| Course Name | | | | | | |
|---|---|---|---|---|---|---|
| **INTRODUCTION to BIOMATERIALS** | | | | | | |
| **Code** | **Semester** | **Local Credits** | **ECTS Credits** | **Course Implementation, Hours/Week** | | |
| | | | | **Theoretical** | **Tutorial** | **Laboratory** |
| MET 328E | 6 | 2 | 4 | 2 | - | - |

| | | | |
|---|---|---|---|
| **Department/Program** | Metallurgical and Materials Engineering | | |
| **Course Type** | Required | **Course Language** | English |
| **Course Prerequisites** | None | | |

| **Course Category by Content, %** | **Basic Sciences** | **Engineering Science** | **Engineering Design** | **General Education** |
|---|---|---|---|---|
| | - | 80 | 20 | - |

| | |
|---|---|
| **Course Description** | A general introduction to biomaterials science, definition and performance of biomaterials, an emphasizing the importance of materials science, basic classification of materials, atomic structure and bonding, bond types, crystal and amorphous structures, classifications of materials used in medicine (metallic, ceramic and polymeric biomaterials, composites as biomaterials), some background concepts (biocompatibility, stress shielding, tissue-implant interactions, structure-property relationships of biological materials), soft and hard tissue replacements, tissue response to implants, host reactions to biomaterials and their evaluation, testing of biomaterials (in-vivo and in-vitro assessments), tissue engineering materials and regeneration, characterization of materials in laboratory visiting. |
| **Course Objectives** | 1.To improve students analytical thinking by focusing structure-property- process relations of biomaterials.<br>2.Learning basic materials science and biomaterials science knowledge and based on these infrastructure recognizing the nowadays engineering materials and biomaterials and their basic production routes, understanding their microstructure and performance relations, selection and safety criteria and related engineering standards.<br>3.To encourage students to understand and experience disciplinary engineering in problem solving. |
| **Course Learning Outcomes** | The Student will<br>1. Understand structure-property-process relations in biomaterials<br>2. Describe atomic bonds, orders, crystallography and the effects of bonding in biomaterials<br>3. Classify and select biomaterials and processes<br>4. Understand the concepts of biological materials<br>5. Explain soft and hard tissue replacements<br>6. Explain tissue response to implants<br>7. Understand the concepts of in-vivo and in-vitro test<br>8. Learn the applications of materials in medicine and dentistry<br>9. Understand tissue engineering<br>10. Understand the basic characterization techniques of biomaterials |
| **Textbook** | • B.D. Ratner, S.A. Hoffman, F.J. Schoen, J.E. Lemons, “Biomaterials Science: An Introduction to Materials in Medicine”, Elsevier Academic Press, 2004, ISBN: 0125824637. |
| **Other References** | • Askeland, D.R., “The Science and Engineering of Materials”, Chapman & Hall,1993<br>• L.L. Hench, J. Wilson, “An Introduction To Bioceramics”, Advanced Series in Ceramics Vol. 1, 2nd Edition, 1999, ISBN: 9810214006.<br>• Shackleford, J.F., “Introduction to Materials Science for Engineers”, Prentice-Hill<br>• Callister, W.D., “Fundamentals of Materials Science and Engineering: An Integrated Approach”, 2nd Edition, Wiley Pub.<br>• Ashby, M., Shercliff, H., Cebon, D., “Materials: Engineering, Science, Processing and Design” |
| **Homework & Projects** | • One term paper and two homework are given for better understanding the lecture |
| **Laboratory Work** | *None* |
| **Computer Use** | |
| **Other Activities** | |

| **Assessment Criteria** | **Activities** | **Quantity** | **Effects on Grading, %** |
|---|---|---|---|
| | **Midterm Exams** | 1 | 35 |
| | **Quizzes** | 1 | 5 |
| | **Homework** | 2 | 5 |
| | **Projects** | - | - |
| | **Term Paper/Project** | 1 | 5 |
| | **Laboratory Work** | - | - |
| | **Other Activities** | - | - |
| | **Final Exam** | 1 | 50 |

## COURSE PLAN

| Weeks | Topics | Course Outcomes |
|---|---|---|
| **1** | Introduction to Biomaterials Science and Structure of Solids | 1, 2 |
| **2** | Classification of Materials Used in Medicine | 1, 3 |
| **3** | Introduction to Biomaterials and Background Concepts (Biocompatibility, Stress Shielding) | 3 |
| **4** | Background Concepts (Structure and Properties of Proteins, Cells and Interactions with Materials) | 3, 4 |
| **5** | Soft and Hard Tissue Replacements, Graft Materials | 1, 5 |
| **6** | Implant-Tissue Interactions-I (Bioinert, Bioactive, Bioresorbable Materials) | 1, 6 |
| **7** | Host Reactions to Biomaterials and Their Evaluation | 6 |
| **8** | Testing of Biomaterials (In-vitro and In-vivo Assessment of Tissue Compatibilities) | 7 |
| **9** | Application of Materials in Medicine and Dentistry (Dental Implants, Orthopedic Applications) | 1, 8 |
| **10** | Application of Materials in Medicine (Drug Delivery Systems) | 1, 8 |
| **11** | Artificial Organs (Implantable Pneumatic Artificial Hearts, Extracorporeal Artificial Organs) | 1, 8 |
| **12** | Tissue Engineering Materials and Regeneration | 6, 9 |
| **13** | Characterization of Materials – Laboratory Visiting - I | 10 |
| **14** | Characterization of Materials – Laboratory Visiting - II | 10 |

**Relationship between the Course and** METALLURGICAL and MATERIALS ENGINEERING **Curriculum**

| | Program Outcomes | Level of Contribution | | |
|---|---|---|---|---|
| | | **1** | **2** | **3** |
| **1** | Ability to apply the knowledge of mathematics, science and engineering principles to solve problems in metallurgical and materials engineering (ABET:a) | | **X** | |
| **2** | Ability to characterize materials using standard and/or self designed experimental methods and to evaluate the results (ABET:b) | X | | |
| **3** | Ability to design a system or a process, taking into consideration of the desired specifications, quality, ethics and environment. (ABET:c) | | | |
| **4** | Ability to communicate both orally and in the written form and to take part in, and provide leadership of the teams in the elucidation of engineering problems; (ABET:d, g) | | | **X** |
| **5** | Ability to define, formulate and solve engineering problems in the development, production, processing, protection and usage of engineering materials. (ABET:e) | | | **X** |
| **6** | An understanding of professional and ethical responsibilities(ABET:f) | | | |
| **7** | An understanding of current/contemporary issues and impact of engineering solutions in broad cultural, national and global levels;. (ABET:h, j) | | **X** | |
| **8** | A comprehension of the nature of engineering progress closely linked with the development of new materials and production processes. An ability to engage in life-long learning and a recognition of its necessity (ABET:i) | | **X** | |
| **9** | Ability to use essential tools and techniques of modern engineering in the development, production, processing, protecting of the existing and new engineering materials. (ABET:k) | | | **X** |

**1: Little, 2. Partial, 3. Full**

**Course relationships with major elements of the field and material classes**

| | | Level of Contribution | | |
|---|---|---|---|---|
| | | **1** | **2** | **3** |
| **MAJOR ELEMENT OF THE FIELDS** | STRUCTURE | | | **X** |
| | PROPERTIES | | | **X** |
| | DESIGN EXPERIMENT/ANALYSE DATA | | | |
| | PROCESSING | | **X** | |
| | COST/PERFORMANCE | **X** | | |
| | QUALITY/ENVIRONMENT | **X** | | |
| | DESIGN PROCESS OR PRODUCT | | **X** | |
| **MATERIAL CLASSES** | METAL | | **X** | |
| | CERAMICS | | **X** | |
| | POLYMERS | | **X** | |
| | COMPOSITES | | **X** | |

**1: Little, 2. Partial, 3. Full**

| ***Prepared by*** | *Date* | **Signature** |
|---|---|---|
| Prof.Dr.Gültekin GÖLLER<br>ASsoc. Prof. Dr. İpek AKIN | December 2020 | |