MEC2204: MATERIALS SCIENCE AND ENGINEERING 1

Hours per semester	Weighted total mark	Weighted exam mark	Weighted continuous assessment mark	Credit unit

LH	PH	TH	CH				CU
52	16		60	100	60	40	4

Course description

This course introduces the subject of materials science to the students. It is designed to make the students appreciate the relationship between material processing, material structure, material properties and material performance. As an introductory course, it presents the basics in materials science like classification of various engineering materials, atomic structure, crystal systems, imperfections in materials and their influence on material properties, phase diagrams, diffusion and strengthening mechanisms.

Aims

The aims of this course are to:

- Ensure that students appreciate the role of materials science in Engineering work
- Guide students through the various material microstructures, properties, and their influence on material performance
- Introduce students to material phase diagrams, and various material strengthening mechanisms

Learning Outcomes

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

- Appreciate the relevance of materials science knowledge in engineering applications
- Understand the various strengthening mechanisms in materials
- Understand, describe and draw phase diagrams, appreciate the use of phase rule and equilibrium conditions as used in Materials Science
- Describe the various imperfections in materials and their influence on the properties.
- Understand the solidification processes of materials
- Classify materials according to their properties.

- Relate mechanical, thermal, electrical and optical properties to material structures. **Teaching and Learning Pattern**

The teaching of students will be conducted through lectures, case studies and group discussions among the students. The lecture material will be availed to the students in advance to enable them have prior reading. Laboratory demonstrations will be conducted to demonstrate important practical aspects of the subject

Course Assessment

Assessment will be done through coursework which will include assignments, lab work, class room tests and a written examination. Course work will carry a total of 40% and written examination carries 60%.

Detailed Course content

The course will be taught as follows

Introduction (4 hours):

- Background and definitions: materials science, materials engineering, structure, properties
- Basic material properties
- Factors for materials selection
- Classification of materials,
- Requirements for modern engineering materials

Atomic structure and Interatomic Bonding (4 hours)

- Atomic structure
- Atomic bonding in solids

Solidification and structural crystallinity of materials (6 hours)

- Crystal structures,
- Crystallographic directions and planes,
- Linear and planar atomic densities
- Crystalline and non crystalline materials,
- Interplannar spacings.

Imperfections in solids (6 hours)

- Point defects; vacancies and interstitial defects
- Line defects; Edge and screw dislocations, characteristics,

- dislocation generation, motion, interaction, and significance
- Interfacial defects; external surfaces, grain boundaries, twin boundaries
- Volume defects; pores, cracks, inclusions, etc

Solid solutions and phase diagrams (6 hours)

- Solid solutions,
- Equilibrium phase diagrams of unary, binary, peritectics, eutectics, eutectoids.
- Non equilibrium phase diagrams,
- Coring,
- Application and examples of phase diagrams

Diffusion in solids (4 hours)

- Mechanisms of solidification,
- Steady state diffusion, Fick's Laws,
- Non-steady state diffusion,
- Factors influencing diffusion,
- Nucleation and growth

Strengthening mechanisms (6 hours)

- Grains and grain boundaries,
- Dislocations and phase deformations,
- Strengthening by grain refinement,
- Solid solution hardening,
- Strain hardening,
- Strain ageing,
- Cold work, recovery, and recrystallisation
- Precipitation hardening

Introduction to polymers and plastics (4 hours)

- Structures,
- Characteristics,

- Processing,
- Applications

Introduction to ceramics (4 hours)

- Structures,
- Properties,
- Applications

Introduction to composites (4 hours)

- Particle reinforcement,
- Fibre reinforcement,
- Structural composites

Laboratories (16 hours) Delivery Methods:

- The course will be taught by using lectures, tutorials, practical sessions involving hands-on project work and laboratories.

Assessment Methods:

- Course work (assignments and tests) and final examination and their relative contributions to final grade are shown as follows:

Requirement	**Percentage contribution**
Course work	40%

Final examination

Total 100%

References

1) Callister W.D (2005). **Fundamentals of Materials Science and Engineering, an Integrated Approach.** 2nd Ed. John Wiley & Sons. ISBN: 0-471-47014-7

2) Groover, M.P (2007). **Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.** 2nd Ed. John Wiley & Sons, Inc. ISBN-13: 978-0-471-74485-6

3) Kalpakjian, S. Schmid, S. (2006). **Manufacturing Engineering and Technology.** 5th Ed. Pearson Education Inc. ISBN: 0-13-148965-8

4) Degarmo, E.P., Black, J.T and Kohser, R.A. (2003). **Materials and Processes in Manufacturing.** 9th Ed. John Wiley & Sons, Inc. ISBN: 0-471-03306-5

5) Higgins R.A (1993). **Engineering Metallurgy. Part 1, Applied Physical Metallurgy,** 6th Ed. Edward Arnold, London. ISBN: 0-340 56830-5

6) Smallman R.E and Bishop R. J (1999). **Modern Physical Metallurgy and Materials Engineering: Science, Process and Applications,** 6th Ed. Butterworth Heinemann ISBN: O- 7506 4564-4