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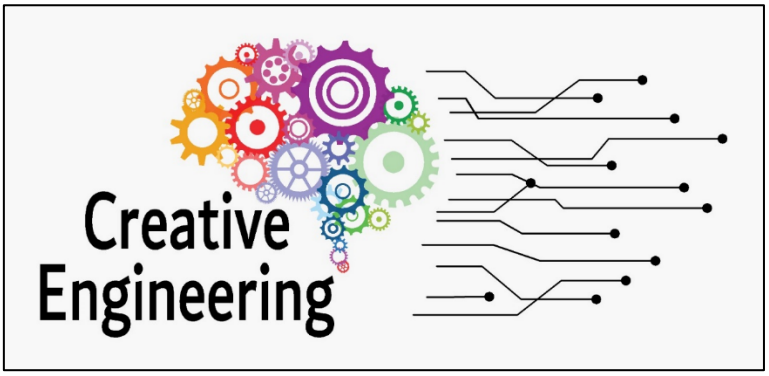

Curriculum “PROBLEM SOLVING FOR CREATIVE ENGINEERING”

2022-1-SK01-KA220-HED-000090102

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CONTENT

1 PROBLEM SOLVING FOR CREATIVE ENGINEERING

Core Unit Title: Creative Engineering

Training Module Title: Problem Solving for Creative Engineering

1.1 Competence Unit

This unit provides students with structured approaches to analyse, ideate, and solve complex engineering problems creatively and effectively. It aims to enhance students' analytical thinking, creativity, collaboration, ethical awareness, and practical implementation skills.

1.2 Learning Outcomes

Upon successful completion of the module, students will demonstrate the following competencies, skills, and knowledge:

1.2.1 Competencies

A – Specific Competences (related to the core unit)

Code	Competence Description
A1	Apply structured analytical methods such as SWOT and Root Cause Analysis to engineering problems.
A2	Generate diverse and innovative solutions using brainstorming and ideation techniques.
A3	Develop, prototype, and refine creative engineering solutions in physical or digital form.

A4	Make ethically sound decisions in complex problem-solving scenarios.
A5	Plan and implement solutions while engaging in reflection and continuous improvement.

B – Basic Engineering Competences

Code	Competence Description
B1	Identify and define complex engineering problems with clarity and precision.
B2	Evaluate multiple solution options based on feasibility, impact, and sustainability.
B3	Use tools such as CAD or rapid prototyping software to model and test concepts.
B4	Apply project management principles to structure and execute problem-solving tasks.
B5	Incorporate feedback and testing results into iterative development processes.

C – Transversal Competences

Code	Competence Description
C1	Collaborate effectively in interdisciplinary teams to develop creative solutions.
C2	Communicate analytical findings and solutions clearly through visual and verbal formats.
C3	Demonstrate ethical reasoning and responsibility in decision-making.
C4	Engage in structured self-reflection to improve future performance.
C5	Take initiative and adapt to change during uncertain or complex challenges.

1.2.2 Knowledge

By the end of the module, students will have gained an understanding of:

Topic	Description
SWOT analysis and Root Cause Analysis	Key frameworks for structuring engineering problem analysis
Ideation techniques	Mind mapping, 6-3-5 method, SCAMPER for creative idea generation
Prototyping tools and methods	Paper prototyping, CAD software, digital modeling
Ethical frameworks in engineering	Integrity, transparency, responsibility, and real-world case studies
Project management principles	Planning, implementation, risk management in engineering settings
Reflective methodologies	Journaling, self-assessment, continuous improvement strategies

1.2.3 Skills

Skill	Linked Competences
Problem identification and analytical reasoning	A1, B1
Creative thinking and brainstorming	A2, C1
Prototyping techniques (physical and digital)	A3, B3
Effective evaluation and selection of solutions	A2, B2, B5
Ethical analysis and decision-making	A4, C3
Reflective practice and continuous improvement	A5, B5, C4

1.3 Evaluation Criteria

The assessment strategy in this module is designed to measure the learner's ability to apply analytical methods, generate creative solutions, develop functional prototypes, and reflect on the decision-making process. Each competence unit includes a mix of individual and group-based tasks, supported by formative and summative assessment tools.

- **Total: 100%**

Assessment is structured into three components:

1.3.1 Analytical and Ideation Tasks – 30%

Students complete a structured case study in which they:

- Conduct SWOT and/or Root Cause Analysis
- Generate and prioritize a set of creative ideas using ideation techniques (e.g. 6-3-5, mind mapping)

Assessed Competences: A1, A2, B1, B2, C2

Evaluation Tool: Case study analysis form + ideation rubric

Criteria: Depth of analysis, originality and feasibility of ideas, clarity of presentation

1.3.2 Prototype and Solution Presentation – 40%

In small teams, students develop a functional concept or prototype. They present:

- The problem and chosen methodology
- Their prototype or simulation
- Justification of the final solution using evaluation criteria (e.g. cost-effectiveness, sustainability)

Assessed Competences: A3, A5, B3, B4, C1, C5

Evaluation Tool: Prototype/project rubric + peer assessment

Criteria: Functionality, innovation, practicality, teamwork and adaptability

1.3.3 Ethics and Reflection – 30%

Each student submits a reflective journal addressing:

- Ethical dimensions of their design decisions
- Their role in the team
- What they learned and how they will apply it in future problem-solving situations

Assessed Competences: A4, B5, C3, C4

Evaluation Tool: Reflection rubric + ethical reasoning checklist

Criteria: Insightfulness, connection to module content, personal learning outcomes

1.4 Methodological strategies

The Problem Solving module combines analytical rigor with creative exploration. It uses **student-centered, experiential, and reflective teaching strategies** that simulate real engineering scenarios and promote interdisciplinary teamwork. Learning methods are carefully selected to support each competence unit and promote both individual insight and collaborative innovation.

1.4.1 Lectures and Theoretical Foundations

Structured input sessions introduce key concepts such as:

- SWOT analysis and Root Cause Analysis
- Ideation frameworks and selection techniques
- Ethical decision-making models

- Project implementation and evaluation strategies

PowerPoint presentations, videos, and short case illustrations are used. Students are expected to take notes and engage with follow-up reading and diagrams available through the learning platform.

Used for: building conceptual clarity and shared vocabulary

Related Competence Units: A1, A4, B1, B4

1.4.2 Case Study Analysis

Students explore **real-world engineering challenges** from different domains. Each case focuses on:

- Understanding the problem's complexity
- Identifying root causes and relevant constraints
- Proposing alternative approaches using creative methods

Used for: applying analytical tools, scenario framing

Related Competences: A1, B1, B2

1.4.3 Interactive Workshops

Facilitated workshops offer hands-on learning through:

- Brainstorming and ideation sessions
- Paper and digital prototyping
- Evaluation of solutions using decision-making grids and criteria matrices

Used for: practicing innovation, rapid experimentation

Related Competences: A2, A3, B3, C2

1.4.4 Guest Lectures and Industry Insight

Invited professionals share practical experiences with:

- Creative engineering solutions

- Risk management and ethical dilemmas
- Innovation under real-world constraints

Used for: connecting theory with professional context

Related Competences: A5, B4, C3

1.4.5 Simulation-Based Learning

Students participate in scenario-based simulations where they:

- Respond to complex, open-ended engineering problems
- Apply problem-solving strategies in teams
- Reflect on decisions and iterate their concepts

Used for: developing adaptability, resilience, teamwork

Related Competences: A3, C1, C5

1.4.6 Reflective Journaling

Throughout the module, students maintain a **learning journal** where they:

- Document insights from each activity
- Analyze their problem-solving mindset
- Reflect on ethical questions and decision processes

Used for: developing metacognition and learning awareness

Related Competences: A5, B5, C4

2 RECOMMENDED OR REQUIRED READING

- **"Design Thinking for Creative Problem Solving" by Nigel Cross** - This book provides a comprehensive introduction to design thinking, a fundamental concept in creative engineering problem-solving.
- **"Root Cause Analysis: The Core of Problem Solving and Corrective Action" by Duke Okes** - Understanding root cause analysis is essential for addressing complex engineering challenges. This book offers practical insights into the process.
- **"Problem Solving 101: A Simple Book for Smart People" by Ken Watanabe** - This straightforward book introduces problem-solving techniques applicable in various contexts, including engineering.
- **"SWOT Analysis: The Ultimate Guide to SWOT Analysis for Business" by David McQuillan** - Understanding SWOT analysis is crucial in the creative engineering problem-solving process. This book provides an in-depth exploration of this tool.
- **"Creative Confidence: Unleashing the Creative Potential Within Us All" by Tom Kelley and David Kelley** - This book explores how to nurture creativity and innovation, which are essential for problem-solving in engineering.
- **"Thinking, Fast and Slow" by Daniel Kahneman** - While not specific to engineering, this book delves into cognitive biases and thought processes, which can be valuable in understanding how people approach and solve problems.
- **"Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and MATLAB" by Michael B. Cutlip and Mordechai**

Shacham - A more technical read, this book provides practical problem-solving techniques for engineering students.

- **"The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries** - This book introduces the concept of lean thinking and how it can be applied to problem-solving and innovation in engineering projects.
- **"Design of Experiments: A No-Name Approach" by Peter R. Nelson and Karen A. F. Copeland** - For a deeper dive into experimental design and problem-solving, this book offers valuable insights.
- **"The Art of Innovation" by** Tom Kelley - This book explores the importance of innovation and creative problem-solving in the design and engineering process. It provides insights into how to foster a culture of innovation within a team or organization.
- **"Prototyping and Modelmaking for Product Design"** by Bjarki Hallgrimsson - This book delves into the world of prototyping and modelmaking, offering practical guidance on creating physical prototypes to test and develop design concepts. It covers various techniques and materials for prototyping.

3 DETAILED CONTENT FOR THE COURSE

Language of the course:

Names of the lectures:

Teaching hours: 15 hours

Mode of delivery: distance, online

Notes:

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1. Introduction to Creative Engineering Problem Solving (1 hour)

- Overview of problem-solving in engineering contexts
- Importance of creativity and innovation in engineering
- Types of engineering problems
- Problem-solving process and methodologies

2. Analyzing Real-World Engineering Challenges (1 hour)

- Understanding the context and scope of real-world problems
- Identifying key elements and constraints
- Real-world examples and case studies
- Critical thinking for engineering problem analysis

3. Analytical Tools and Techniques (3 hour)

- Introduction to SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats)
- Root Cause Analysis (RCA) methodology
- Application examples and practical exercises
- Evaluating the effectiveness of analytical tools

4. Brainstorming and Ideation (2 hour)

- Fundamentals of brainstorming
- Techniques: Mind mapping, 6-3-5 method, SCAMPER
- Group ideation exercises
- Techniques for enhancing creative idea generation

5. Solution Prototyping and Concept Development (2 hour)

- Importance and objectives of prototyping
- Types of prototypes: Physical vs digital
- Introduction to prototyping tools (CAD, rapid prototyping, mockups)
- Hands-on prototyping activities

6. Selecting the Best Solutions (1 hour)

- Criteria for evaluating engineering solutions (cost, sustainability, feasibility, impact)
- Decision-making processes and prioritization techniques
- Comparative analysis of alternative solutions
- Practical group activities and case study analysis

7. Planning for Implementation (1 hour)

- Basics of project planning and management
- Developing implementation plans and timelines
- Resource allocation and risk management
- Addressing potential roadblocks and contingency planning

8. Ethical Considerations in Problem Solving (3 hour)

- Understanding ethical responsibilities in engineering
- Ethical frameworks and principles (integrity, transparency, responsibility)
- Case studies highlighting ethical dilemmas in engineering
- Group discussions on ethical decision-making

9. Reflection and Improvement (1 hour)

- Importance of reflective practice in engineering
- Methods of effective self-assessment and reflection
- Identifying lessons learned and areas for improvement
- Developing continuous improvement plan