SUBJECT OUTLINE: EN 113 ENGINEERING MATERIALS AND PROPERTIES

Programs	Common to all Bachelor of Engineering Courses
Subject Name	Engineering Materials and Properties
Subject Code	EN113
Duration	One semester
Contact Hours	6 Hours (3 Lectures + 3 practical)
Credit Points	18
Delivery Mode	On campus
Prerequisites	Nil
Co-requisites	Nil

Synopsis

Engineering Materials and Properties provides students with the opportunity to attain a fundamental knowledge of materials used in the different fields of engineering. It will impart cognitive skills to think critically about the materials relevant for industrial and domestic applications. The subject examines the physicochemical properties of materials and how they impact on their design and applications in engineering. The materials studied cover the broad spectrum from hydrocarbons through to metals, lubricants, cements, nanomaterials, polymers and ceramics. The subject adopts a hands-on experimental approach through the use of laboratory practical sessions that enhance the theoretical concepts.

Subject Topics

1. Topic 1: Structure of Solids
2. Topic 2: Mechanical Properties of Materials
3. Topic 3: Equilibrium Diagrams
4. Topic 4: Electrical and Magnetic Materials
5. Topic 5: Corrosion Processes
6. Topic 6: Material Selection

1. Structure of solids: Classification of engineering materials, Structure-property relationship in engineering materials, Crystalline and non-crystalline materials, Miller Indices, Crystal planes and directions, Determination of crystal structure using X-rays, Inorganic solids, Silicate structures and their applications. Defects; Point, line and surface defects.

2. Mechanical properties of materials: Elastic, Inelastic and Viscoelastic behavior, Engineering stress and engineering strain relationship, true stress - true strain relationship, review of mechanical properties including tensile, bending and shear.

3. Equilibrium diagrams: Solids solutions and alloys, Gibbs phase rule, Unary and binary eutectic phase diagrams, Examples and applications of phase diagrams like Iron - Iron carbide phase diagram.

4. Electrical and magnetic materials: Conducting and resistor materials, and their engineering application; Semiconducting materials, their properties and applications; Magnetic materials, Soft and hard magnetic materials and applications; Superconductors; Dielectric materials, their properties and applications. Smart materials: Sensors and actuators, piezoelectric, magnetostrictive and electrostrictive materials.

5. Corrosion process: Corrosion, Causes of corrosion, Types of corrosion, Protection against corrosion including coatings such as paints and galvanizing.

6. Materials selection: Overview of properties of engineering materials. Selection of materials for different engineering applications.

Subject Learning Outcomes

After completing this Subject, students will be able to:

1. Demonstrate fundamental knowledge of the structures of solids and their analysis.
2. Demonstrate how to assess the mechanical properties of different materials to determine their uses for various engineering disciplines.
3. Appy equilibrium diagrams relevant to the various engineering disciplines to discern alloying outcomes.
4. Achieve the capacity to investigate and evaluate the properties of Electrical and Magnetic materials for engineering applications.
5. Undertake the selection of materials for engineering tasks based on non-dimensional analysis based on a wide strictum of parameters such as tensile, bending and shear strength, resistivity and corrosion resistance.
6. Develop teamwork and communication skills by participating in laboratory practical sessions and writing reports.

Assessment Tasks and Weightings

To obtain a pass grade in this Subject, 50% overall must be achieved. Formative assessments will contribute 50% and summative final written examination will contribute 50% to overall assessment**.**

Subject Assessment consists of assignments, laboratory practicals and a final examination as summarized below. Students must also refer to the Assignments and the Subject Assessment Guide for Engineering Materials and Properties where detailed information is provided for each assessment.

1. **Assignment 1 (team) -** The assignment provides student with the opportunity to undertake a critical analysis of engineering materials. It contributes **5%** of the total marks for the Subject.
2. **Test -** There will be 2 tests. They contribute **20%** of the total marks for the Subject.

3. **Laboratory Sessions (team) –** Group experimental work contributes **25%** of the total marks for the Subject.
4. **Final Examination:** The final examination is of 2 hours duration consisting of two parts. Part A is compulsory. Part B consists of a selection. The final exam is worth **50%** of the total marks for the Subject.

It is important that all students familiarize themselves with the PNG Unitech Assessment Guidelines including those on plagiarism. This can be viewed on the PNG Unitech website: http://asix.unitech.ac.pg/apps/pnguot/?q=unitech/policies

Subject Mapping

Subject Learning Outcomes (SLO) are mapped to each of; PNG National Qualifications Framework (NQF), Course Learning Outcomes (CLO), Unitech Graduate Attributes (GA) and Engineers Australia Stage 1 Competencies.

The Subject Learning Outcomes for this Subject combine with those of all Subjects within your course to collectively deliver the Engineers Australia Stage 1 Competencies.

Subject Mapping Matrix

SLO	SLO to NQF	SLO to CLO	SLO to GA	SLO to AT	SLO to EA Stage 1 Competencies
1	Knowledge and skills	1,2	Critical Thinker	1, 2, 3	1.1, 1.2, 1.3
2	Knowledge and skills	1,2	Critical Thinker	1, 2, 3	1.1, 1.3
3	Knowledge and skills	1,2	Critical Thinker	1, 2, 3	1.1, 1.3
4	Knowledge and skills	1,2	Critical Thinker	1, 2, 3e	1.1, 1.3
5	Knowledge and skills	1,2	Critical Thinker	1, 2, 4	1.1, 1.3, 2.3
6	Knowledge and skills	1,2,7	Effective communicator, team player, cultural modernist	3, 4	1.1, 1.3, 3.2, 3.5, 3.6

Graduate Capability Statement

This subject is common to all Bachelor of Engineering courses. Student should refer to their own engineering discipline for the Graduate Capability Statement that applies to their course/discipline.

Engineering Courses Learning Outcomes - EA Stage 1 Competencies

This Subject is common to all engineering courses and its Learning Outcomes are mapped to the following broad engineering Course Learning Outcomes, which mesh with those of each engineering discipline.

The following table is included to demonstrate to students that overall, the Engineering CLOs address all Competencies. The combined mapping details for all SLOs to Engineers Australia Stage 1 Competencies for each course provides finer detail.

Course Learning Outcome	Engineers Australia Stage 1 Competencies
1. Possession of a deep understanding of the sciences, math, information systems and engineering fundamentals that underpin the engineering disciplines.	1.1, 1.2
2. An in-depth understanding of the body of knowledge that forms the engineering disciplines.	1.2, 1.3
3. Collection, synthesis and application of information within the engineering disciplines.	1.4, 1.5, 2.1, 2.3, 2.4, 3.4
4. Undertaking research, analysis & evaluation of ideas and concepts within engineering.	1.3, 1.4, 1.6, 2.1, 2.3, 2.4, 3.2, 3.4
5. Applying problem solving skills to complex engineering systems and processes.	1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3
6. Undertake engineering design and manage engineering projects.	1.6, 2.2, 2.4, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6
7. Communication via multiple media to diverse audiences, undertaking team roles, teamwork and providing team leadership.	2.4, 3.2, 3.3, 3.4, 3.5, 3.6
8. Behaving in an ethical and professional manner and respecting others.	1.6, 2.4, 3.1, 3.4, 3.5, 3.6
9. Being cognisant of the importance of sustainability and the environmental impact of engineering.	1.5, 1.6, 3.1, 3.3, 3.4

***Note:** While the course learning outcomes will have minor differences for each engineering course the above mapping remains valid for use in all courses.

Engineers Australia Stage 1 Competencies

1. KNOWLEDGE AND SKILL BASE	2.ENGINEERING APPLICATION ABILITY	3. PROFESSIONAL AND PERSONAL ATTRIBUTES
1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.	2.1 Application of established engineering methods to complex engineering problem solving.	3.1 Ethical conduct and professional accountability.
1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline.	2.2 Fluent application of engineering techniques, tools and resources.	3.2 Effective oral and written communication in professional and lay domains.
1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline.	2.3 Application of systematic engineering synthesis and design processes.	3.3 Creative, innovative and pro-active demeanour.
1.4 Discernment of knowledge development and research directions within the engineering discipline.	2.4 Application of systematic approaches to the conduct and management of engineering projects.	3.4 Professional use and management of information.
1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline.		3.5 Orderly management of self, and professional conduct.
1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline		3.6 Effective team membership and team leadership.

Unitech Graduate Attributes

Attribute	Academic Dimension	Personal Dimension	Transferable Dimension
1. Lifelong Learner	Sustained Intellectual Curiosity and Use of Feedback Reflected in Work	Sets Aspiration Goals for Personal Improvement and Career Growth	Takes responsibility for one's learning and development.
2. Critical Thinker	Use of Inference Rules in Analyzing and Finding Solutions for Complex Problems	Non-Emotional, Logic and Critical Thinking Abilities in all Situations.	Ability to find solutions to problems by using logical and imaginative thinking.
3. Effective Communicator	Abilities in Articulate Discussions	Skills in Delivering high Quality written essays and oral presentations.	Ability to communicate and negotiate with others and to listen to them.
4. Cultural Modernist	Familiarity with international standards, world cultures and human	Tolerance of the religions and cultures of others.	Ability to work in a multicultural setting and comprehension and tolerance of religious and

	rights.		cultural differences.
5. Moral Uprightness	Understand and act upon the ethical responsibilities of their actions.	Character of acting in a morally upright way in all situations.	Professional behaviour at all times.
6. Technologically Savvy	Familiarity and use of technologies appropriately.	Keeping up to date with innovations.	Character of accepting new technology and quickly adapting to it.

Student Workload

The total workload for the subject for the 'average' student is a nominal 150 hours, based on a 15-week semester with 14 weeks of teaching as per the PNG National Qualification Framework.

Text books

1. W.D. Callister, Materials Science and Engineering; John Wiley & Sons, Singapore, 2002.
2. W.F. Smith, Principles of Materials Science and Engineering: An Introduction; Tata Mc-Graw Hill, 2008

Reference Textbooks

1. V. Raghavan, Introduction to Materials Science and Engineering; PHI, Delhi, 2005.
2. S. O. Kasap, Principles of Electronic Engineering Materials; Tata Mc-Graw Hill, 2007.
3. L. H. Van Vlack, Elements of Material Science and Engineering; Thomas Press, India, 1998.
4. K. G. Budinski, Engineering Materials – Properties and selection, Prentice Hall India, 1996.

Web references:

- www.tndte.com
- nptel.ac.in/downloads
- www.scribd.com
- cuiet.info
- www.sbtebihar.gov.in

Relevant Unitech Policies:

It is important that all students familiarize themselves with the PNG Unitech Assessment Guidelines including those on plagiarism. This can be viewed on the PNG Unitech website: http://asix.unitech.ac.pg/apps/pnguot/?q=unitech/policies