MATERIALS ENGINEERING

In today’s world there is a constant demand for new materials of superior quality or with particular combinations of properties. It is the task of the materials engineer to use chemical and physical processes to provide new materials, more useful and valuable products, and improvements in the properties of existing materials on a cost-effective basis.

Materials engineering, like other branches of engineering, is based on mathematics, physics, and chemistry.

Necessarily, the engineer must work with every type of material, whether it be metal, glass, plastic, or naturally occurring rock or wood; and electrical conductors, semiconductors, or insulators, transparent or otherwise. The variety of available materials is as wide as the applications; to use them to good effect, the engineer must understand the nature of the substances that might be used for a particular purpose and the chemical and physical processes that are involved in their production.

Being in a central position in the development and design of new products, the materials engineer has excellent and varied career opportunities, extending from fundamental research through primary production processes and subsequent manufacturing to quality control and failure analysis.

Mission Statement

The Materials Department is committed to provide comprehensive undergraduate and graduate education in Materials Engineering, outstanding research, and service to our students, College, the University of Wisconsin-Milwaukee, and the community, as well as to active participation in professional societies.

Programs


Materials Engineering Courses

MATLENG 150 It's a Material World: The Role of Materials in Society
3 cr. Undergraduate.
Introductory course on the nature of materials and their role in the development of society. Historical perspectives, current societal issues, and future trends are discussed.
Prerequisites: none.
General Education Requirements: NS+
Current Offerings: http://uwm.edu/schedule

MATLENG 201 Engineering Materials
4 cr. Undergraduate.
Basic behavior and processing of engineering materials emphasizing metals and alloys and including ceramics and plastics. Laboratory work is included.
Prerequisites: Math 231(C), score of 1 on chem placement test or min grade C in Chem 100(P)
Current Offerings: http://uwm.edu/schedule

MATLENG 299 Topics in Materials:
1-3 cr. Undergraduate.
Work on new material in materials. Section title and credits announced whenever course is offered.
Prerequisites: specific courses dependent on topic.
Course Rules: May be retaken w/chg in topic to 6 cr max.
Current Offerings: http://uwm.edu/schedule

MATLENG 330 Materials and Processes in Manufacturing
3 cr. Undergraduate.
Principles and practice of manufacturing processes for engineering materials. Processes include casting, forging, rolling, extrusion, sintering and machining. Laboratory work is included.
Prerequisites: MatlEng 201(P).
Current Offerings: http://uwm.edu/schedule

MATLENG 380 Engineering Basis for Materials Selection
3 cr. Undergraduate.
The study of the basis for materials selection in the design of engineering systems. Materials design parameters, classes of materials case studies in material’s selections.
Prerequisites: MatlEng 201(P).
Current Offerings: http://uwm.edu/schedule

MATLENG 385 Introduction to Biomaterials
3 cr. Undergraduate.
Introduction to the fundamentals of biomaterials including ceramics, metals, and polymers. Important issues in the selection, design, manufacturing, and evaluation of biomaterials. Current applications, and emerging technologies.
Prerequisites: jr st, MatlEng 201(P).
Course Rules: Jointly offered with & counts as repeat of BME 385.
Current Offerings: http://uwm.edu/schedule

MATLENG 402 Physical Metallurgy
3 cr. Undergraduate/Graduate.
Crystal binding and electron theory of solids, phase diagrams, diffusion, nucleation and growth, recrystallization, precipitation hardening, solidification, austenite decomposition.
Prerequisites: jr st, MatlEng 201(P).
Current Offerings: http://uwm.edu/schedule

MATLENG 410 Mechanical Behavior of Materials
3 cr. Undergraduate/Graduate.
An introduction to the mechanical behavior of metals, ceramics, polymers and composite materials. Topics include elastic, plastic and viscoelastic deformation, fracture, fatigue, and creep.
Prerequisites: jr st, MatlEng 201(P); or grad st; or cons instr.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATLENG 411 Materials Laboratory
3 cr. Undergraduate.
Experiments demonstrating the basic laws governing the structure, properties, and processing of materials.
Prerequisites: sr st; MatlEng 201(P).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule
MATLENG 431 Welding Engineering
3 cr. Undergraduate/Graduate.
An engineering course on joining processes; reaction of materials to welding, brazing and soldering; distortion; process and material selection and structural engineering considerations.
Prerequisites: jr st; MatlEng 201(P).
Last Taught: Spring 2018, Fall 2013, Fall 2011, Fall 2007.
Current Offerings: http://uwm.edu/schedule

MATLENG 442 Thermodynamics of Materials
3 cr. Undergraduate/Graduate.
Third law of thermodynamics; application of thermodynamics to materials processes and systems; behavior of solutions; reaction equilibria.
Prerequisites: jr st, admis to MatlEng major, MatlEng 201(P); or grad st; or cons instr.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATLENG 443 Transport Phenomena in Materials Processing
3 cr. Undergraduate/Graduate.
A study of phenomena related to transport of mass, energy, and momentum with applications to materials processing.
Prerequisites: jr st, MatlEng 442(P); & ElecEng 234(P) or Math 234(P); or grad st.
Current Offerings: http://uwm.edu/schedule

MATLENG 452 Ceramic Materials
3 cr. Undergraduate/Graduate.
Ceramic bonding, crystallography and structure, defects and Brouwer diagram, mass and electrical transport of ceramics, phase equilibria, mechanical properties, and processing of ceramics including sintering.
Prerequisites: jr st, MatlEng 201(P); or grad st.
Course Rules: Not open for cr to students with cr in MatlEng 451(ER).
Last Taught: Fall 2017, Fall 2016, Spring 2015, Fall 2013.
Current Offerings: http://uwm.edu/schedule

MATLENG 453 Polymeric Materials
3 cr. Undergraduate/Graduate.
Structure, crystallinity of polymers, amorphous polymers and elastomers, synthesis method, polymerization, copolymerization, polymer characterization, polymer solutions, and viscoelasticity, deformation mechanics of polymers.
Prerequisites: jr st, MatlEng 201(P); or grad st.
Course Rules: Not open for cr to students with cr in MatlEng 451(ER).
Current Offerings: http://uwm.edu/schedule

MATLENG 456 Metal Casting Engineering
3 cr. Undergraduate/Graduate.
Pattern and core design; molding technology; pouring and feeding castings; metallurgy of cast engineering alloys and their foundry practice; casting design.
Prerequisites: jr st; MatlEng 201(P).
Course Rules: MatlEng 456(421) and MechEng 456 are jointly offered; they count as repeats of one another.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2013.
Current Offerings: http://uwm.edu/schedule

MATLENG 457 Engineering Composites
3 cr. Undergraduate/Graduate.
Prerequisites: jr st; MatlEng 201(P).
Course Rules: MatlEng 457(455) & MechEng 457 are jointly offered; they count as repeats of each other.
Current Offerings: http://uwm.edu/schedule

MATLENG 460 Nanomaterials and Nanomanufacturing
3 cr. Undergraduate/Graduate.
Structure, properties, processing and manufacture of nanoparticles, nanotubes, nanofibers, bulk nanomaterials, nanocomposites including polymer, metal, ceramic, natural and biocomposites; nanofluidics, nanorheology, nanomachines, and nanotribology.
Prerequisites: jr st; MatlEng 201(P).
Course Rules: MatlEng 460 & MechEng 460 are jointly offered; they count as repeats of each other.
Current Offerings: http://uwm.edu/schedule

MATLENG 461 Environmental Degradation of Materials
3 cr. Undergraduate/Graduate.
Technical and economic aspects of material degradation including corrosion and corrosion control. Forms of corrosion, other degradation mechanisms, thermodynamics, kinetics, materials, design, protection strategies.
Prerequisites: jr st; MatlEng 201(P).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATLENG 465 Friction and Wear
3 cr. Undergraduate/Graduate.
Friction and wear of engineering materials. Effect of environment, surface interactions, lubrication, and material properties. Techniques of analysis and measurement.
Prerequisites: jr st; MatlEng 201(P).
Course Rules: Not open to students who have cr in MechEng 465, which is identical to MatlEng 465.
Last Taught: Fall 2017, Fall 2016, Spring 2015, Fall 2013.
Current Offerings: http://uwm.edu/schedule

MATLENG 471 Heat Treatment of Materials
3 cr. Undergraduate/Graduate.
Study of the heat treatment processes and their effect on the microstructure and properties of metals. Emphasis is on steels, but all alloy systems of importance are covered.
Prerequisites: jr st; MatlEng 201(P).
Current Offerings: http://uwm.edu/schedule
MATLENG 481 Electronic Materials
3 cr. Undergraduate/Graduate.
Prerequisites: Jr st; MatlEng 201(P) or cons instr.
Course Rules: MatEng 481 and ElecEng 481 are jointly offered; they count as repeats of one another.
Current Offerings: http://uwm.edu/schedule

MATLENG 483 Materials for Energy Systems
3 cr. Undergraduate/Graduate.
Processing, structure, and properties of materials used in energy systems. Focus on materials applied to solid oxide fuel cells, photovoltaics, and advanced secondary batteries.
Prerequisites: Jr st, MatlEng 201(P).
Last Taught: Fall 2017, Fall 2016, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATLENG 490 Senior Design Projects I
1 cr. Undergraduate.
Project identification and planning; proposals, project management, ethics, professional responsibilities, standards and team procedures. Written and oral engineering reports and proposals. For first semester seniors.
Prerequisites: Sr st; MatEng 411(C).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Spring 2015.
Current Offerings: http://uwm.edu/schedule

MATLENG 491 Senior Design Projects II
3 cr. Undergraduate.
Independent and team design projects under the direction of a faculty member. Written and oral engineering reports must be submitted on each design project undertaken.
Prerequisites: MatEng 490(P).
Current Offerings: http://uwm.edu/schedule

MATLENG 511 Advanced Materials Characterization
3 cr. Undergraduate/Graduate.
Theory and operation of advanced materials characterization instrumentation including thermal analysis (TGA, DSC, DMA), XRD, SEM/EDS, FTIR/Raman, 3D confocal microscopy. Prereq: Jr st & MatEng 411(P).
Prerequisites: Last Taught: Spring 2018, Spring 2017, Spring 2016, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATLENG 585 Advanced Biomaterials
3 cr. Undergraduate/Graduate.
Theory and application of advanced biomaterials including cardiovascular devices, orthopedic applications, drug delivery systems, biosensors, and tissue engineering.
Prerequisites: Sr st, MatEng 385(P) or BME 385(P); or cons instr.
Course Rules: Jointly offered with & counts as repeat of BME 585.
Current Offerings: http://uwm.edu/schedule

MATLENG 690 Topics in Materials:
3 cr. Undergraduate/Graduate.
Lectures on special topics in materials engineering and science.
Prerequisites: Jr st; cons instr.
Course Rules: May be retaken with change in topic to max of 9 cr.
Last Taught: Spring 2017, Fall 2015, Fall 2014, Fall 2012.
Current Offerings: http://uwm.edu/schedule

MATLENG 699 Independent Study
1-3 cr. Undergraduate/Graduate.
Prerequisites: Jr st; cons instr.
Course Rules: May be retaken to max of 6 cr applied toward undergraduate degree.
Current Offerings: http://uwm.edu/schedule

MATLENG 700 CEAS Graduate Seminar
1-3 cr. Graduate.
Seminar in professional ethics, oral and written communication, contemporary social issues, career development, time management, and laboratory safety.
Prerequisites: Grad st
Course Rules: Civ Eng 700, CompSci 700, ElecEng 700, Ind Eng 700, MatEng 700 & MechEng 700 are jointly offered and count as repeats of one another.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATLENG 701 Properties of Solids
3 cr. Graduate.
The applications of physics to the understanding of the properties of solids, including lattice mechanics, band theory, electrical, thermal, magnetic, and defect properties.
Prerequisites: MatEng 402(P).
Last Taught: Spring 2018, Spring 2016, Fall 2014, Fall 2012.
Current Offerings: http://uwm.edu/schedule

MATLENG 702 Advanced Materials Thermodynamics
3 cr. Graduate.
Thermodynamics of materials including solutions, mixtures, and interfaces. Topics including statistical interpretation of entropy, chemical reactions, Ellingham diagrams, phase diagrams, and intermediate phases.
Prerequisites: Grad st; MatEng 442(P)
Current Offerings: http://uwm.edu/schedule

MATLENG 710 Advanced Mechanical Behavior of Materials
3 cr. Graduate.
Advanced topics on the mechanical properties of materials including plasticity, anelasticity, fracture, creep, fatigue, and the effects of temperature, rates, and processing history.
Prerequisites: Grad st; MatEng 410(P).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Spring 2014.
Current Offerings: http://uwm.edu/schedule

MATLENG 720 Kinetic Processes in Materials
3 cr. Graduate.
Absolute reaction rate theory, defects in materials, diffusion, phase transformation in metals.
Prerequisites: Grad st; MatEng 442(P).
Current Offerings: http://uwm.edu/schedule
MATLENG 731 Deformation Processing
3 cr. Graduate.
Application of engineering principles to shape generation by deformation processing. Analysis of forging, stamping, drawing. Effect of deformation material properties and behavior.
Prerequisites: grad st; MatEng 410(P).
Last Taught: Fall 2017, Fall 2004.
Current Offerings: http://uwm.edu/schedule

MATLENG 732 Solidification Processing
3 cr. Graduate.
Solidification phenomena and its engineering application to metals, semiconductors, ceramics, properties of cast products. Foundry processes.
Prerequisites: grad st; MatlEng 330(P).
Course Rules: MatlEng 732 and MechEng 732 are jointly offered; they count as repeats of each other.
Last Taught: Fall 2016, Fall 2014, Spring 2013, Fall 2008.
Current Offerings: http://uwm.edu/schedule

MATLENG 740 Heterogeneous Equilibria
3 cr. Graduate.
Quantitative description of heterogeneous equilibria for unary, binary, and ternary systems from the thermodynamic point of view; composite systems and current experimental techniques in high temperature materials.
Prerequisites: grad st; MechEng 301(P); MatlEng 201(P).
Last Taught: Fall 2013, Fall 2011, Fall 2009, Spring 2008.
Current Offerings: http://uwm.edu/schedule

MATLENG 750 Thin Solid Films
3 cr. Graduate.
Application of materials science to thin films. Nucleation, growth, and characterization. Discussion of optical, electrical, and mechanical behavior in terms of atomic order and chemistry. Consideration of specific deposition methods and applications.
Prerequisites: grad st; MatEng 201(P) & Physics 210(P).
Current Offerings: http://uwm.edu/schedule

MATLENG 760 Surface Analysis of Solids
3 cr. Graduate.
Prerequisites: grad st or cons instr.
Current Offerings: http://uwm.edu/schedule

MATLENG 880 Bioengineering Seminar
1 cr. Graduate.
Presentations by bioengineering affiliated faculty, invited speakers, and graduate students.
Prerequisites: grad st
Course Rules: MechEng 880, ElecEng 880, CompSci 880, MatEng 880, Ind Eng 880 & Civ Eng 880 are jointly offered and count as repeats of one another. May be repeated to 3 cr. max.
Current Offerings: http://uwm.edu/schedule

MATLENG 888 Candidate for Degree
0 cr. Graduate.
Available for graduate students who must meet minimum credit load requirements.
Prerequisites: grad st.
Course Rules: Fee assessed for 1 cr.
Current Offerings: http://uwm.edu/schedule

MATLENG 890 Advanced Topics in Materials:
3 cr. Graduate.
Lectures on special topics in materials engineering and science.
Prerequisites: grad st; cons instr.
Course Rules: May be repeated with change in topic to max of 9 cr.
Current Offerings: http://uwm.edu/schedule

MATLENG 990 Masters Thesis
1-9 cr. Graduate.
Prerequisites: grad st; cons instr.
Current Offerings: http://uwm.edu/schedule

MATLENG 998 Doctoral Thesis
1-12 cr. Graduate.
Prerequisites: grad st; cons instr.
Current Offerings: http://uwm.edu/schedule

MATLENG 999 Advanced Independent Study
1-3 cr. Graduate.
Prerequisites: grad st; cons instr & grad prog committee.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

Faculty

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
<th>Degree</th>
<th>School</th>
<th>Graduate Faculty</th>
<th>Emeritus Faculty</th>
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<tbody>
<tr>
<td>Nidal Abu-Zahra</td>
<td>Associate Professor, Chair</td>
<td>PhD</td>
<td>Cleveland State University</td>
<td>✓</td>
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<tr>
<td>George S. Baker</td>
<td>Professor</td>
<td>PhD</td>
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<tr>
<td>Benjamin Church</td>
<td>Associate Professor</td>
<td>PhD</td>
<td>Georgia Institute of Technology</td>
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<tr>
<td>Changsoo Kim</td>
<td>Associate Professor</td>
<td>PhD</td>
<td>Carnegie Mellon University</td>
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<tr>
<td>Hugo F. Lopez</td>
<td>Professor</td>
<td>PhD</td>
<td>Ohio State University</td>
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<tr>
<td>Joachim P. Neumann</td>
<td>Professor</td>
<td>PhD</td>
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<tbody>
<tr>
<td>Junjie Niu</td>
<td>Associate Professor</td>
<td>PhD</td>
<td>Zhejiang University, China</td>
<td>✔️</td>
</tr>
<tr>
<td>Pradeep K. Rohatji</td>
<td>Wisconsin Distinguished Professor</td>
<td>ScD</td>
<td>Massachusetts Institute of Technology</td>
<td>✔️</td>
</tr>
<tr>
<td>Dev Venugopalan</td>
<td>Associate Professor, Vice Provost</td>
<td>PhD</td>
<td>McMasters University</td>
<td>✔️</td>
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