# Metallurgical Engineering B.S. and Minor (Materials Science – Metals)

## Contact Information

**Dr. Jon J. Kellar**
Department of Materials and Metallurgical Engineering
Mineral Industries 112
(605) 394-2343
e-mail: Jon.Kellar@sdsmt.edu

## Faculty

Douglas W. Fuerstenau Professor Kellar, Chair; Professor Howard; Associate Professor Medlin; Associate Professor Cross; Assistant Professor West; Research Scientist Hong; Adjunct Professors Arbegast, Kim and Sears, Distinguished Professor Emeritus Han; Professor Emeritus Stone.

## Materials and Metallurgical Engineering

Materials and metallurgical engineering is the branch of engineering that develops and supplies the materials for virtually every other engineering field. Three-fourths of all chemical elements are metals, so metals play a vital role in nearly every aspect of modern life. metallurgical engineers transform the Earth's mineral resources into finished products by extracting metals from ores, producing ceramics from metal compounds, and fabricating composite structures.

Today's materials are exotic and so are the methods of producing them. Metallurgy is based upon the principles of chemistry, physics, and mathematics. These sciences provide an understanding of the methods of metal production processes and the behavior of materials. In addition to familiar materials such as steel, aluminum, copper, glass, gold, and silver, metallurgical engineers produce many exotic materials such as metals with shape memories, ultrahigh-purity materials for integrated circuits, materials for surgical implants, ceramics for space vehicles, nano-scale metal particles and superconductors. There are three (3) areas of specialization in metallurgical engineering: mineral processing, extractive metallurgy, and materials engineering. Mineral processors concentrate ores and recycle materials so that extractive metallurgists can produce pure, high-quality metals and non-metallics for use by materials engineers who transform these materials into the marvels of our advanced civilization, ranging from space craft to thin diamond films. Metallurgical engineers are actively involved in nanotechnology and production and utilization of nano-scale materials.

Advances made by metallurgical and material engineers make possible advances in other engineering fields. This happens because virtually every engineering field is in constant search of higher-performance materials. Metallurgical engineers are responsible for the production of materials and also for the evaluation of metals, ceramics, and polymer-based composites. The evaluation of materials includes tests to determine strength, hardness, toughness, corrosion behavior, and many others. It is the role of the Metallurgical Engineer to develop processing methods to create materials with specific and exacting properties for every conceivable application.

The primary source for materials continues to be the Earth in forms such as ores and petroleum. However, recycled materials are an increasingly important material source for metallurgical engineers.

Materials and Metallurgical Engineers are employed throughout the nation and the world.

## The Objectives of the B.S. Metallurgical Engineering Degree Program

The program graduates will:

- Successfully apply metallurgical engineering principles in their employment
- Meet societal needs through science and technology
- Grow professionally and personally
- Serve their profession and community

## Materials and Metallurgical Engineering Laboratories

Laboratory facilities in metallurgical engineering are equipped for instruction in mineral processing, chemical metallurgy, physical metallurgy, and mechanical metallurgy. Sample preparation facilities, laser light scattering particle size analyzers, gravitational separation equipment, laser Doppler particle size and zeta potential measurement equipment are available for mineral and materials processing. Induction melting and vacuum furnaces, fluidized-bed reactors, corrosion potentiostat, contact angle goniometer, and high pressure autoclaves are available for chemical metallurgy. X-ray diffraction units, Fourier transform infrared spectrometer, Raman Spectrometer, Langmuir-Blodgett trough, metallographs, atomic force microscope, controlled atmosphere furnaces, quantitative image analyzer, scanning and transmission electron microscopes, universal testing machine (MTS), Charpy impact testing machine, and microhardness, Rockwell and Vickers hardness testers are available for measuring material performance.

State-of-the art laboratory facilities in welding and joining are available within the metallurgical engineering laboratories. These facilities include traditional joining (fusion welding) as well as advanced joining (friction stir joining) equipment.

Co-curricular opportunities in blacksmithing and the artistic aspects of metallurgy are also available. Where appropriate, these co-curricular activities are integrated into the metallurgical engineering curriculum.

## Minor in Materials Science — Metals

The requirements for a minor in Materials Science — Metals are MET 232, 330, 332, 443, and two classes from MET 430, 440 and 445, for a total of 18 credits. MET 330, MET 332, MET 440, MET 443 and MET 445 are offered in alternate years, so plans for a materials science-metals minor should be made early. This minor is designed for students in the engineering and science disciplines that desire focused training in the field of Materials Science with special emphasis on metals. Students completing the minor in materials science-metals will demonstrate the following outcomes:

1. a proficiency in Materials Science concepts covering metals and alloys;
2. the ability to develop new metals/alloys, and improve metals/alloys;
3. the ability to predict and evaluate the performance of metals and alloys.

Given the redundancy in the B.S. metallurgical engineering core curriculum, the minor in materials science-metals is not available to those students who receive a B.S. degree in metallurgical engineering. A minor in materials science-metals must be approved by the student's major department. Academic and Enrollment Services has forms that should be completed and signed by the department chairs from both departments involved in this minor.

## Metallurgical Engineering Curriculum/Checklist

It is the student's responsibility to check with his or her advisor for any program modifications that may occur after the publication of this catalog.

### Freshman Year

**First Semester**

| | | |
|---|---|---|
| MATH 123 | Calculus I[5] | 4 |
| CHEM 112 | General Chemistry I[6] | 3 |
| ENGL 101 | Composition I[1] | 3 |
| GE 130 | Intro to Engineering | 2 |
| PE | Physical Education | 1 |
| Humanities or Social Sciences Elective(s)[3, 4] | | 3 |

| | | |
|---|---|---|
| **TOTAL** | | **16** |

**Second Semester**

| | | |
|---|---|---|
| MATH 125 | Calculus II | 4 |
| CHEM 114 | General Chemistry II[6] **OR** | 3 |
| BIOL 153 | General Biology II[6] **OR** | 3 |
| BIOL 151 | General Biology I[6] | 3 |
| PHYS 211 | University Physics I | 3 |
| CHEM 112L | General Chem Lab | 1 |
| PE | Physical Education | 1 |
| Humanities or Social Sciences Elective(s)[3, 4] | | 3 |
| Humanities or Social Sciences Elective(s)[3, 4] | | 3 |
| **TOTAL** | | **18** |

## Sophomore Year

**First Semester**

| | | |
|---|---|---|
| MET 232 | Properties of Materials | 3 |
| MET 231 | Structures and Properties of Materials Lab | 1 |
| MATH 321 | Differential Equations | 4 |
| PHYS 213 | University Physics II | 3 |
| CHEM 114L | General Chem II Lab **OR** | 1 |
| BIOL 151L | General Biology I Lab **OR** | 1 |
| BIOL 153L | General Biology II Lab | 1 |
| ENGL 279 | Technical Comm [I1] | 3 |
| EM 214 | Statics | 3 |
| **TOTAL** | | **18** |

**Second Semester**

| | | |
|---|---|---|
| MATH 225 | Calculus III | 4 |
| EM 321 | Mechanics of Materials **OR** | 3 |
| ME 216 | Intro to Solid Mechanics | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| MET 220L | Min Proc and Res Recov Lab | 1 |
| Humanities or Social Sciences Elective(s)[3, 4] | | 4 |
| **TOTAL** | | **16** |

## Junior Year

**First Semester**

| | | |
|---|---|---|
| ENGL 289 | Technical Comm II[2] | 3 |
| MET 320 | Metallurg Thermodynamics | 4 |
| MET 351 | Engineering Design I | 2 |
| Set A or C | | 7 |
| **TOTAL** | | **16** |

**Second Semester**

| | | |
|---|---|---|
| MET 352 | Engineering Design II | 1 |
| MATH 373 | Intro to Numerical Analysis | 3 |
| Free Elective | | 2 |
| Set B or D | | 11 |
| **TOTAL** | | **17** |

## Senior Year

**First Semester**

| | | |
|---|---|---|
| MET 464 | Engineering Design III | 2 |
| IENG 301 | Basic Engineering Econ | 2 |
| Science Elective[7] | | 3 |
| Humanities or Social Sciences Elective(s) | | 3 |
| Set A or C | | 7 |
| **TOTAL** | | **17** |

**Second Semester**

| | | |
|---|---|---|
| MET 433 | Process Control | 3 |
| MET 465 | Engineering Design IV | 1 |
| Science Elective[7] | | 3 |
| Set B or D | | 11 |
| **TOTAL** | | **18** |

**136 credits required for graduation**

**Curriculum Notes**

[1] Satisfies General Education Goal #1
[2] Satisfies General Education Goal #2
[3] Satisfies General Education Goal #3
[4] Satisfies General Education Goal #4
[5] Satisfies General Education Goal #5
[6] Satisfies General Education Goal #6
[7] See Advisor for approved Science Electives

**Set A-Fall Even Years**

| | | |
|---|---|---|
| MET 422 | Transport Phenomena | 4 |
| Free Elective | | 3 |

**Set B-Spring Odd Years**

| | | |
|---|---|---|
| MET 321 | High Temp Extract/Conc/Rec | 4 |
| Directed Met Elective | | 3 |
| EE 301 | Intro Circuits, Machines, Syst | 4 |

**Set C-Fall Odd Years**

| | | |
|---|---|---|
| MET 330 | Physics of Metals | 3 |
| MET 330L | Physics of Metals Lab | 1 |
| MET 332 | Thermomechanical Treatment | 3 |

**Set D-Spring Even Years**

| | | |
|---|---|---|
| MET 440 | Mechanical Metallurgy | 3 |
| MET 440L | Mechanical Metallurgy Lab | 1 |
| Directed Met Elective | | 3 |
| MET 310 | Aqueous Extract/Conc/Rec | 3 |
| MET 310L | Aq Extract/Conc/Rec Lab | 1 |