CRITERION 5 - CURRICULUM

This chapter provides a detailed description of the program curriculum and how it achieves the program goals and outcomes.

A. Program curriculum

Table 5-1 summarizes the new 130-credit semester hour curriculum BS Metallurgical Engineering, which was reduced from 136 credits in 2013. One credit hour is earned for completing a lecture class that meets one hour a week for the entire semester, which is approximately 15 weeks in duration. One credit is awarded for each three hours of laboratory work per week for the entire semester.

The 130 credit hours required for a BS Metallurgical Engineering Degree are allocated as follows:

• Math and basic science	39 credits	30.0%
• Engineering topics	61 credits	46.9%
• General ed. less math and basic science	24 credits	18.5%
• Other	6 credits	4.6%

The curriculum satisfies all ABET requirements having

- 39 semester hours of basic science and mathematics beginning with
  - College chemistry and
  - Calculus I,
- 49 credit hours of discipline-specific courses (MET),
- 12 credits of technical out-of-department credits including
  - Statics
  - Engineering mechanics
  - Engineering economics
  - Electrical engineering,
- 24 credits of general education credits including
  - Humanities and social science -15 credits and
  - Technical communication – 9 credits,
- 5 credits free elective, and
- 1 credit of physical education.

Table 5-2 is a list of all program-approved science electives for the BS Metallurgical Engineering. Prerequisites, if any, are indicated below each approved course and indented. Each course is three credits unless indicated otherwise.

In addition to ABET requirements, there are regental requirements that must be satisfied. The South Dakota Regents specify General Education Requirement for all four-year degree South Dakota college graduates. The mathematics and science requirements are easily satisfied by engineering students. The humanities and social science requirements generally do not add

Table 5-1 Curriculum for BS Metallurgical Engineering

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year. Freshmen Fall Spring Sophomore Fall Spring Junior Fall Spring Senior Fall Spring	R-Required E-Elective SE-Selected Elective[1]	*Curricular Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and Semester	Average Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Discipline Specific Topics	General Education	Other		
MATH 123 Calculus I	R	4				16S, 15F	32.6
CHEM 112 General Chemistry	R	3				16S, 15F	115.9
ENGL 101 Composition I	R			3		16S, 15F	22.1
MET 110 Intro to Engineering	SE		0			15F, 14F	40.5
PE Physical Education	R				1		
HSS Hum or Soc Sci Elective	SE			3			
HSS Hum or Soc Sci Elective	SE			3			
MATH 125 Calculus II	R	4				16S, 15F	35.7
CHEM 114 General Chemistry II	R	3				16S, 15F	130.0
PHYS 211 University Physics I	R	3				16S, 15F	81.5
CHEM 112L General Chem Lab	R	1				16S, 15F	21.4
HSS Hum or Soc Sci Elective	SE			3			
HSS Hum or Soc Sci Elective	SE			3			

Table 5-1 Curriculum (cont'd)

MET 232 Prop of Materials	R		3			16S, 15F	106.0
MET 231 Structure & Prop of Mat Lab	R		1			16S, 15F	14.2
MATH 321 Differential Eqs	R	3				16S, 15F	36.8
PHYS 213 University Physics II	R	3				16S, 15F	66.8
CHEM 114L Gen Chem II Lab	R	1				16S, 15F	22.7
ENGL 279 Technical Comm I	R			3		16S, 15F	22.9
EM 214 Statics	R				3	16S, 15F	49.0
MATH 225 Calculus III	R	4				16S, 15F	33.4
EM 321 Mechanics of Materials -OR- ME 216 Intro to Solid Mechanics	R				3	16S, 15F 16S, 15F	54.5 36.0
MET 220 Min Proc & Resource Rec	R		3			16S, 15S	61.0
MET 220L Min Proc & Resource Rec Lab	R		1			16S, 15S	23.5
Science Elective	SE	3					
Free Elective	E				2		
ENGL 289 Tech Comm II	R			3		16S, 15F	20.9
MET 320 Metallurgical Thermo	R		4			15F, 14F	35.5
MET 351 Eng Design I	R		2			15F, 14F	16.5
Set A or C (7) (see below)							
MET 352 Engineering Design II	R		1			16S, 15S	16.0
MATH 373 Intro to Numerical Analysis	R	3				16S, 15F	33.8
Set B or D (11) (see below)	R						
MET 464 Engineering Design III	R		2			15F, 14F	15.5
IENG 301 Basic Engineering Economics	R				2	16S, 15F	32.0
HSS Hum or Soc Sci Elective	SE			3			
Sci Elective	SE	3					
Set A or C (7) (see below)							32.0
MET 433 Process Control	R		3			16S, 15F	
MET 465 Engineering Design IV	R		1			16S, 15S	6.5
Set B or D (11)	R						14.0

Table 5-1 Curriculum (cont'd)

A (Fall Even Calendar Years)							
MET 422 Transport Phenomena	R		4			14F, 12F	29.5
Elective Free Elective	E				3		
B (Spring Odd Calendar Years)							
MET 321 High Temp Extract/Conc/Rec	R		4			15S, 13S	30.0
Directed MET Elective	SE		3				
EE 301 Intro Circuits, Machines, Sys	R				4	16S, 15F	28.8
C (Fall Even Calendar Years)							
MET 330 Physics of Metals	R		3			15F, 13F	36.5
MET 330L Physics of Metals Lab	R		1			15F, 13F	22.3
MET 332 Thermomechanical Treatment	R		3			15F, 13F	36.5
D (Spring Odd Calendar Years)							
MET 440 Mechanical Metallurgy	R		3			16S, 14S	33.0
MET 440L Mechanical Metallurgy Lab	R		1			16S, 14S	21.5
Directed MET Elective	SE		3				0.0
MET 310 Aqueous Extract/Conc/Rec	R		3			16S, 14S	29.5
MET 310L Aqueous Extract/Conc/Rec Lab	R		1			16S, 14S	26.5
Subtotals		38	50	24	18		
Total					130		

1. Required courses are required of all students in the program, elective courses are optional for students, and selected electives are courses where students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the average enrollment in each element.

Table 5-2 BS Metallurgical Engineering approved science electives for 2015-16

AES 201 INTRODUCTION TO ATMOSPHERIC SCIENCES
AES 401/501 ATMOSPHERIC PHYSICS
PHYS 213/213-A, MATH 321, and AES 404/504
AES 403/503 BIOGEOCHEMISTRY
CHEM 106 or CHEM 112 ; BIOL 151 ; PHYS 111 or PHYS 211/211-A
AES 404/504 ATMOSPHERIC THERMODYNAMICS (2 or 3 credits)
PHYS 211/211-A and MATH 225
AES 405/505 AIR QUALITY
MATH 125, and CHEM 106 or CHEM 112
AES 406 GLOBAL ENVIRONMENTAL CHANGE
CHEM 112, PHYS 111 or PHYS 113 or PHYS 211/211-A or PHYS 213/213-A and BIOL 311
AES 430/530 RADAR METEOROLOGY
MATH 125 and PHYS 213/213-A
AES 450 SYNOPTIC METEOROLOGY I
AES 201 and AES 404/504
AES 460/560 ATMOSPHERIC DYNAMICS
MATH 321 and PHYS 211/211-A
BIOL 121 BASIC ANATOMY
BIOL 123 BASIC PHYSIOLOGY
BIOL 151 GENERAL BIOLOGY I
BIOL 153 GENERAL BIOLOGY II
BIOL 151
BIOL 221 HUMAN ANATOMY
BIOL 311 PRINCIPLES OF ECOLOGY
BIOL 326 BIOMEDICAL PHYSIOLOGY
Four hours of CHEM, BIOL 153 or BIOL 221
BIOL 331 MICROBIOLOGY
BIOL 341 MICROBIAL PROCESSES IN ENGINEERING AND NATURAL SCIENCES
CHEM 112
BIOL 371 GENETICS
BIOL 151

Table 5-2 BS Metallurgical Engineering approved science electives for 2015-16, (cont'd)

BIOL 375 CURRENT BIOETHICAL ISSUES
BIOL 383 BIOETHICS
BIOL 403 GLOBAL ENVIRONMENTAL CHANGE
CHEM 112, PHYS 111 or PHYS 113 or PHYS 211/211-A or PHYS 213/213-A and BIOL 311
BIOL 423 PATHOGENESIS
BIOL 331
BIOL 431 INDUSTRIAL MICROBIOLOGY
BIOL 331
BIOL 444 DNA STRUCTURE AND FUNCTION
BIOL 151 and CHEM 326
BIOL 446/546 MOLECULAR CELL BIOLOGY
BIOL 151 and BIOL 371 or permission of instructor
BIOL 478/578 MICROBIAL GENETICS
BIOL 331 and BIOL 371
BIOL 480/580 BIOINFORMATICS
BIOL 331, BIOL 341, or BIOL 371 or permission of instructor
CHEM 316 FUNDAMENTALS OF ORGANIC CHEMISTRY
CHEM 114
CHEM 326 ORGANIC CHEMISTRY I
CHEM 114
CHEM 328 ORGANIC CHEMISTRY II
CHEM 326
CHEM 332 ANALYTICAL CHEMISTRY
CHEM 114
CHEM 342 PHYSICAL CHEMISTRY I
CHEM 114 and PHYS 213/213-A and MATH 225 or MATH 321
CHEM 344 PHYSICAL CHEMISTRY II
CHEM 342 and PHYS 213/213-A
CHEM 352 SYSTEMATIC INORGANIC CHEMISTRY
CHEM 114
CHEM 420/520 ORGANIC CHEMISTRY III
CHEM 328

Table 5-2 BS Metallurgical Engineering approved science electives for 2015-16 (cont'd)

CHEM 421/521 SPECTROSCOPIC ANALYSIS
CHEM 328
CHEM 426/526 POLYMER CHEMISTRY
CHEM 328 and CHEM 342
CHEM 434 INSTRUMENTAL ANALYSIS
CHEM 230 or CHEM 332 and CHEM 342
CHEM 452/552 INORGANIC CHEMISTRY
CHEM 352, CHEM 328 and CHEM 342
CHEM 464/564 BIOCHEMISTRY I
CHEM 465/565 BIOCHEMISTRY II
CHEM 464/564
CHEM 482/582 ENVIRONMENTAL CHEMISTRY
CHEM 316 or CHEM 328
GEOL 201 PHYSICAL GEOLOGY
GEOL 212/212L MINERALOGY AND CRYSTALLOGRAPHY
GEOL 322/322L STRUCTURAL GEOLOGY/LAB
GEOL 331/331L and GEOL 341/341L or MEM 314/314L
GEOL 323 SEARCH FOR OUR PAST
GEOL 201 or GEOE 221/221L
GEOL 331/331L STRATIGRAPHY AND SEDIMENTATION
GEOL 201 /GEOL 201L or GEOE 221/221L
GEOL 341/341L IGNEOUS AND METAMORPHIC PETROLOGY/LAB
CHEM 112 /CHEM 112L, GEOL 201L or GEOE 221/221L and GEOL 212/212L or MEM 314/314
GEOL 351 EARTH RESOURCES AND THE ENVIRONMENT
GEOL 201 or GEOE 221/221L
GEOL 361 OCEANOGRAPHY I
GEOL 372 DINOSAURS
GEOL 420/520 INTRODUCTION TO REMOTE SENSING
Junior standing
GEOL 422/422L/522/522L TECTONICS AND SEDIMENTARY BASIN ANALYSIS/LAB
GEOL 322/322L and GEOL 331/331L
GEOL 442/442L/542/542L OPTICAL PETROLOGY/LAB
GEOL 341/341L or MEM 314/314L
GEOE 451/451L ECONOMIC GEOLOGY/LAB
Junior or senior standing. GEOL 322/322L
GEOL 652 PROBLEMS IN ORE DEPOSITS
GEOE 451/451L

Table 5-2 BS Metallurgical Engineering approved science electives for 2015-16 (cont'd)

PHYS 213/213-A, PHYS 213L , CHEM 114, MATH 321
NANO 445/545 INTRODUCTION TO NANOMATERIALS
MET 232, EM 321
PHYS 183 ELEMENTS OF MODERN ASTRONOMY
PHYS 275 RELATIVITY
PHYS 111 or PHYS 211/211-A and a working knowledge of elementary algebra and trigonometry.
PHYS 312 EXPERIMENTAL PHYSICS DESIGN I (2 cr.)
CENG 244/244L
PHYS 314 EXPERIMENTAL PHYSICS DESIGN II (2 cr.)
CENG 244/244L
PHYS 321 THE PHYSICS & IMPLICATIONS OF SPACE TRAVEL
PHYS 331 INTRODUCTION TO MODERN PHYSICS
PHYS 113 or PHYS 213/213-A
PHYS 341 THERMODYNAMICS
PHYS 213/213-A, and MATH 225
PHYS 343 STATISTICAL PHYSICS
PHYS 213/213-A, and MATH 225
PHYS 361 OPTICS
PHYS 113 or PHYS 213/213-A and MATH 225
PHYS 386/386L OBSERVATIONAL ASTRONOMY/LAB
PHYS 183
PHYS 404/504 NANOPHOTONICS
Introductory quantum mechanics and electricity and magnetism; ordinary differential equations and linear systems.
PHYS 421/521 ELECTROMAGNETISM (4 cr.)
PHYS 213/213-A and MATH 321
PHYS 433/533 NUCLEAR AND ELEMENTARY PARTICLE PHYSICS
PHYS 471
PHYS 439/539 SOLID STATE PHYSICS (3 or 4 cr.)
MATH 225, MATH 321, PHYS 331
PHYS 445/545 STATISTICAL MECHANICS (4 cr.)
PHYS 451/551 and MATH 321
PHYS 451/551 CLASSICAL MECHANICS (4 cr.)
MATH 321
PHYS 471/571 QUANTUM MECHANICS (4 cr.)
MATH 321
PHYS 481/581 MATHEMATICAL PHYSICS (4 cr.)
Permission of instructor

additional requirements beyond those required by ABET except for ENGL 101 Composition I, ENGL 279/289 Technical Communications I and II; however, they do require some planning to meet the Regent's expectations. The Regent's general education requirement consists of a 30-credit hour system-wide.

- 9 credits of written and oral communications,
- 6 credits of humanities,
- 6 credits of social sciences,
- 6 credits of a science with laboratory
- 3 credits of mathematics

This general education requirement supports the following program outcomes:

- (a) Apply Knowledge of Math, Science, and Engineering
- (f) Know Professional and Ethical Responsibilities and Practices
- (g) Communicate Effectively
- (h) Know Engineering's Global Societal Context
- (j) Know Contemporary Issues

South Dakota School of Mines and Technology BS Metallurgical Engineering graduates must complete an additional 3 credits of humanities or social science at the upper division level, as well as mathematics and science courses far in excess of those required to satisfy the general education and the ABET requirements.

The general education requirements are now described in some detail followed by a description of the university and BS Metallurgical Engineering degree program requirements.

General Education Requirements

The following seven learning outcomes for general education are held in common by all schools in the South Dakota Board of Regents system:

1. Students will write effectively and responsibly and will understand and interpret the written expression of others
2. Students will communicate effectively and responsibly through listening and speaking
3. Students will understand the organization, potential, and diversity of the human community through study of the social sciences
4. Students will understand the diversity and complexity of the human experience through study of the arts and humanities
5. Students will understand and apply fundamental mathematical processes and reasoning
6. Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world
7. Students will recognize when information is needed and have the ability to locate, organize, critically evaluate, and effectively use information from a variety of sources with intellectual integrity

The following rules on graduation requirements apply for the BS degree in any curriculum offered by the university. General education core requirements must be completed within the first 64 credits of course work. Requests for exceptions to these general education requirements must be approved by the student's advisor and by the Vice President for Academic Affairs/Provost.

The regent's general education requirements prescribe that the following seven goals be accomplished.

Goal #1: Students will write effectively and responsibly and understand and interpret the written expression of others. Student Learning Outcomes: As a result of taking courses meeting this goal, a student will

1. Write using standard American English, including correct punctuation, grammar, and sentence structure;
2. Write logically;
3. Write persuasively, with a variety of rhetorical strategies (e.g., expository, argumentative, descriptive);
4. Incorporate formal research and documentation in their writing, including research obtained through modern, technology-based research tools.

Credit Hours: 6 hours
Courses:
ENGL 101 Composition I
ENGL 201 Composition II
ENGL 279/289 Technical Communications I and II
Note: Engineering and sciences students at SDSM&T take this six credit sequence in the sophomore and junior years. Both courses develop written and speech communications in an integrated fashion in the context of the major. Students must finish the entire sequence, as well as ENGL 101, to satisfy the requirements of Goal #1 and Goal #2.

Goal #2: Students will communicate effectively and responsibly through speaking and listening. Student Learning Outcomes: Courses satisfying this goal will require students to

1. Prepare and deliver speeches for a variety of audiences and settings;
2. Demonstrate speaking competencies including choice and use of topic, supporting materials, organizational pattern, language usage, presentational aids, and delivery;
3. Demonstrate listening competencies by summarizing, analyzing, and paraphrasing ideas, perspectives and emotional content.

Credit Hours: 3 hours
Courses:
ENGL 279/289 Technical Communications I and II
SPCM 101 Fundamentals of Speech
Note: Technical Communications I and II develop written and speech communications in an integrated fashion in the context of the major. Students must finish the entire sequence, as well as ENGL 101, to satisfy the requirements of Goal #1 and Goal #2.

Goal #3: Students will understand the organization, potential, and diversity of the human community through study of the social sciences. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Identify and explain basic concepts, terminology and theories of the selected social science disciplines from different spatial, temporal, cultural, and/or institutional contents.

2. Apply selected social science concepts and theories to contemporary issues;
3. Identify and explain the social or aesthetic values of different cultures. In addition, as a result of taking course meeting this goal, students will be able to demonstrate a basic understanding of at least one of the following:
   - The origin and evolution of human institutions;
   - The allocation of human or natural resources within societies;
   - The impact of diverse philosophical, ethical or religious views.

Credit Hours: 6 hours in two disciplines
Courses:
ANTH 210 Cultural Anthropology
ECON 201 Principles of Microeconomics
ECON 202 Principles of Macroeconomics
GEOG 101 Introduction to Geography
GEOG 212 Geography of North America
HIST 151/152 United States History I/II
POLS 100 American Government
POLS 210 State and Local Government
PSYC 101 General Psychology
SOC 100 Introduction to Sociology
SOC 150 Social Problems
SOC 250 Courtship and Marriage

Goal #4: Students will understand the diversity and complexity of the human experience through study of the arts and humanities. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Demonstrate knowledge of the diversity of values, beliefs, and ideas embodied in the human experience;
2. Identify and explain basic concepts of the selected disciplines within the arts and humanities. In addition, as a result of taking courses meeting this goal, students will be able to do at least one of the following:
   - Identify and explain the contributions of other cultures from the perspective of the selected disciplines within the arts and humanities;
   - Demonstrate creative and aesthetic understanding;
   - Explain and interpret formal and stylistic elements of the literary or fine arts;
   - Demonstrate foundational competency in reading, writing, and speaking a non-English language.

Credit Hours: 6 hours in two disciplines or in a sequence of foreign language courses
Courses:
ART 111/112 Drawing I and II
ARTH 211 History of World Art I
ENGL 221/222 British Literature I and II
ENGL 241/242 American Lit I and II
ENGL 250 Science Fiction
FREN 101/102 Introductory French I and II
GER 101/102 Introductory German I and II
HIST 121/122 Western Civilization I and II

HUM 100 Introduction to Humanities
HUM 200 Connections: Humanities and Technology
LAKL 101/102 Introductory Lakota I and II
MUS 100 Music Appreciation
PHIL 100 Introduction to Philosophy
PHIL 200 Introduction to Logic
PHIL 220 Introduction to Ethics
PHIL 233 Philosophy and Literature
SPAN 101/102 Introductory Spanish I and II

Goal #5: Students will understand and apply fundamental mathematical processes and reasoning. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Use mathematical symbols and mathematical structure to model and solve real world problems;
2. Demonstrate appropriate communication skills related to mathematical terms and concepts;
3. Demonstrate the correct use of quantifiable measurements of real world situations.

Credit Hours: 3 hours
Courses:
MATH 102 College Algebra
MATH 115 Precalculus
MATH 120 Trigonometry
MATH 123 Calculus I
MATH 125 Calculus II
MATH 225 Calculus III
MATH 281 Statistics

Goal #6: Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Demonstrate the scientific method in a laboratory experience;
2. Gather and critically evaluate data using the scientific method;
3. Identify and explain the basic concepts, terminology and theories of the selected natural sciences;
4. Apply selected natural science concepts and theories to contemporary issues.

Credit Hours: 6 hours
Courses:
BIOL 151/151L General Biology I and Laboratory
BIOL 153/153L General Biology II and Laboratory
CHEM 106/106L Chemistry Survey/Laboratory
CHEM 108/108L Organic Chemistry/Laboratory
CHEM 112/112L General Chemistry I and Laboratory
CHEM 114/114L General Chemistry II and Laboratory
GEOL 201/201L Physical Geology/Laboratory
PHYS 111/111L Introduction to Physics I and Laboratory
PHYS 113/113L Introduction to Physics II and Laboratory

PHYS 211 University Physics I
PHYS 213/213L University Physics II and Laboratory

Goal #7: Students will recognize when information is needed and have the ability to locate, organize, critically evaluate, and effectively use information from a variety of sources with intellectual integrity. Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Determine the extent of information needed;
2. Access the needed information effectively and efficiently;
3. Evaluate information and its sources critically;
4. Use information effectively to accomplish a specific purpose;
5. Use information in an ethical and legal manner.

Credit Hours*:* 9 hours
Courses:
ENGL 101 Composition I
SPCM 101 Fundamentals of Speech
ENGL 201 Composition II
ENGL 279/289 Technical Communications I and II

In addition to these seven system-wide general education requirements, all students will achieve learning outcomes focused on advancing their writing skills and their knowledge of global issues. Each academic program has designated one or more classes (the equivalent of one credit hour of study) as meeting each of these requirements. The syllabi of the courses designated state the requirement(s) met and explain how student achievement of the outcomes are assessed and factored into the course grade.

Globalization/global issues goal statement
Students will understand the implications of global issues for the human community and for the practice of their disciplines. As a result of taking courses meeting this goal, students will

1. Identify and analyze global issues, including how multiple perspectives impact such issues; and
2. Demonstrate a basic understanding of the impact of global issues on the practice of their discipline.

Writing intensive goal statement
Students will write effectively and responsibly in accordance with the needs of their own disciplines. As a result of taking courses meeting this goal, students will

1. Produce documents written for technical, professional, and general audiences within the context of their disciplines;
2. Identify, evaluate, and use potential sources of information from within their disciplines for writing assignments that require research and study; and,
3. Use instructor feedback throughout the semester to improve the quality of their writing.

Students entering the South Dakota School of Mines and Technology are expected to have prepared themselves to start with the curriculum show in Table 5-1. Students who are not able to begin at that level are deemed in need of remedial courses. These pre-general education courses include ENGL 031, ENGL 032, ENGL 033, READ 041, MATH 021, and MATH 101. Students taking pre-general education courses have the following requirements:

1. Students placed in pre general education courses must enroll in and complete the courses within the first 30 credits hours attempted.
2. If a student does not complete the pre general education course(s) within the first 30 credit hours attempted, a registration hold is placed on the student‘s record. During the next 12 credit hours attempted, the student must enroll in and complete the pre general education course(s).
3. If the pre general education course(s) is not completed within the first 42 credit hours attempted, the only course(s) in which a student may enroll is the pre-general education course(s); and the student‘s status is changed from degree seeking to non-degree seeking.
4. Students transferring from non-regental institutions must enroll in pre-general education courses during the first 30 attempted regental credit hours. These students may enroll in other courses concurrently with the pre-general education courses. If the student does not complete the pre-general education courses during the first 30 Regental credit hours attempted during the next 12 credit hours attempted, the student must enroll in and complete the pre-general education course(s). If the student does not successfully complete the pre-general education course(s) within 42 attempted Regental credit hours, the only course(s) in which a student may enroll in the pre-general education course(s); and the student‘s status is changed from degree seeking to non-degree seeking. The Vice President for Academic Affairs/Provost may grant an exception.

Credit hours for the pre-general education courses are included in the total number of credit hours attempted. The grades assigned for courses numbered less than 100 will be RI, RS and RU.

University Requirements

All BS programs require the general education core requirements as described earlier. Other requirements for each degree are determined by the faculty in each program, with approval through the university curriculum approval process. The SDSM&T curricular requirements are shown in Table 5-3.

Transfer credit may be allowed for previous college education if the courses are equivalent to required or elective courses at this university and if each course presented is of passing quality. The acceptability of transfer credit is determined by the student‘s major department.

BS Metallurgical Engineering Program requirements

The 130 credits of course work in program consists of

- 18 credits of math starting at or above the level of calculus.
- 20 credits of college level basic science 6 credits of which are program-approved science electives,
- 15 credits of humanities and social science courses,
- 9 credits of writing (ENGL 101, 279, and 289),
- 6 credits composed of 1 credits of physical education and 5 credits of free electives, and
- 50 credits of metallurgical engineering coursework (including 6 credits of Met-directed electives),
- 12 credits of other engineering coursework including 2 credits of engineering economics; 6 credits of statics and strengths; and 4 credits of electrical engineering.

Table 5-3 University curricular requirements

Humanities and social sciences requirements

All courses numbered 300 and above are upper level courses.

This subject area must include 6 credits in humanities and 6 credits in social sciences. The number required for each major is listed in the department section of the catalog. Students majoring in engineering must complete at least three of these credits at an advanced level.

Humanities

Art

ART 111/111A Drawing I Credits: (3-0) 3
ART 112/112A Drawing II Credits: (3-0) 3
ARTH 211 History of World Art I Credits: (3-0) 3
ARTH 321 Modern and Contemporary Art Credits: (3-0) 3
ARTH 491 Independent Study Credits: 1 to 9
ARTH 492 Topics Credits: 1 to 6

English

ENGL 210 Introduction to Literature Credits: (3-0) 3
ENGL 212 World Literature II Credits: (3-0) 3
ENGL 221 British Literature I Credits: (3-0) 3
ENGL 222 British Literature II Credits: (3-0) 3
ENGL 241 American Literature I Credits: (3-0) 3
ENGL 242 American Literature II Credits: (3-0) 3
ENGL 250 Science Fiction Credits: (3-0) 3
ENGL 300 The Literary Experience of Nature Credits: (3-0) 3
ENGL 330 Shakespeare Credits: (3-0) 3
ENGL 343 Selected Authors Credits: (1-0) 1
ENGL 350 Humor in American Culture Credits: (3-0) 3
ENGL 360 Studies in European Literature Credits: (3-0) 3
ENGL 374 Studies in American Literature Credits: 1 to 3
ENGL 383 Creative Writing Credits: (3-0) 3
ENGL 391 Independent Study Credits: 1 to 3
ENGL 392 Topics Credits: 1 to 3

Foreign Language

CHIN 101 Introductory Chinese I Credits: (4-0) 4
CHIN 102 Introductory Chinese II Credits: (4-0) 4
GER 101 Introductory German I Credits: (4-0) 4
GER 102 Introductory German II Credits: (4-0) 4
SPAN 101 Introductory Spanish I Credits: (4-0) 4
SPAN 102 Introductory Spanish II Credits: (4-0) 4

Table 5-3 University curricular requirements (cont'd)

History
HIST 121 Western Civilization I Credits: (3-0) 3
HIST 122 Western Civilization II Credits: (3-0) 3

Humanities
HUM 100 Introduction to Humanities Credits: (3-0) 3
HUM 200 Connections: Humanities & Technology Credits: (3-0) 3
HUM 291 Independent Study Credits: 1 to 4
HUM 292 Topics Credits: 1 to 3
HUM 350 American Social History Credits: (3-0) 3
HUM 375 Computers in Society Credits: (3-0) 3
HUM 491 Independent Study Credits: 1 to 4
HUM 492 Topics Credits: 1 to 3

Music
MUAP 200 Applied Music-Voice Credits: 1 to 4
MUAP 201 Applied Music-Voice Credits: 1 to 4
MUS 100 Music Appreciation Credits: (3-0) 3
MUS 110 Basic Music Theory I Credits: 2 to 4
MUS 217 Music in Performance I Credits: (3-0) 3
MUS 317 Music in Performance II Credits: (3-0) 3

Philosophy
PHIL 100 Introduction to Philosophy Credits: (3-0) 3
PHIL 200 Introduction to Logic Credits: (3-0) 3
PHIL 220 Introduction to Ethics Credits: (3-0) 3
PHIL 233 Philosophy and Literature Credits: (3-0) 3

Social Sciences

Anthropology
ANTH 210 Cultural Anthropology Credits: (3-0) 3

Geography
GEOG 101 Introduction to Geography Credits: (3-0) 3
GEOG 210 World Regional Geography Credits: (3-0) 3
GEOG 212 Geography of North America Credits: (3-0) 3
GEOG 400 Cultural Geography Credits: (3-0) 3
GEOG 492 Topics Credits: 1 to 3

History
HIST 151 United States History I Credits: (3-0) 3
HIST 152 United States History II Credits: (3-0) 3
HIST 492 Topics Credits: 1 to 4

Table 5-3 University curricular requirements (cont'd)

Political Science
POLS 100 American Government Credits: (3-0) 3
POLS 250 World Politics Credits: (3-0) 3
POLS 350 International Relations Credits: (3-0) 3
POLS 407 Environmental Law & Policy Credits: (3-0) 3
POLS 492 Topics Credits: 1 to 3

Psychology
PSYC 101 General Psychology Credits: (3-0) 3
PSYC 319 Teams and Teaming Credits: (1-0) 1
PSYC 323 Human Develop Through the Lifespan Credits: (4-0) 4
PSYC 331 Industrial and Organizational Psychology Credits: (3-0) 3
PSYC 391 Independent Study Credits: 1 to 3
PSYC 392 Topics Credits: 1 to 3
PSYC 451 Psychology of Abnormal Behavior Credits: (3-0) 3
PSYC 461 Theories of Personality Credits: (3-0) 3

Sociology
SOC 100 Introduction to Sociology Credits: (3-0) 3
SOC 150 Social Problems Credits: (3-0) 3
SOC 250 Courtship and Marriage Credits: (3-0) 3
SOC 351 Criminology Credits: (3-0) 3
SOC 391 Independent Study Credits: 1 to 3
SOC 392 Topics Credits: 1 to 3
SOC 411 Licit and Illicit Drugs Credits: (3-0) 3
SOC 420 Alcohol Use and Abuse Credits: (3-0) 3

All degree candidates must complete
ENGL 101 Composition I Credits: (3-0) 3
ENGL 279 Technical Communications I Credits: (3-0) 3
ENGL 289 Technical Communications II Credits: (3-0) 3
These courses cannot be used to meet the humanities and social sciences requirements.

Electives
Free Electives vary with the individual department. Any course may be selected which is at freshman level or higher (i.e. 100 level or higher). ROTC credits may be accepted, depending on the number of degree electives available in each department.

Science Electives
Courses may be selected —from biology, chemistry, geology, physics, or atmospheric science.

The General Education Requirements, the University General Requirements, and the ABET curricular requirements are satisfied by the BS Metallurgical Engineering curriculum as show in Table 5-4.

Military Science credits may apply to all degrees as free electives. This option varies with the number of free electives available in an individual curriculum. A veteran may petition the Registrar and Director of Academic Services to receive credit for basic military science and physical education.

Prerequisites are managed through a system established by Registrar and Academic Services (RAS). Students cannot enroll through the digital system unless they fulfill all prerequisites including *permission of instructor*. In unusual cases, an override is possible providing the instructor and the department head for the course signs a waiver that the requesting student delivers to the RAS. In addition to the course descriptions, program faculty and students have available the Curriculum Flow Diagram (CFD) shown in Figure 5-1.

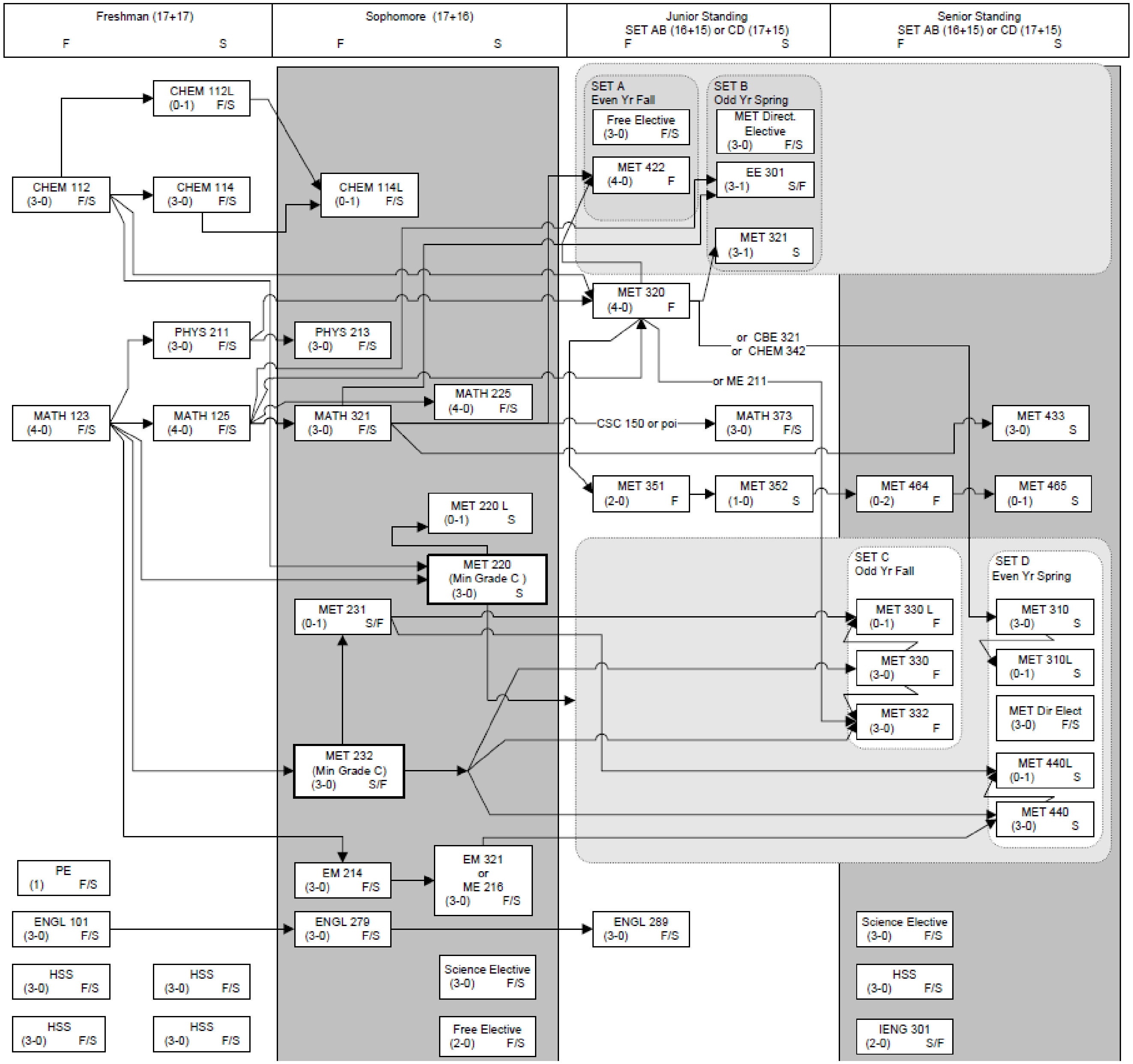
Table 5-4 Comparison of curricular requirements

<table>
<tr><th>Category</th><th>Gen Ed</th><th>ABET</th><th>BS Met Eng</th></tr>
<tr><td>Hum and Soc Sci</td><td>12</td><td>Sufficient[1]</td><td>15</td></tr>
<tr><td>Engl and Comp</td><td>9</td><td>-</td><td>9</td></tr>
<tr><td>Basic Science</td><td>6</td><td rowspan="2">32</td><td>20</td></tr>
<tr><td>Mathematics</td><td>3</td><td>18</td></tr>
<tr><td>Engineering</td><td>-</td><td>48</td><td>50</td></tr>
<tr><td>Other Engineering</td><td>-</td><td>-</td><td>12</td></tr>
<tr><td>Free Electives and PE</td><td>-</td><td>-</td><td>6</td></tr>
<tr><td>Total</td><td>30</td><td>92</td><td>130</td></tr>
</table>

[1] previous ABET requirement was 12 credits hours

The metallurgical engineering curriculum is designed to provide students with a well-rounded knowledge of metal origins, production, treatment, use, failure analysis, and recycling. Well rounded includes associated knowledge on the societal effects of engineering and the context of engineering in a global society. Safety, economics, environmental, and ethical grounding is an essential element of each graduate’s educational experience.

Graduates with the BS Metallurgical Engineering Degree are very adaptable in that they possess a wide range of engineering skills pertaining to metallurgical engineering. To assure the graduates from the program have strong fundamental skills which allow them to continue life-long learning through the application of fundamental engineering principles, they are required to complete eight credits of college-level chemistry/biology, six credits of calculus-based physics, 18 credits of calculus-based mathematics including differential equations and introduction to numerical analysis. To foster the students’ awareness of the historical, political, and societal context of their potent engineering skills and the ethical application of those skills, each student is required to complete 15 credits of course work in the humanities and social sciences. Of these 15 credits, 12 are part of the system general education



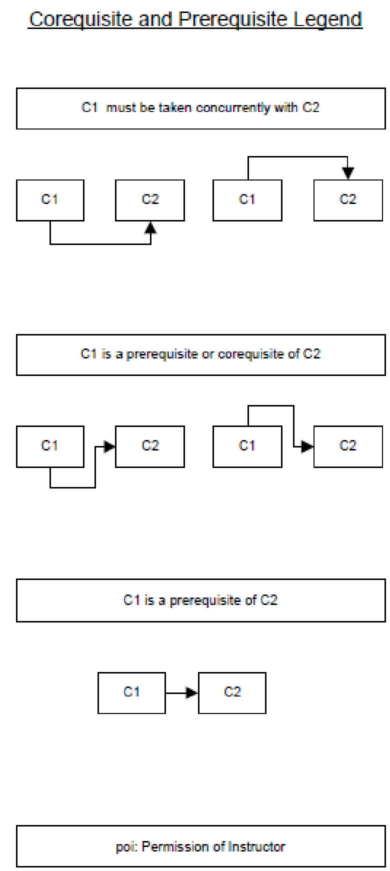


Figure 5-1 Curriculum Flow Diagram

requirement, discussed earlier. The BS Metallurgical Engineering program is a strong advocate for not falling to the minimal standard in this critical area.

A total of 50 credits of metallurgical engineering course work are required: 12 in process/extractive metallurgy, 15 in physical and mechanical behavior of metals and materials, 11 in general metallurgical engineering sciences, and six in design. These courses provide each student with a solid fundamental knowledge that allows them to adapt to a wide range of industrial processes, as well as an excellent foundation for graduate studies. These intrinsic metallurgical engineering skills are bolstered with courses in statics and strengths of materials, engineering economics, and electrical engineering system analysis. To assure the graduates possess excellent communication skills, each one is required to complete nine credits of English/technical communication. Additionally, their technical course work requires numerous laboratory reports, both oral and written. The laboratory credits required in the curriculum give the students first-hand knowledge of natural systems and an opportunity to develop their experimental and practical skills. Design assignments are common throughout the curriculum. The design experience includes experiences in both the
junior and senior years and culminates in the senior year with a capstone design project where the many elements of their course work are assimilated in the final hierarchy of learning. All of the students work in teams and are required to present their work in written and oral format and participate in periodic reviews of all program design projects which are trending towards 100 percent industrial sponsorship. In addition, they are required to participate in the campus annual design fair in the spring semester.

Metallurgical Engineering Program Criteria

An important aspect of this undergraduate metallurgical engineering program is the integrated understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing, and performance related to metallurgical engineering systems.

Structure: The fundamental scientific and engineering principles associated with the microstructure of metallurgical elements and alloys is taught is several of the undergraduate lecture courses including MET 232 (Properties of Materials), MET 330 (Physics of Metals), MET 332 (Thermomechanical Treatment), and additional coverage of this topic is incorporated in several of the Directed Met Elective courses. In addition, students obtain hands-on laboratory experience with microstructural principles and the application of these principles to engineering problems and materials selection issues in the following laboratories: MET 231(Structure and Properties of Materials Laboratory) and MET 330L (Physics of Metals Laboratory). The specific topics can be reviewed in the course syllabi contained in the Appendix of this section and in the examples of course examinations and design problems. MET 440 and MET 440L inform the student about the practical relationship between structure and aspects of mechanical behavior, deformation processing, and failure analysis of metals and alloys.

Properties: The fundamental principles associated with material properties and their application to solving engineering problems and material selection is taught in MET 232 (Properties of Materials), MET 330 (Physics of Metals), MET 332 (Thermomechanical Treatment), MET 440

(Mechanical Metallurgy), and several of the Directed Met Elective courses. In addition laboratory experience with understanding how to measure and use material properties is taught in MET 231(Structure and Properties of Materials Laboratory), MET 330L (Physics of Metals Laboratory) and MET 440L (Mechanical Metallurgy Laboratory). The specific topics can be reviewed in the course syllabi contained in the Appendix of this section and in the examples of course examinations and design problems.

Processing: The fundamental principles and application to engineering problems of metallurgical processing is taught in several of the courses including: MET 220 (Mineral Processing), MET 232 (Properties of Materials), MET 310 (Aqueous Extractive Metallurgy), MET 320 (Metallurgical Thermodynamics), MET 321 (High Temperature Extractive Metallurgy), MET 332 (Thermomechanical Processing), and MET 442 (Transport Phenomena). Additional hands on laboratory experience and application to engineering problems is taught in MET 220L (Mineral Processing) and MET 310L (Aqueous Extractive Metallurgy). The specific topics can be reviewed in the course syllabi contained in the Appendix of this section and in the examples of course examinations and design problems.

Performance: Understanding the application of microstructure, properties and processing to the performance of a material in an engineering design is a critical component in the undergraduate curriculum. This topic is covered in MET 232 (Properties of Materials), MET 330L (Physics of Metals Laboratory), MET 332 (Thermomechanical Processing), and MET 440/440L (Mechanical Metallurgy/Laboratory). The professors in this program spend a significant amount of time explaining to students the importance of material performance. Students are actively involved with design projects and applied homework assignments that specifically concentrate on using the principles of microstructure, properties and/or processing to solve engineering problems specifically applied to metallurgical engineering. In addition, students cover the performance of systems important to metallurgical engineering practice in MET 220 (Mineral Processing), MET 321 (High Temperature Extractive Metallurgy), and MET 433 (Process Control).

Understanding Statistical and Computational Methods: Aspects of statistics and statistical data analysis are covered in several courses within the program curriculum. These begin with MET 231 (Properties of Materials Laboratory), usually the first laboratory course MET program students take followed by MET 220L (Mineral Processing and Resource Recovery Laboratory). Upper division courses with significant statistics and statistical data analysis content are MET 310L (Aqueous Extraction, Purification and Recycling Laboratory) and MET 440L (Mechanical Metallurgy Laboratory). Generally, these are designed so that the experiences in MET 310L and MET 440L build upon and extend the materials covered during MET 231 and MET 220L. At the end of this series, the students are expected to be able to calculate basic statistical measures, such as mean and standard deviation, perform hypothesis testing and determine confidence intervals, and design experiments, including randomization, repeatability and reproducibility, to determine if data sets from experimental procedures are from the same population. A synopsis of the statistical and computational elements of each course follows.

MET 231
The first laboratory assignment in MET 231 involves an introduction to basic statistics calculations, including mean, standard deviation, variance and significance. In addition, later laboratory reports require least squares data fits and the determination and use of means and standard deviation data to properly interpret data.

MET 310L
In this course, the background from MET 231 and MET 220L are expanded through inclusion of design and analysis of experiments concepts. This includes factorial design, analysis of variance (ANOVA) and procedures for linking experimentation with analysis. All student group performed laboratories involving designing a set of experiments to test a hypothesis and analyzing the experimental results through proper procedures such as ANOVA or Yates method.

MET 440L
In this course, the background from MET 231 are used and expanded on through three laboratory assignments – hardness reproducibility and repeatability, fatigue analysis and statistical process control. In addition to using means, standard deviations and confidence intervals, the students learn and use non-parametric statistics through the runs test and learn Six Sigma procedures for process control.

A more complete analysis of how the curriculum satisfies the ABET Program Criteria for Met Eng appears in the section titled Program Criteria.

The design experience is critical to the student's incorporation of fundamental engineering skills into a coherent understanding of the practice of engineering. This integrated understanding is an underlying program criterion for the successful practice of metallurgical engineering. As such it is specifically labeled here for easy reference in the program curriculum. Additionally an extensive summary of the students' design experience is provided.

Integrated Understanding: Many of the courses in the curriculum apply several of the four major elements of the field together in the course content; however, the four capstone design courses are designed to specifically challenge and stimulate the students' knowledge and problem solving abilities in these fundamental elements. The capstone design courses are

- MET 351 (Metallurgical Design I)
- MET 352 (Metallurgical Design II)
- MET 464 (Metallurgical Design III)
- MET 465 (Metallurgical Design IV)

This sequence of courses requires students to work on a design team and solve a specific metallurgical engineering problem. In 2008 and during the first few years of the current ABET accreditation cycle (through 2011), multiple student teams worked on a Samurai Sword Design Project. The goal of this project was to design and make a traditional Samurai sword using iron ore from the Black Hills and have comparable mechanical properties and appearance to a traditional sword. Four design teams were developed:

- Agglomeration Team
- Furnace Team

- Forge Welding Team
- Forge Drawing Team

The faculty presented a paper on the project that is published in the 2009 TMS Conference Proceedings: Kellar, Howard, Cross, West, Medlin, Kellogg, *The Samurai Sword Design Project and Opportunities for Metallurgical Programs*, TMS Conference Proceedings, October 2009, Pittsburgh, PA.

The Agglomeration Team took iron ore collected from the dewatering process at the Deep Underground Science and Engineering Laboratory, removed impurities, added fluxes and made pellets for the Furnace Team. The team designed a process that would develop the optimum iron reducing pellets for the Furnace team and then made the pellets.

The Furnace Team designed a small blast furnace to reduce the pellets that the Agglomeration Team produced and made a high and low carbon iron for the Forge Welding Team. The team designed and made two difference blast furnaces and reduced several pounds of steel. The first blast furnace was made from two joined water heaters and masonry refractory. The Team needed more time to develop a higher quality steel for this project, however, the design and development of two furnaces was remarkable.

The Forge Drawing Team was designed to take the low and high carbon steel from the previous two teams and forge weld together a rough blank for a sword. The team designed two different sword designs based on historical evidence of Japanese swords and modern metallurgical engineering science. Because the previous two teams did not make sufficient quantity and quality steel, the Forge Welding Team used modern steels to create their rough blank sword. They also design the heat treatment procedure for the sword so the final sword would have the distinctive curved shape. The final sword blank had the distinctive curved shape and was free from quench cracking.

The Forge Drawing Team took the sword blank developed by the Forge Welding Team and designed a thermomechanical process to make a final sword. This involved designing a process to forge draw the sword blank using traditional blacksmithing techniques, as well as designing a more efficient system that utilized an air hammer. Temperature and forge strain rate limits needed to be accounted for in this process. The team also evaluated the forge weld quality and microstructural consistency of the final sword and what properties would be expected.

In 2010 Drs. Medlin, Kellar, West, and other supporting university faculty members were awarded a $150,000 NSF CCLI grant to integrate the kinesthetic blacksmithing activities into a metallurgical engineering program to improve student learning and motivation. The project was redesigned sophomore- through senior-level laboratories to include metalworking components to help students develop a better understanding of how microstructural development relate to mechanical properties. Additional project activities included: 1) expanding a weekly open forge time for all interested campus science and engineering students, 2) establishing an annual exhibit featuring undergraduate student work at the campus art gallery, 3) building and equipping a mobile trailer for outreach activities, and 4) training undergraduate students in technical communications. The project included strong outreach to Native American high schools and two-year colleges. Program outcomes were measured through five interrelated assessment instruments including materials concept inventories, longitudinal student tracking, and the Teamwork KSA inventories. A blueprint teaching and implementation strategy for other schools and a web-based seminar were used to disseminate the project. The project's progress was filmed by personnel from the Road Show of the South Dakota Public Broadcast Service (SDPBS).

The blacksmithing activity was supported by local resident Mr. Jack Parks, a board member of the Artist Blacksmith Association of North America (ABANA). This association continues to today. He advises our students during our HammerIn activities held every Friday afternoon. Food is also served as students from across campus are invited to learn the art of blacksmithing and the associated microstructural changes. The department sponsors a local Blacksmithing Club for those wishing to participate regularly.

The departmental association with ABANA led to the association holding its Annual Meeting in Rapid City in July 2012. They set up their workshops at the Pennington County Fairgrounds, which are immediately across the street from SDSM&T. Students led and participated in outdoor workshops at the fairgrounds. In the afternoon artists attended SDSM&T sponsored lectures by the metallurgical engineering faculty and students on campus.

As an outgrowth of these activities, faculty pitched the concept of the integrated Material Advantage sponsored blade contest at the annual Materials Science and Technology Meeting (MS&T), but it did not receive adequate support for fruition. However, in 2014 Dr. Howard led a new effort under the auspices of TMS. The result was the first student Bladesmithing Competition which was held at the TMS Annual Meeting in Orlando in 2015 and the first Student Bladesmithing Symposium in Nashville in 2016 with more planned. Over 20 student teams from all over the world have participated in this competition.

After a few years of conducting the Samurai Sword design project, the metallurgical engineering program faculty, realized that a new portfolio of design projects was needed. In 2013, a decision was made to integrate several industrially-linked projects in an effort to 1) increase the portfolio of design projects and 2) increase the student interest and excitement. The industrially-linked projects were defined between faculty and an industry partner. Student teams work on current metallurgical engineering problems faced by industry with frequent contact from an industrial mentor. These industrially linked and sponsored programs have grown over the last several years and are strongly supported by the program faculty. The goal is to have one faculty advisor per group of three or four students. This has been the norm for several years.
A brief summary of design projects undertaken since 2013 is given below with sponsored projects titled with the sponsor's name.

<u>2013</u>

- *Nucor Steel* – Design a process for joining high-strength low-alloy steel.
- *Freeport McMoRan* – Design a sequential metal extraction plant to remove iron and aluminum from copper streams.
- *Micron* – Investigate and design a process change to increase reliability in solder joints.

- *Kondex* – Design a process for laser deposition to increase the wear resistance of straw-chopper blades.
- *Boston Scientific* – Investigate and design a material change to replace Platinum in endovascular coils.
- *Steelmaking* – Design a process to produce steel from local iron ore sources.
- Bench Scale Solvent Extraction – Design and build a bench-scale mixer settler.
- *Aerodesign team* – Design landing gear for the aerodesign competition vehicle.
- Human powered vehicle – Design and build the frame for the human powered competition vehicle.

2014

- *Nucor Steel* – Investigate and design process change to prevent hot cracking in rolled steel.
- *Freeport McMoRan* – Design a system to utilize bioprocess off-gas to precipitate copper sulfides.
- *Micron* – Design an optimal test to improve reliability of microelectronic interconnects.
- *Barrick Gold* – Design a process to recover gold from mine tailings.
- *Wharf Resources* – Design and investigate process economics for different crushed ore size gold recovery.
- *PVD Team* – Design a wear resistant coating using physical vapor deposition.
- *Chromium Melting for Univ of Virginia*– Design a process to melt and recover high purity chromium.
- *3-D Printing/Casting* – Design a process to rapidly prototype cast aluminum parts using 3-D printing capabilities on SDSM&T campus.

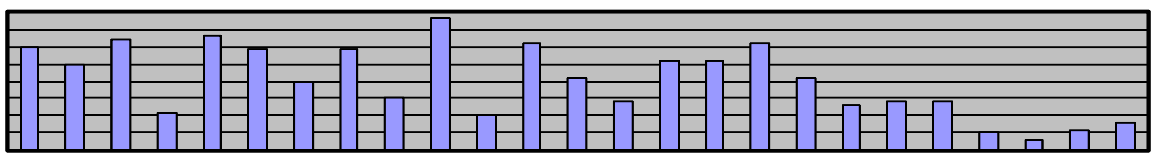
2015

- *Nucor Steel* - Design a process for the extraction of manganese from South Dakota manganese nodules
- *Freeport McMoRan* - Design and model a high-temperature concentrate leach process plant addition, and perform a scoping study, including cost estimates of equipment, necessary to evaluate the merit of the design and economic viability of the addition
- *Real Alloy* - Design a rapid NaCl-KCl flux composition analysis method for aluminum melting processes.
- *Logan Aluminum* - Design a process change to prevent hot cracking in rolled aluminum
- *Nordson-Xaloy* - Design and demonstrate direct laser hard facing of a blade
- *Sapa Extrusions* - Design a joining process for a Al extrusion to a base plate
- *Barrick Goldstrike* - Design a method for reducing Au loss to carbonaceous gangue
- Vacuum Induction Melting - Design and build a vacuum induction billet caster

The program faculty continues their interest in graduating students who are as prepared as possible for the rigors of the post university world. One means of determining where in the curriculum students receive value-added qualities is via the Quality Function Deployment Matrix (QDFM). Table 5-5 (duplicate here from Table 3-4 for convenience) shows the QFDM for the BS Metallurgical Engineeering Degree program. Each program outcome is shown in the first column while program courses are shown in the top row. The functional importance of each

Table 5-5 Quality function deployment matrix for metallurgical engineering courses

Outcome Criteria	**Course**																								
	MET 220	MET 220L	MET 231	MET 232	MET 310	MET 310L	MET 320	MET 321	MET 330	MET 330L	MET 332	MET 351/352	MET 422	MET 433	MET 440	MET 440L	MET 464/465	MET Electives	Math sequence	Required Eng Courses	H&SS curriculum	Elective Courses	PE, Music, Band, MS	ENGL Sequence	Chem/Physics Seq
(a) Apply math, sci and eng prin	**5**	3	3	**5**	**5**	**3**	**5**	3	**5**	**5**	**5**	1	**5**	5	3	3	1	3	**5**	**5**		3			3
(b) Design & cond exp/interpret	3	**5**	**5**		3	**5**	3	3	3	**5**		1	3		3	**5**	1	3	3						3
(c) Design to meet design needs	3			3	3	3	3	**5**				**5**	**5**	3	3	3	**5**	3	1						
(d) multidisciplinary teaming	1	3	**5**		1	1				**5**		**5**			1	3	**5**	1			1		3	1	1
(e) Ident, form, & solve eng prob	**5**	3	3	3	3	3	3	**5**	**5**	**5**	**5**	**5**	**5**	1	**5**	3	**5**	3	3	5		1			1
(f) Knowing prof and ethic respon	3	1	1		3	1	1	**5**	1	3		3			3	1	3	1			1				
(g) communicate effectively	3	**5**	3		3	**5**	1	3		3		**5**			3	**5**	**5**	1	1		1			**5**	
(h) impact of eng in a glob context	3		**5**		3	1	1			3								1		1	**5**				
(i) Be life-long learner			3		3	1				3		1			1		1	3			1	1			
(j) Know contemporary issues	3		1		1	1		**5**	1	1					1			1			**5**				
(k) Use tech, skills, & mod tools	1	5	3		**5**	**5**	3			**5**		**5**	3	**5**	3	3	**5**	1		3					
	30	25	32	11	33	29	20	29	15	38	10	31	21	14	26	26	31	21	13	14	14	5	3	6	8



LEGEND

5 High importance
3 Medium Importance
1 Low Importance
No importance

ourse to each outcome is assigned an importance from a high of 5 to a low of 1. If there is no functional relationship, the cell is blank. Along the bottom the functional ratings are totaled and plotted. The last column totals the number of curricular functions having the highest functional relationship to the outcome. Every outcome has significant representation in the last column except for Outcome (i): Recognition of the need for and an ability to engage in life-long learning. There is no one place for the attainment of this outcome because it is believed to be a diffuse outcome that is captured by the students through their entire educational experience and in particular by their interaction with program faculty who are now communicating the need to develop a life-long learning plan. Additionally, each student is required to write a life-long learning plan as an assignment in MET 440. The QFDM shows the desired uniform and well balanced distribution of metallurgical engineering course function to program outcomes. A second QFDM for a broader spectrum of campus activities is shown in Appendix E.

Learning outcomes in the SDSM&T required general education program can be aligned with the ABET (a)-(k) outcomes. The first way to relate the general education requirements to outcomes (a)-(k) is through the stated intent of the requirements. This relationship is shown in the panels in Table 5-6 for general education requirements 1-7. The (a)-(k) outcomes directly related to the general education requirement are highlighted while those that do not relate to the specific general education objective are left dimmed. The second way to relate the general education requirements to outcomes (a)-(k) is through the courses students take in fulfillment of the general education requirements since a set of courses account for nearly all general education credit hours.

The panels in Table 5-6 are based on an analysis of all students between 2012 to the 2016. The shading indicates which ABET (a - k) outcomes these courses address to a high degree. The dark blue shaded courses are required courses required of all BS Metallurgical Engineering students while the light blue shaded courses are elective courses that 70 percent to 90 percent of all students take to meet the general education requirements. Even if students take other elective courses, they are still required to meet the general education requirement related to the (a)-(k) outcomes as shown by the highlighted headers.

Finally, the program outcomes map to each of the seven General Educational Requirements as shown in Table 5-6.

As described in Criterion 1, Section B, the assessment of the attainment of general education outcomes is the Collegiate Assessment of Academic Proficiency (CAAP) exam. Between 1995 and 2014, all students were required to take and pass the CAAP exam. Beginning in 2014, students with ACT scores of a certain level were exempt from the requirement to pass the CAAP exam. This exemption provision appears to be reducing the number of SDSM&T students taking the CAAP by approximately 90 percent.

Historically, SDSM&T student outperform students system wide in all four subject areas of the test. Table 5-7 below shows the percentage of SDSM&T students passing the CAAP at the first attempt as compared to all other students attending a public university in South Dakota. SDSM&T students score the highest in Math and science reasoning, as expected.

Engineering programs typically find difficult inculcating their students with the *soft skills* of professional, ethical, social, health and safety, and economic awareness compared with the *hard*

Table 5-6 Relationship of General Education Requirements to ABET Outcomes (a)-(k)

Objective #1: *Students will write effectively and responsibly and understand and interpret the written expression of others.*

ABET Outcomes → **High-Enrollment GenEd courses that meet Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
ENGL 101 - Composition I							■				
ENGL 201 - Composition II							□				
ENGL 279 - Technical Communications I				■		■	■				■
ENGL 289 - Technical Communications II				■		■	■				■

GEP Objective #2: *Students will communicate effectively and responsibly through speaking and listening.*

ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
SPCM 101 - Fundamentals of Speech							□				
ENGL 279 - Technical Communications I							■				
ENGL 289 - Technical Communications II							■				

GEP Objective #3: *Students will understand the organization, potential, and diversity of the human community through study of the social sciences*

ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
PSYC 101 - General Psychology						□		□	□	□	
SOC 100 - Introduction to Sociology						□		□	□	□	
HIST 151 - American History I						□		□	□		
GEOG 101 – Introduction to Geography								□	□	□	
POLS 100 – American Government						□	□	□	□	□	

Table 5-6 Relationship of General Education Requirements to ABET Outcomes (a)-(k) (cont'd)

GEP Objective #4: *Students will understand the diversity and complexity of the human experience through study of the arts and humanities*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
HIST 121 - Western Civilization I											
HIST 122 - Western Civilization II											
HUM 100 - Introduction to Humanities											
PHIL 100 - Introduction to Philosophy											
ENGL 210 – Introduction to Literature											

GEP Objective #5: *Students will understand and apply fundamental mathematical processes and reasoning.*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
MATH 102/102L - College Algebra											

GEP Objective #6: *Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
Chemistry 112 – General Chemistry											
CHEM 114 – General Chemistry II											
GEOL 201 – Physical Geology											
Physics 211 – University Physics I											
Physics 213 – University Physics II											

Objective #7: *Students will recognize when information is needed and have the ability to locate, organize, critically evaluate, and effectively use information from a variety of sources with intellectual integrity*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
ENGL 101 - Composition I											
ENGL 201 - Composition II											
ENGL 279 - Technical Communications I											
ENGL 289 - Technical Communications II											

Table 5-7 Pass Rates on CAAP proficiency exam by sub-scores for SDSM&T

	Writing		Math		Reading		Science	
Year	Mines	System	Mines	System	Mines	System	Mines	System
2014	94.9%	89.4%	100%	98.0%	96.2%	93.3%	100%	98.80%
2013	96.1%	91.7%	99.8%	98.2%	98.8%	93.7%	99.8%	99.0%
2012	93.8%	90.4%	100%	97.8%	97.8%	94.1%	100%	98.2%
2011	93.6%	91.9%	100%	97.7%	96.4%	94.6%	99.7%	98.8%
2010	96.5%	92.4%	100%	98.0%	97.2%	94.6%	100%	99.0%

engineering skills associated with typical engineering science and practice courses. In recognition of the importance of these *soft skills*, the program works to assure the program students achieve professional temperament, skill, understanding, and appreciation in each one through a deliberate pedagogy as described below.

Professional Awareness

Students in the program often interact one-on-one with the faculty. Faculty members are very careful to always project their dedication to ethical practice, social obligations, safe practice, and the importance of economics to engineering. The senior capstone design projects require attention to professional concerns including ethics, social obligations, safety, and economics. The junior and senior students in the design courses are required to discuss, coordinate and develop plans and strategies for these issues and incorporate their plans into weekly verbal and written update reports and the final design report.

Program students are active in Materials Advantage. They hold monthly meetings and engage in several community service projects each year, sponsor profession meetings, participate in scholarship programs, and send representatives to selected professional meetings as funding permits.

The department has a plasma screen TV and a digital display board to help with student professional awareness. The display board and projector runs informational videos from professional societies (TMS/ASM), industry, and alumni testimonials as well as other topical areas specific to the program. The displays are updated regularly and contain historical information (such as the history of steelmaking) as well as other topical information such as the "Metal of the Week", current metal prices, scholarships and other program opportunities (e.g. job openings, student chapter meetings, seminar notices, field trips).

Ethical Awareness

Ethical practice is a frequent item for discussion in the metallurgical engineering classroom. Each professor in the department discusses ethical issues during their semester when issues regarding ethics correspond to the discussion. Many metallurgical engineering students are inducted into the Order of the Engineer during Engineers Week. Part of this ceremony is a pledge to ethical practice.

Every student enrolled in required MET 422, Transport Phenomena, and MET 321, High Temperature Extraction, Concentration, and Recycling, participates in two half-hour discussions on ethical problems and the hierarchy of values needed to successfully address such issues. Every student is given a copy of the Code of Conduct for Professional Engineers during their senior or junior year as a prelude to discussions of ethics. Every departmental professor is asked to spend at least a portion of one class period during the spring semester discussing ethical issues. Copies of the Code of Conduct for Professional Engineers in made available to any student who has not already received one during the semester.

Every student enrolled in MET 310, Aqueous Extraction, Concentration and Recycling, will write an essay on the ethics and global impacts of metal extraction processes. All senior capstone design projects include an ethical component during their final presentation and report.

Social Awareness

Items contributing to overall student social awareness are listed below:

- The program's moderate enrollment permits a great deal of discussion between faculty and students. The faculty frequently engages the students in informal discussions outside the classroom, for example in the student lounge or at the annual Materials Advantage picnic. The faculty knows all the students and spends considerable effort with them to assure their professional and social growth.
- Students exit interviews routinely indicate that the students are clearly aware of the devotion of the faculty to the students' development and success. The students recognize this devotion exceeds professional obligations and is a measure of the faculty's interest in the students' success. This extra measure given by the faculty fosters a deep connection between professional practice and service in each student.
- Students' social skills are honed through social events including barbecues, banquets, local professional meetings, and trips to the Annual TMS and SME meetings. Typically, when the department has an important guest visiting, one or two undergraduate students are invited to join the faculty and the guest at lunch or dinner. Faculty members routinely host students at the local SME meetings where the subjects frequently focus on abiding environmental obligations and responsibilities.
- Students are involved in a weekly Hammer-In. This is a blacksmithing activity held every Friday afternoon where students are encouraged to design and make a variety of blacksmithing items. Occasionally, students will have a barbecue and local professional blacksmiths will participate in this activity to give students tips on what to do.
- Culture and Attitude program students along with the Women in Science and Engineering sponsor laboratory and technical skills workshops for women students in the department including welding, casting, and metalworking.
- Students are advised and guided by the faculty on matters of conduct with other professionals. Students frequently visit with their advisors on a wide range of social and professional issues. Students are routinely asked to visit their advisors before interview trips and professional activities to assure they have a good sense of what behavior is expected as young professionals.
- Meetings of the student Materials Advantage chapter are a frequent crucible of discussion of good and bad practices. In the course of conducting chapter business, students discuss a variety of proposals and arrive at good practices. The faculty advisor occasionally is needed to help students consider potentially troublesome consequences in their deliberations.
- The Materials Advantage Chapter members perform highway cleanup during the year.

Health and Safety Awareness

Items contributing to overall student health and safety awareness are listed below:

- Each year campus safety personnel present a safety training class in the fall semester to all metallurgical engineer juniors and senior enrolled in design. The course covers the proper handling and use of chemicals, general hazards, understanding chemical safety information labels, response to injury, safe workplace, safety responsibility, electrical hazards, explosion hazards, and safe disposal.
- Students' awareness of safety concerns is most strongly reinforced by their laboratory activity. Every laboratory involving hazardous activity includes instructions on safe practice. These are always presented orally and in most instances they are also written. The laboratory handouts in the course materials may be reviewed for a more detailed accounting of safety instruction.
- Safety issues are also experienced during the weekly Hammer-Ins where the blacksmithing activities incorporate several safety issues and students must take the time to educate new students on all this important safety concerns.

Economic Awareness

Items contributing to overall student economic awareness are listed below:

- Every metallurgical engineering student completes a two credit course in engineering economics: IENG 301. Students are expected to perform some economic analysis in departmental design assignments.
- All senior capstone designs must include an economic analysis during the preliminary proposal presentation, the final presentation, and final report.
- The majority of the program students is involved with the campus Materials Advantage chapter and routinely solicits the campus student association for chapter funding. This activity requires the students to write a proposal, including a proposed budget, and to manage and account for all funds secured.
- Every two years all junior and senior students taking the capstone engineering design courses participate in the "Dollars and Tons" activity sponsored by NUCOR Steel. Representatives from NUCOR Steel visit campus and teach the students about business economics during an 8 hour business simulation game. Students work in teams and learn how to build a steel mill and participate in the world steel market. Typically, during the last 2-3 hours of the game, students get very intense about this activity in trying to win.

The program faculty is actively involved in support and leading students in professional maturation. Some of the salient activities of the program faculty are described below.

Professional Societies

Dr. Howard serves as the Materials Advantage chapter advisor. The students meet monthly and engage in a variety of professional and community service projects. The chapter has sponsored the numerous industrial and university speakers. Approximately 75 percent of all students in the program are members of Materials Advantage. The department also has a student chapter of SME. The membership for the SME chapter is made up of geological, mining, and metallurgical engineering students. Students regularly attend at least one area SME meeting each year. Every year approximately ten students attend either the annual TMS or SME meeting. A few students typically also attend the fall MS&T meeting. Dr. West initiated the student chapter of the American Welding Society (AWS) in 2008 and advises it and the Blacksmithing Club. The department actively supports (including financially) the Material Advantage, the local

SME chapter, and the student chapter of the American Welding Society (AWS). It also supports the local Blacksmithing Club. SME is largely advised by the Mining Engineering Department but faculty members from Materials and Metallurgical Engineering co-advise students and attend the Annual SME meeting with the students.

Professional Practice

As mentioned earlier, many of the students in the program have at least one intern experience before graduation. In addition, some students are hired by the faculty to work on research projects during the summer, and still others participate in the undergraduate research programs funded by various federal agencies, particularly in the Advanced Materials Processing Center. It is rare for a student who wants an intern position not to find one.

Metallurgical engineering students may participate in large campus-wide CAMP Program designing competitive systems such as the Super mileage Vehicle, The Mini Indy Racer, Aero Team, and the Mini Baja. Students may also participate in the many specialized centers as members of these teams, as student part-time employees, or students having been assigned certain experiments relying on the centers' specialized equipment. These centers include the Center for Advanced Manufacturing and Production, the Advanced Materials Processing (CAMP) Laboratory, Center for Polymers Engineering (CAPE), or Security Printing and Anti-Counterfeiting Technology center (SPACT).

Program faculty members provide considerable professional counseling to students. They help them with

- Advice on seeking employment
- Advice and editing of professional letters
- Advice on writing of resumes
- Writing recommendation letters for them
- Identifying and applying for scholarships
- Counsel on conflict resolution, professional demeanor, and professional practice
- Frequent (unremitting) advice on professional bearing and communication
- Lively discussion on professional matters
- Advice on special projects outside normal departmental sphere of activity
- Sponsor and invite students to social skill seminars, dinners, and other such events

Professional Examination and Registration

Students in the metallurgical engineering program are encouraged to take the Fundamentals in Engineering Examination. Topic review sessions are periodically offered by the university. Faculty member Dr. Howard is been active within TMS and NCEES in writing PE exam questions for the Materials Engineering Exam and serving on cut score panels, etc.

Internships

Many program graduates complete at least one intern experience during their academic career. The variety of these intern experiences vary from industrial to academic research. Students may obtain course credit for a co-op position (CP 297, CP 397, CP 497), but most do not opt to pay tuition. Students typically apply directly to prospective employers for available co-op/intern positions similar to the manner in which graduating seniors apply for full-time positions.

The Career Center staff and faculty members assist students in identifying Co-op/intern opportunities and in applying for available positions. Career services provided to students include career fairs each fall and spring semester, campus interviews, resume and cover letter reviews, online job postings, and a series of career development workshops. The first step in this process involves a visit between the student and the program coop/intern coordinator to determine how many co-op credits the student should register for. SDSM&T's co-op policy allows 1-3 credit hours for the semester students are on co-op. Co-op credits may be applied toward graduation requirements in accordance with university policy and individual department curricular requirements. Because the work performed by a co-op student is equivalent to the workload of a full-time student, a student on a co-op assignment who is registered for credit is considered to have full-time status. Before returning to campus, students must turn in a formal co-op/intern report (using a format specified by the Career Planning Center) along with an employer evaluation form to the program department head to receive credit for the coop/intern experience. The department uses email and classroom announcements to keep students aware of co-op opportunities.

Peer mentors
Table 5-8 shows the students engaged as peer mentors during the 2015-16 year.

Organization of review materials for the PEV
Table 5-9 shows the materials to be displayed in the review room for evaluation by the program Evaluator (PEV). In addition to the syllabi for each course, there be for each course notebooks containing examples of all graded work, textbooks, references, and any significant supplementary materials used for instruction. All requirements of 2015-2016 APPM section II.G.6.b.(2) will be satisfied.

B. Course syllabi
Appendix A contains complete syllabi for all courses employed in the BS Metallurgical Engineering Degree curriculum. Table 5-10 shows a listing of the Table of Contents for that Appendix A. It is a directory to the available course syllabi and is arranged by significant categories.

Table 5-8 Peers mentors (6/22/2015-6/21/2016)

Name	Title	Dept
Seivert, Robert	Peer Mentor	BS.MET,
Wagehoft, Baylor	Peer Mentor	BS.GEOE,
Asel, Michael	ME Peer Mentor	BS.ME,
Bane, William	MET Peer Mentor	BS.MET,
Benedix, Hannah	ME Peer Mentor	BS.ME,
Clark, Rebecca	ABS Peer Mentor	BS.ABS,SPECG.SPEC,
Costello, Harrison Chance	GGE Peer Mentor	BS.GEOE,
Crandall, Zachery	CHEM Peer Mentor	BS.CHEM,
Crecco, Daniel	MET Peer Mentor	BS.MET,
Earney, Tait	GGE Peer Mentor	BS.GEOL,
Hirschey, Travis	CEE Peer Mentor	BS.CEE,
Jewell, Paul	MIN Peer Mentor	BS.MINE,
Karatekeli, Kayhan	CSC Peer Mentor	BS.CSC,
Keene, Lauren	CSC Peer Mentor	BS.CSC,
Kreuzer, Jena	ME Peer Mentor	BS.ME,
Leonard, Rashyll	MATH Peer Mentor	BS.ACMA,
Monk, Chandler	ME Peer Mentor	MS.ENMG,
Schwab, Roye	ME Peer Mentor	BS.ME,
Seidel, Matthew	ME Peer Mentor	BS.ME,
Stelter, Andrew	CSC Peer Mentor	BS.CSC,
Taylor, Christina	ME Peer Mentor	BS.ME,
Thune, Jonah	ME Peer Mentor	BS.ME,
Trapp, Cassidy	AES Peer Mentor	BS.CEE,
Vincent, Hunter	CEE Peer Mentor	BS.CEE,MS.CENE,SPECG.SPEC,
Lee, Sunghee	Math Supp Instructor	BS.CENG,BS.MINE,
Brubaker, Noah	Math Supp Instructor	BS.APCMATH,BS.CSC,
Ryther, Tyler	CHEM Supp Instructor	BS.CHEM,
Braasch-Turi, Margaret	CHEM Supp Instructor	CHEM Supp Instructor
Huntington, Samuel	Math Supp Instructor	BS.ME,BS.APCMATH,
Angelo, Michael	Internatl Peer Mentor	BS.IEEM,
Dulal, Rohit	Internatl Peer Mentor	BS.ME,MS.MES,
Singh, Akshay	Internatl Peer Mentor	BS.CSC,

Table 5-9 Plan for Organizing and Presenting Course and Student Work Materials

BS Metallurgical Engineering Degree Program
(ABET Accreditation Policy and Procedure Manual (APPM) §II. E.3.c.(10))

Resource Room Course, Assessment, and Evaluation Documents

By Course

Course materials for all SDSM&T Met Eng courses used to meet graduation requirements for the degree BS in Metallurgical Engineering will be arranged by course on tables in the resource room. These materials will consist of the following:

- Syllabus
- Text
- Graded representative samples of exams
- Graded representative samples of graded homework
- Graded representative samples of lab reports
- A compilation of handouts and supplementary materials

By Outcome

- A directory of all outcomes and the material assessed will be posted above these documents.
- Materials used to assess outcomes will be arranged by year followed by outcome on a table in the resource room.

By Objective

- A directory of all objectives and the material assessed will be posted above these documents.
- Materials used to evaluate objectives will be arranged by assessment vehicle (Alumni Survey, Advisory Board Report, etc.) on a table in the resource room.

Table 5-10 Table of Contents for Appendix A: Course Syllabi

Courses in the Metallurgical Engineering Curriculum	
MET 110	Intro to Engineering
MET 220	Min Proc & Resource Rec
MET 220L	Min Proc & Resource Rec Lab
MET 231	Structures & Prop of Mat Lab
MET 232	Prop of Materials
MET 310	Aqueous Extract/Conc/Rec
MET 310L	Aqueous Extract/Conc/Rec Lab
MET 320	Metallurgical Thermodynamics
MET 321	High Temp Extract/Conc/Rec
MET 330	Physics of Metals
MET 330L	Physics of Metals Lab
MET 332	Thermomechanical Treatment
MET 351	Eng Design I
MET 352	Engineering Design II
MET 422	Transport Phenomena
MET 432 [‡]	Advanced Metal Processing
MET 433	Process Control
MET 440	Mechanical Metallurgy
MET 440L	Mechanical Metallurgy Laboratory
MET 464	Engineering Design III
MET 465	Engineering Design IV
Metallurgical Engineering Elective Courses	
MET 426/526	Steelmaking
MET 430/430L	Welding Engrg & Design of Welded Structures
MET 443[†]	Composite Materials
MET 450/550	Forensic Engineering
MET 445/545	Oxidation and Corrosion of Metals
MET 491[*]	Security Printing Technology
Other Required Engineering Courses	
EE 301	Intro Circuits, Machines, Sys
EM 214	Statics
EM 321 or	Mechanics of Materials
ME 216	Intro to Solid Mechanics
IENG 301	Basic Engineering Economics
Support Courses	
CHEM 112	General Chemistry
CHEM 112L	General Chem Lab
CH EM 114	General Chemistry II
CHEM 114L	Gen Chem II Lab
ENGL 101	Composition I
ENGL 279	Technical Comm I
ENGL 289	Tech Comm II
MATH 123	Calculus I
MATH 125	Calculus II
MATH 225	Calculus III
MATH 321	Differential Eqs
MATH 373	Intro to Numerical Analysis
PHYS 211	University Physics I
PHYS 213	University Physics II

† After 2010 MET 443 was replaced by the 2-credit hour Advances in Processing and Nanoengineering of Polymers (MES 475) and the 1-credit hour Composites Manufacturing (MET 489)

* Beginning in 2015-16, MET 491 was renumbered as Security Printing Technology (MET 444/544)

‡ New course Spring 2016

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