conducting high-quality research. Students will learn how to plan, execute, and present research effectively. The course emphasizes practical techniques, ethical considerations, and the unique perspective of engineering research.

Topics Covered:

1. **Introduction to Engineering Research:**
   - Understanding the research process
   - Identifying research topics and objectives
   - Literature review and problem formulation
2. **Research Design and Methodology:**
   - Quantitative vs. qualitative research
   - Experimental design

    - Data collection methods (surveys, experiments, case studies)
3. **Statistical Analysis for Engineers:**
    - Descriptive statistics
    - Hypothesis testing
    - Regression analysis
4. **Ethical Considerations:**
    - Responsible conduct of research
    - Intellectual property and plagiarism
    - Human subjects and safety
5. **Effective Communication of Research:**
    - Writing research proposals
    - Presenting results (oral and written)
    - Peer review and publication

Assessment and Grading:

- Regular assignments and research proposals: 30%
- Midterm examinations: 20%
- Research project (data collection and analysis): 25%

Course Title: Applied Heat and Mass Transfer

Course Description:

Applied Heat and Mass Transfer explores the principles governing the transfer of heat and mass in engineering systems. Students will learn fundamental concepts related to conduction, convection, radiation, and diffusion. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Conduction Heat Transfer:**
    - Fourier's law
    - Steady-state and transient conduction
    - Heat conduction in solids and composite materials
2. **Convective Heat Transfer:**
    - Forced and natural convection
    - Boundary layers and heat transfer coefficients
    - Heat exchangers and cooling systems
3. **Radiation Heat Transfer:**
    - Blackbody radiation
    - Stefan-Boltzmann law
    - Radiative heat exchange in enclosures
4. **Mass Transfer:**
    - Diffusion and Fick's law
    - Mass transfer coefficients
    - Applications in chemical engineering and environmental systems

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%

- Lab experiments and practical applications: 25%

Course Title: Computational Fluid Dynamics (CFD)

Course Description:

Computational Fluid Dynamics (CFD) is a crucial field in mechanical engineering that focuses on simulating fluid flow and heat transfer using numerical methods. Students will learn how to model, analyze, and solve complex fluid dynamics problems. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Introduction to CFD:**
    - Overview of CFD applications
    - Governing equations (Navier-Stokes)
    - Discretization methods (finite difference, finite volume, finite element)
2. **Grid Generation:**
    - Structured and unstructured grids
    - Preprocessing tools
    - Boundary conditions
3. **Numerical Solvers:**
    - Implicit and explicit methods
    - Iterative solvers
    - Turbulence models (k-ε, Reynolds-averaged Navier-Stokes)
4. **Applications in Mechanical Engineering:**
    - Aerodynamics simulations
    - Heat exchanger design
    - Combustion modeling

Assessment and Grading:

- Regular assignments and CFD simulations: 30%
- Midterm examinations: 20%
- Project (e.g., analyzing flow around an airfoil): 25%

Course Title: Mechanics of Machines

Course Description:

Mechanics of Machines explores the principles governing the behavior and design of mechanical systems. Students will delve into various aspects related to machine components, kinematics, dynamics, and power transmission. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Kinematics:**
    - Displacement, velocity, and acceleration analysis

- Mechanisms (linkages, gears, cams)
    - Synthesis of mechanisms
2. **Dynamics of Machines:**
    - Force analysis
    - Balancing of rotating masses
    - Vibration analysis
3. **Power Transmission:**
    - Belt and chain drives
    - Gear trains
    - Clutches and brakes
4. **Machine Components:**
    - Bearings and lubrication
    - Shafts and couplings
    - Springs and dampers

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Design projects (e.g., analyzing a mechanical system): 25%

Course Title: Finite Element Analysis (FEA)

Course Description:

Finite Element Analysis (FEA) is a powerful numerical technique used to simulate and analyze complex engineering problems. In this course, students will learn the principles of FEA, its applications, and practical implementation. The focus will be on modeling, solving, and interpreting results for various engineering structures and components.

Topics Covered:

1. **Introduction to FEA:**
    - Overview of FEA applications
    - Discretization and meshing
    - Types of elements (1D, 2D, 3D)
2. **Mathematical Basis:**
    - Governing equations (e.g., equilibrium, heat transfer)
    - Element stiffness matrices
    - Assembly and solution techniques
3. **Linear and Nonlinear Analysis:**
    - Linear static analysis
    - Buckling and stability analysis
    - Nonlinear material behavior
4. **Advanced Topics:**
    - Dynamic analysis (vibration, transient response)
    - Heat transfer simulations
    - Coupled field problems (fluid-structure interaction, thermal stress)

Assessment and Grading:

- Regular assignments and FEA simulations: 30%

- Midterm examinations: 20%
- Project (e.g., analyzing stress distribution in a mechanical component): 25%

Course Title: Mechanical Design III

Course Description:

Mechanical Design III builds upon foundational knowledge from previous courses and focuses on advanced topics related to engineering design. Students will delve into more specialized areas, gaining expertise in designing mechanical systems and components. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Advanced Machine Elements:**
    - Gear design and analysis
    - Bearing selection and lubrication
    - Couplings and clutches
2. **Finite Element Analysis (FEA):**
    - Introduction to FEA
    - Modeling techniques
    - Stress analysis and optimization
3. **Design for Manufacturing and Assembly (DFMA):**
    - Tolerances and fits
    - Assembly processes and cost considerations
    - Concurrent engineering
4. **Materials Selection and Failure Analysis:**
    - Material properties and selection criteria
    - Fatigue, fracture, and wear analysis
    - Case studies

Assessment and Grading:

- Regular assignments and design projects: 30%
- Midterm examinations: 20%
- FEA simulations and practical applications: 25%

Course Title: Engineering Capstone Project A

Course Description:

The Engineering Capstone Project A is a culmination of your engineering education, where you apply the knowledge and skills acquired throughout your program to a real-world project. This course provides an opportunity for hands-on experience, teamwork, and problem-solving. You'll work on a substantial project related to your field of study, integrating various aspects of engineering.

Topics Covered:

1. **Project Selection and Proposal:**
    - Identifying project ideas
    - Defining project scope and objectives
    - Writing a project proposal
2. **Project Planning and Management:**
    - Work breakdown structure
    - Scheduling and milestones
    - Resource allocation
3. **Design and Prototyping:**
    - Conceptual design
    - Detailed design
    - Building prototypes
4. **Testing and Validation:**
    - Performance testing
    - Verification and validation
    - Iterative improvements
5. **Documentation and Presentation:**
    - Technical reports
    - Oral presentations
    - Reflecting on the project experience

Assessment and Grading:

- Proposal and project plan: 20%
- Design and prototyping progress: 30%

Course Title: Renewable Energy Systems

Course Description:

Renewable Energy Systems focuses on clean and sustainable energy technologies. Students will explore various renewable energy sources, their design, and practical applications. The course emphasizes both theory and hands-on experience.

Topics Covered:

1. **Introduction to Renewable Energy:**
    - Overview of renewable energy technologies
    - Environmental impact and sustainability
2. **Solar Energy:**
    - Photovoltaic systems
    - Solar thermal technologies
    - Design and installation considerations
3. **Wind Energy:**
    - Wind turbine anatomy
    - Wind resource assessment
    - Grid integration and control
4. **Hydropower and Ocean Energy:**
    - Hydropower plants
    - Tidal and wave energy
    - Environmental implications
5. **Bioenergy and Geothermal Systems:**

- Biomass conversion
- Geothermal heat pumps
- Case studies

Assessment and Grading:

- Regular assignments and projects: 30%
- Midterm examinations: 20%
- Renewable energy system design: 25%

Course Title: Automotive Control

Course Description:

The “Automotive Control” course focuses on the principles and techniques used to control various aspects of automotive systems. Students will learn about control theory, sensors, actuators, and their applications in vehicles. The course emphasizes both theory and practical implementation.

Topics Covered:

1. **Introduction to Automotive Control:**
   - Overview of automotive control systems
   - Role of control in vehicle performance and safety
   - Historical context and recent advancements
2. **Control Theory Basics:**
   - Feedback control
   - PID controllers
   - State-space representation
3. **Sensors and Actuators:**
   - Sensor types (temperature, pressure, speed, etc.)
   - Actuators (fuel injectors, throttle, brakes)
   - Signal conditioning and interfacing
4. **Vehicle Dynamics Control:**
   - Stability control (ABS, ESP)
   - Traction control
   - Active suspension systems
5. **Powertrain Control:**
   - Engine management (fuel injection, ignition timing)
   - Transmission control
   - Hybrid and electric vehicle control

Assessment and Grading:

- Regular assignments and problem sets: 30%
- Midterm examinations: 20%
- Control system design project (e.g., stability control algorithm): 25%

Course Title: Engineering and Enterprise

Course Description:

The “Engineering and Enterprise” course bridges the gap between technical engineering skills and business acumen. Students will explore the intersection of engineering, entrepreneurship, and management. The course emphasizes both theory and practical applications in the context of real-world projects and industry practices.

Topics Covered:

1. **Introduction to Engineering Entrepreneurship:**
   - Understanding the role of engineers in business
   - Identifying opportunities for innovation and commercialization
   - Intellectual property and patents
2. **Business Fundamentals:**
   - Basics of business models
   - Market analysis and feasibility studies
   - Financial planning and budgeting
3. **Project Management:**
   - Project planning and scheduling
   - Risk assessment and mitigation
   - Team dynamics and leadership
4. **Innovation and Product Development:**
   - Design thinking and ideation
   - Prototyping and testing
   - Scaling up for production
5. **Case Studies and Guest Speakers:**
   - Learning from successful engineering entrepreneurs
   - Analyzing real-world examples
   - Networking opportunities

Assessment and Grading:

- Business plan development: 30%
- Entrepreneurial project execution: 25%
- Presentations and pitches: 20%

Course Title: Mechanical Design Optimization

Course Description:

Mechanical Design Optimization focuses on enhancing engineering designs by systematically improving their performance, efficiency, and reliability. Students will learn techniques to optimize mechanical systems, components, and processes. The course emphasizes both theory and practical applications.

Topics Covered:

1. **Introduction to Optimization:**
   - Understanding design objectives and constraints

    - Types of optimization (single-objective, multi-objective)
    - Optimization algorithms (gradient-based, genetic algorithms)
2. **Design Sensitivity Analysis:**
    - Calculating sensitivities with respect to design variables
    - Gradient-based optimization methods
    - Response surface modeling
3. **Multi-Disciplinary Optimization (MDO):**
    - Coupling mechanical, thermal, and fluid analyses
    - Trade-offs between conflicting objectives
    - Collaborative optimization
4. **Design for Manufacturing and Assembly (DFMA):**
    - Incorporating manufacturing constraints
    - Minimizing material waste
    - Assembly-oriented design
5. **Case Studies and Practical Applications:**
    - Structural optimization (weight reduction, stiffness improvement)
    - Heat exchanger design
    - Topology optimization

Assessment and Grading:

- Regular assignments and optimization projects: 30%
- Midterm examinations: 20%
- Design optimization case study: 25%

Course Title: Manufacturing Processes and Automation

Course Description:

This course provides a comprehensive understanding of modern manufacturing techniques, automation systems, and production processes. Students will learn to design, analyze, and optimize manufacturing operations, preparing them for careers in manufacturing and process engineering industries.

Learning Outcomes:

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

1. Demonstrate a thorough understanding of principles and theoretical bases related to manufacturing processes, automation, and production.
2. Identify appropriate manufacturing systems for different production requirements and analyze their performance.
3. Apply technology, quality tools, and manufacturing methodologies to design, re-design, and improve manufacturing operations.
4. Plan, execute, and oversee experiments and research projects, analyze data, and disseminate results effectively.
5. Collaborate as part of a multidisciplinary team, exhibit self-motivation, independence, and leadership.

Prerequisites:

- Basic knowledge of mechanical engineering principles, mathematics, and physics.

Assessment:

Assessment methods include coursework, exams, and the dissertation.

Course Title: Engineering Capstone Project B

Course Description:

The Engineering Capstone Project B focuses on applying engineering principles to design a system, component, product, process, or set of research inquiries. Students work collaboratively in teams to address open-ended problems, develop research methodologies, and propose innovative solutions. The projects are often practical and relevant to industrial and mechanical engineering.

Learning Outcomes:

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

1. Integrate knowledge from various engineering domains to solve real-world problems.
2. Formulate design problem statements and specifications based on project requirements.
3. Generate and evaluate alternative solutions, considering safety, usability, and feasibility.
4. Apply economic factors, sustainability principles, and global impact considerations to their designs.
5. Work effectively as part of a diverse team, considering notions of diversity, equity, inclusion, and belonging.

Course Structure:

1. **Project Selection and Formation (1-2 weeks):**
    - Students form self-selected teams or join existing teams based on shared interests.
    - Teams identify or bid for specific design projects with faculty approval.
2. **Project Development (10-12 weeks):**
    - Teams conduct research, analyze requirements, and develop design methodologies.
    - They create detailed system descriptions, considering constraints and practical implications.
3. **Prototype Development (8-10 weeks):**
    - Teams build prototypes or implement solutions based on their designs.
    - Intellectual property rights and patent considerations are addressed.
4. **Project Evaluation and Documentation (2-3 weeks):**
    - Teams evaluate their prototypes, considering performance, safety, and usability.
    - Documentation includes project reports, presentations, and technical documentation.

Prerequisites:

- Completion of relevant engineering coursework (varies by university).

Assessment:

Assessment methods include project deliverables, presentations, and team evaluations.

Course Title: Robotics and Automation

Course Description:

Robotics and Automation involves the design, development, and implementation of sensor-based systems and robotic technologies. This interdisciplinary field combines mechanical, electrical, electronic engineering, and computer science (mechatronics). Students explore topics related to intelligent control, robotics, and industrial automation.

Learning Outcomes:

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

1. Understand the principles of robotics and automation systems.
2. Design and analyze robotic mechanisms and control algorithms.
3. Apply sensors, actuators, and programming techniques to automate processes.
4. Evaluate safety considerations and ethical implications in automation.
5. Collaborate effectively in multidisciplinary teams for real-world projects.

Course Structure:

1. **Introduction to Robotics (10 credits):**
    - Kinematics and dynamics of robot manipulators.
    - Motion planning and trajectory generation.
    - Robot programming languages.
2. **Industrial Automation (15 credits):**
    - PLC (Programmable Logic Controller) systems.
    - Sensors and actuators in manufacturing processes.
    - Factory automation and process optimization.
3. **Robot Control Systems (12 credits):**
    - PID (Proportional-Integral-Derivative) control.
    - Feedback control and adaptive control.
    - Robotic vision systems.
4. **Robotics Project (8 credits):**
    - Students work on a practical robotics project.
    - Design, build, and program a robot for a specific task.

Prerequisites:

- Basic knowledge of mechanical engineering, electronics, and programming.

Assessment:

Assessment methods include exams, practical assignments, and project evaluations.

Course Title: Engineering Project Management

Course Description:

Engineering Project Management focuses on the principles and practices of managing engineering projects effectively. Students learn how to plan, execute, and control projects within the engineering domain. The course covers project lifecycle, risk management, scheduling, and stakeholder communication.

Learning Outcomes:

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

1. Understand project management methodologies and tools specific to engineering projects.
2. Apply project planning techniques, including work breakdown structures and critical path analysis.
3. Evaluate project risks and develop mitigation strategies.
4. Effectively communicate with project stakeholders and manage project teams.

Course Structure:

1. **Introduction to Project Management**
   - Overview of project management concepts.
   - Project lifecycle phases.
2. **Project Planning and Scheduling**
   - Work breakdown structures (WBS).
   - Gantt charts and critical path analysis.
   - Resource allocation.
3. **Risk Management**
   - Identifying and assessing project risks.
   - Risk mitigation strategies.
   - Contingency planning.
4. **Stakeholder Communication**
   - Effective communication with project sponsors, team members, and clients.
   - Conflict resolution.

Prerequisites:

- Basic understanding of engineering principles.

Assessment:

Assessment methods include coursework, project reports, and presentations.

Course Title: Advanced Materials Science and Engineering

Course Description:

Advanced Materials Science and Engineering delves into the study of cutting-edge materials, their properties, and applications. This course equips students with in-depth knowledge to address complex engineering challenges related to materials selection, design, and performance.

Learning Outcomes:

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

1. Analyze advanced materials' structural, mechanical, and thermal properties.
2. Apply materials selection criteria for specific engineering applications.
3. Design innovative materials for various industries, including aerospace, automotive, and energy.
4. Evaluate sustainability and environmental impact considerations in material choices.

Course Structure:

1. **Advanced Materials Characterization**
   - Techniques for analyzing crystal structures, defects, and microstructures.
   - Advanced microscopy and spectroscopy methods.
2. **Materials for Extreme Environments**
   - High-temperature materials (ceramics, refractories, superalloys).
   - Materials for corrosive or radiation-intensive conditions.
3. **Nanomaterials and Nanotechnology**
   - Properties and applications of nanomaterials.
   - Nanofabrication techniques.
4. **Materials Design and Simulation**
   - Computational modeling of material behavior.
   - Optimization for specific properties (strength, conductivity, etc.).
5. **Materials Innovation Project**
   - Collaborative project to develop novel materials.
   - Real-world applications and prototyping.

Prerequisites:

- Completion of foundational materials science courses.
- Basic understanding of solid mechanics and thermodynamics.

Assessment:

Assessment methods include coursework, laboratory experiments, and a final project.

Course Title: Mechatronics and Control Systems

Course Description:

Mechatronics and Control Systems explores the integration of mechanical, electrical, and computer engineering principles to design intelligent systems. Students learn about sensors, actuators, control algorithms, and automation techniques.

Learning Outcomes:

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

1. Understand the interdisciplinary nature of mechatronics and control.
2. Design and analyze sensors and actuators for real-world applications.
3. Develop control algorithms for dynamic systems.
4. Apply principles of automation and robotics.

Course Structure:

1. **Introduction to Mechatronics**
   - Basics of sensors and transducers.
   - Actuator types (electric, hydraulic, pneumatic).
   - Mechatronic system modeling.
2. **Control Systems**
   - Transfer functions and block diagrams.
   - Time response analysis.
   - PID controllers and stability.
3. **Robotics and Automation**
   - Kinematics and dynamics of robotic systems.
   - Path planning and trajectory generation.
   - Industrial automation techniques.
4. **Laboratory Projects**
   - Hands-on experiments with sensors, actuators, and control systems.
   - Design and implementation of mechatronic systems.

Prerequisites:

- Basic knowledge of mechanical engineering, electronics, and programming.

Assessment:

Assessment methods include coursework, lab reports, and a final project.

Course Title: Product Design and Development

Course Description:

Product Design and Development focuses on creating innovative and functional products that meet customer needs. This course integrates design principles, engineering science, and manufacturing processes to turn concepts into real-world products.

Learning Outcomes:

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

1. Apply design principles to create aesthetically pleasing and functional products.
2. Understand materials selection, manufacturing processes, and quality control.
3. Develop prototypes and iterate designs based on user feedback.
4. Collaborate effectively in multidisciplinary teams for product development.

Course Structure:

1. **Introduction to Product Design**

    - Design thinking methodologies.
    - Sketching, ideation, and concept development.
2. **Materials and Manufacturing**
    - Materials selection criteria.
    - Manufacturing processes (casting, machining, injection molding).
3. **Prototyping and Testing**
    - Rapid prototyping techniques (3D printing, CNC machining).
    - Functional testing and validation.
4. **User-Centered Design**
    - Ergonomics, user experience, and usability.
    - Human factors in product design.

Prerequisites:

- Basic knowledge of mechanical engineering and design principles.

Assessment:

Assessment methods include coursework, design projects, and presentations.

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