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| **Course Title** | Thermal and Mechanical Properties of Materials |
| **Course Code** | MSE510 |
| **Credit Hours** | 3 |
| **Pre-requisites (if any)** | Undergraduate in materials science or mechanical engineering, or instructor approval |
| **Co-requisites (if any)** | |
| **Name of Faculty** | Dr Mahieddine Emziane – Associate Professor (Part I)<br>Dr Raed Hashaikeh – Associate Professor (Part II) |
| **E-mail of Faculty** | memziane@masdar.ac.ae<br>rhashaikeh@masdar.ac.ae |
| **E-mail of Faculty** | memziane@masdar.ac.ae; rhashaikeh@masdar.ac.ae |
| **Office hours of Faculty** | Open |
| **Brief Course Description** | Thermal and mechanical properties of various materials such as metals, semiconductors, ceramics, polymers and composites. Correlations of these properties with: (1) their internal structures (atomic, molecular, crystalline, micro-and macro); (2) processing and; (3) service conditions (mechanical and thermal).<br>Case studies drawn from a variety of real applications including metals and alloys, semiconductor devices, heat storage, energy conversion, thin film technology, biomaterials, and composites. |
| **Course Objectives** | 1-Understanding, from a microstructural point of view, the thermal properties of materials and related applications.<br>2-To develop a fundamental understanding about the mechanical behavior of materials by relating the continuum descriptions to the microscopic and or atomistic mechanisms. |
| | 3- Define the basic physical principles underlying the thermal and mechanical properties of materials.<br>4- Explain the relationship between the microscopic structure and the macroscopic thermal and mechanical properties of materials.<br>5- Discuss the behavior of metals under applied loads, the atomic-scale origin for specific aspects of stress-strain responses.<br>6-Discuss the anticipated thermal and mechanical properties of materials as a function of their fabrication, processing conditions and service conditions.<br>7- Distinguish between the plastic behaviors of crystalline and non-crystalline materials. |

| **Relationship of course to program outcomes** | |
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| **Outcome 2** | Successfully apply advanced concepts of materials engineering to the analysis, design and development of materials, devices, systems, and processes to meet desired needs of society professionally and ethically. |
| **Outcome 4** | Be continuously aware of contemporary issues and research opportunities/challenges in the field of materials engineering as related to energy and sustainability and engage in life-long learning in the field and in the fundamentals of other related disciplines. |
| **Outcome 5** | Use advanced materials characterization techniques, skills, and modern scientific and engineering tools. |
| **Outcome 6** | Communicate effectively in written and oral form, both, individually and as a |

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| | member of a multidisciplinary team. |

| Week | Course Topics and Contents |
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| ***Part 1: Thermal Properties*** | |
| **1** | Introduction, specific heat, thermal conductivity |
| **2** | Thermal expansion, thermal stress, thermal stability |
| **3** | Thermal radiation, emissivity, thermal diffusivity |
| **4** | Relationship between structure and thermal properties of materials |
| **5** | Experimental methods for thermal analysis of materials |
| **6** | Case studies: Phase change materials, thermochromic and thermoelectric materials, etc. |
| **7** | Review and First exam |
| ***Part 2: Mechanical Properties*** | |
| **8** | Stress and Strain |
| **9** | Elasticity |
| **10** | *Mid semester break* |
| **11** | Plasticity |
| **12** | Experimental methods Lab week |
| **13** | Crystallography/Defects in Crystalline Materials |
| **14** | Dislocations Theory/ Crystallographic Slip |
| **15** | Composite Materials/Second Exam. |
| **16** | Project presentations and reports due. |

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| **Out-of-class assignments and dues dates for submission** | Weekly homework and reading assignments. |
| **Methods and dates of student evaluation, including relative weight of various assessment methods in determining course grade** | Homeworks: 30%<br>Mid-term exam: 20%<br>Final exam: 20%<br>Individual Course project: 30% |
| **Teaching and learning methodologies** | 2 Lectures (1.5 hour each) and 1 hour weekly for tutorials if needed. |
| **Main course texts** | - T.H. Courtney, *Mechanical Behavior of Materials*, Waveland Press, 2nd Edition, 2000, 733 pages, ISBN: 1577664256.<br><br>- G. Grimvall, *Thermophysical Properties of Materials*, North Holland, 2nd Edition, 1999, 424 pages, ISBN 0444827943.<br><br>- William F. Hosford, *Mechanical Behavior of Materials*, Cambridge University Press, 2005, 425 pages, ISBN: 9780521846707. |
| **Recommended readings** | - G.E. Dieter, *Mechanical Metallurgy*, McGraw Hill, 3rd Edition, 1986, ISBN 0-07-100406-8.<br><br>- N. E. Dowling, *Mechanical Behavior of Materials*, Pearson Prentice Hall, 3rd Edition, 2007, 912 pages, ISBN: 0131863126 |

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| **Instructional materials and resources** | OCW @ MIT, and other resources TBA. |