CRITERION 5. CURRICULUM

This section describes the curriculum for the BS Metallurgical Engineering Degree offered by the South Dakota School of Mines and Technology.

A. Program Curriculum

The program curriculum requires 136 semester credit hours for graduation. 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.

A1. Student Preparation for a Professional Career and further Study in the BS Metallurgical Engineering and Consistency of the Curriculum with the Program Educational Objectives and Program Outcomes

The matter of *Student Preparation for a Professional Career and further Study in the BS Metallurgical Engineering* is covered here in §5.1. The matter of *Consistency of the Curriculum with the Program Educational Objectives and Program Outcomes* is covered in §5.4 using a quality function deployment matrix (QFDM).

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 additional requirements beyond those required by ABET but do require some planning to meet the Regent's expectations.

The General Education Requirement supports program outcomes (a) through (k) outcomes: particularly

- (a) Apply Knowledge of Math, Science, and Engineering
- (g) Communicate Effectively
- (h) Know Engineering's Global Societal Context
- (j) Know Contemporary Issues
- (k) Use Engineering Techniques, Skills, and Tools

All students complete a 30 credit hour system-wide general education core curriculum consisting of

- 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

South Dakota School of Mines and Technology (SDSM&T) engineering students take 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 requirements.

Table 5-1 shows the course curriculum for the BS Metallurgical Engineering Degree at the South Dakota School of Mines and Technology. The four columns on the right show the category that each course is attributed to with regard to the objectives of the metallurgical engineering program and institutional. The 136 required credits for graduation are allocated as follows:

- Math and basic science" 40 credits 29.4%
- Engineering topics 64 credits 47.1%,
- General education 25 credits 18.4%
- Other 7 credits 5.1%.

Table 5-2 is a summary of the relevant course in the metallurgical engineering curriculum, the approximate number of sections taught in a year, and the average enrollment in each section.

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 following seven goals must 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.

Table 5-1 Curriculum for the BS Metallurgical Engineering Degree

Year Semester	**Course**		**Category (Credit Hours)**			
	Number	Title	Math & Basic Sciences	Engineering Topics *Check if Contains <u>Significant</u> Design (✓)*	General Education	Other
Year 1	MATH 123	Calculus I	4			
Sem 1	CHEM 112	General Chemistry	3			
	ENGL 101	Composition I			3	
	MET 110	Intro to Engineering		2✓		
	PE	Physical Education				1
	HSS	Hum or Soc Sci Elective			3	
Sem 2	MATH 125	Calculus II	4			
	BIOL 151 or BIOL 153 or CHEM 114	General Biology I General Biology II General Chemistry II	3			
	PHYS 211	University Physics I	3			
	CHEM 112L	General Chem Lab	1			
	PE	Physical Education				1
	HSS	Hum or Soc Sci Elective			3	
	HSS	Hum or Soc Sci Elective			3	
Year 2	MET 232	Prop of Materials		3✓		
Sem 1	MET 231	Struct & Prop of Mat Lab		1		
	MATH 321	Differential Eqs	4			
	PHYS 213	University Physics II	3			
	BIOL 151L or BIOL 153L or CHEM 114L	Gen Biology Lab I Gen Biology Lab II Gen Chem II Lab	1			
	ENGL 279	Technical Comm I			3	
	EM 214	Statics		3		
Sem 2	MATH 225	Calculus III	4			
	EM 321 or ME 216	Mechanics of Materials Intro to Solid Mechanics		3		
	PHYS 213L	Univ Physics II Lab	1			
	MET 220	Min Proc & Resource Rec		3		
	MET 220L	Min Proc & Resource Rec Lab		1✓		
	HSS	Hum or Soc Sci Elective(s)			4	
Year 3	ENGL 289	Tech Comm II			3	
Sem 1	MET 320	Metallurgical Thermo		4		
	MET 351	Eng Design I		2✓		
	Set A or C (7)	(see below)				
Sem 2	MET 352	Engineering Design II		1✓		

	MATH 373	Intro to Numerical Analysis	3			
	Elective	Free Elective				2
	Set B or D (11)	(see below)				
Year 4	MET 433	Process Control		3✓		
Sem 1	MET 464	Engineering Design III		2✓		
	IENG 301	Basic Engineering Economics		2		
	Sci Elective		3			
	Set A or C (7)	(see below)				
Sem 2	MET 465	Engineering Design IV		1✓		
	Elective	Science Elective	3			
	HSS	Hum of Soc. Sci. Elective			3	
	Set B or D (11)					
SET						
A	MET 422	Transport Phenomena		4✓		
	Elective	Free Elective				3
B	MET 321	High Temp Extract/Conc/Rec		4✓		
	Elective	Directed Met Elective*		3✓		
	EE 301	Intro Circuits, Machines, Sys		4		
C	MET 330	Physics of Metals		3		
	MET 330L	Physics of Metals Lab		1✓		
	MET 332	Thermomechanical Treatment		3✓		
D	MET 440	Mechanical Metallurgy		3		
	MET 440L	Mechanical Metallurgy Lab		1		
	Elective	Directed Met Elective*		3✓		
	MET 310	Aqueous Extract/Conc/Rec		3		
	MET 310L	Aq Extract/Conc/Rec Lab		1✓		
TOTALS-ABET BASIC-LEVEL REQUIREMENTS			40	64	25	7
OVERALL TOTAL FOR DEGREE: 136 credit hours						
PERCENT OF TOTAL			29.4	47.1	18.4	5.1
Minimum semester credit hours			32 hrs	48 hrs		
Minimum percentage			25%	37.5 %		

* *Some of the Met Eng Directed Electives, such as MET 450, MET 443, MET 430/430L, have a significant design component.*

Table 5-2 Course and Section Size Summary for BS Metallurgical Engineering

Course No.	Title	Responsible Faculty Member	No. of Sections Offered in Current Year	Avg Section Enrollment
MATH 123	Calculus I	Math Dept	13	34
CHEM 112	General Chemistry	Chem Dept	4	117
ENGL 101	Composition I	Hum Dept	15	20
GE 130	Intro to Engineering	Engineering	5	27
PE	Physical Education	PE Dept	30	23
	Hum. Or SS Electives	Hum Dept	52	37
MATH 125	Calculus II	Math Dept	13	31
CHEM 114	General Chemistry II	Chem Dept	3	84
BIOL 151	General Biology I	CBE Dept	1	67
BIOL 153	General Biology II	CBE dept	1	58
PHYS 211	University Physics I	Physics Dept	2	113
CHEM 112L	General Chem Lab	Chem Dept	15	27
PE	Physical Education	PE Dept	30	24
	Hum. or SS Elective(s)	Hum Dept	52	37
MET 232	Properties of Materials	Kellar/West	2	56.
MET 231	Struct. & Prop. of Mat. Lab	M. West	6	14.
MATH 321	Differential Equations	Math Dept	9	33
PHYS 213	University Physics II	Physics Dept	3	91
CHEM 114L	General Chem II Lab	Chem Dept	6	40
BIOL 151L	--or-- Gen. Biol. I Lab	CBE Dept	3	15
BIOL 153L	--or-- Gen. Biol .II Lab	CBE Dept	3	32
ENGL 279	Technical Comm I	Hum Dept	15	22
EM 214	Statics	CEE Dept	4	42
MATH 225	Calculus III	Math Dept	9	36
EM 321	Mechanics of Materials	CEE Dept	3	80
ME 216	--or-- Intro to Solid Mech.	ME Dept	2	18
PHYS 213L	University Physics II Lab	Phys Dept	6	29
MET 220	Min Proc and Res Recov	J. Kellar	1	39
MET 220L	Min Proc & Res Recov Lab	W. Cross	1	17.
	Hum. or Soc Sci Elective(s)	HUM-SS Dept	52	37
ENGL 289	Technical Comm II	Hum Dept	16	18
MET 320	Metallurgical Thermo	S. Howard	1	22
MET 351	Engineering Design I	J. Kellar	1	10
MET 352	Engineering Design II	S. Howard	1	10
MATH 373	Intro to Num. Analysis	Math Dept	2	45
MET 464	Engineering Design III	D. Medlin	1	15
IENG 301	Basic Engr Econ Sci. Elec	IE Dept	1	26
	Hum or SS Elective(s)	HUM-SS Dept	52	37
MET 433	Process Control	Chem Eng Dept	1	10

MET 465	Engineering Design IV	S. Howard	1	15
MET 310	Aqueous Extrac., Conc. & Recycling	W. Cross	1	28
MET 310L	Aqueous Extrac. Conc. & Recy. Lab	W. Cross	1	27
MET 321/321L	Hi Temp. Ext., Conc., and Recycling	S. Howard	1	27
MET 330	Physics of Metals	M. West	1	33
MET 330L	Physics of Metals Lab	D. Medlin	1	29
MET 332	Thermomechanical Treatment	D. Medlin	1	33
MET 422	Transport Phenomena	S. Howard	1	18
MET 426/526	Steelmaking	S. Howard	1	8
MET 430/430L	Weld. Engr. & Design of Welded Struct.	M. West	1	20
MET 440/540	Mechanical Metallurgy	D. Medlin	1	32
MET440L/540L	Mechanical Metallurgy Lab	D. Medlin	1	30
MET 443	Composite Materials	J. Kellar	1	10
MET 455/545	Oxid and Corrosion of Metals	D. Medlin	1	18
MET 450/550	Forensic Engineering	D. Medlin	1	12
MET 491	Independent Study	MET Dept	2	1
MET 492	Special Topics	MET Dept	3	2

Some courses are taught every two years. See Sets A, B, C, and D in Table 5-1

Credit Hours: 6 hours
Courses:

ENGL 101 Composition I
ENGL 201 Composition II
ENGL 279/289 Technical Communications I and II[1]

1 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[2]
SPCM 101 Fundamentals of Speech[1]

2 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[1]

In addition to the seven system-wide general education requirements described above, 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. Some of these other program requirements are common to most or all programs offered at SDSM&T. These include

A. Mathematical Sciences: all programs, with the exception of interdisciplinary science, geology and mining engineering, require a minimum of 16 credit hours of mathematics at the level of calculus and above. To qualify for MATH 123, Calculus I, a student must have completed at least three units of mathematics in high school and must have obtained an acceptable score on the SDSM&T mathematics placement examination. A student with less preparation in mathematics may register as a freshman in engineering but will be required to start the mathematics sequence at a level indicated by his or her formal preparation and all SDSM&T mathematics placement examination scores or ACT placement score. Mathematics courses taken below the level of MATH 123 are not totaled in the semester hours required for each curriculum with the exception of the BS in Interdisciplinary Science and the A.A. in General Studies. MATH 021 and MATH 101 do not count toward any degree.
B. Basic Sciences: minimum of 16 credit hours - CHEM 112, 112L, PHYS 211, and PHYS 213 are required for all engineering curricula.
C. Humanities and social sciences: minimum of 15 or sixteen 16 credit hours - This subject area must include six 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.
D. All degree candidates must complete ENGL 101, ENGL 279, and ENGL 289, which cannot be used to meet the humanities and social sciences requirements.
E. Physical Education: minimum of 2 credit hours. MUEN 101, 121, 122, and MSL 101L and MSL 102L can be counted for the physical education requirement.

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

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.

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 Degree Program Requirements
The General Education requirements do not add to the total course load required under the prevailing university requirements. These consist essentially of

• Mathematics	16
• Hum and Soc Sci	16
• Basic Science	16
• Engl	9
• PE	2
Total	59

This leaves the program 74 credits of course work assignment. Ten of these 74 credits are assigned as follows: 3 for Intro to numerical Methods, 5 for free electives, and 2 for physical education. Table 5.1 summarizes these as

- 40 credits of Math and Basic Science, which are composed from 16 credits of university-required math plus 3 credits of MATH 373 (Introduction to Numerical Analysis), 21 credits of basic science of which 6 credits are electives;
- 25 credits of General Education, which are composed of 16 credits of university-required 16 credits of humanities and social sciences and 9 credits of writing (ENGL 101, 279, and 289);
- 7 credits of *other* composed of 2 credits of physical education and 5 credits of free electives; and
- 64 credits of engineering course work, 46 of which are metallurgical engineering coursework; 6 met directed electives; 2 engineering economics; 6 statics and strengths; and 4 electrical engineering.

The metallurgical engineering curriculum is designed to provide students with a well-rounded knowledge of metal origins, production, treatment, use, failure analysis, and recycling. 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, seven credits of calculus-based physics, 19 credits of calculus-based mathematics including differential equations and introduction to numerical methods. 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 16 credits of course work in the humanities and social sciences. Of these 16 credits, 12 are part of the system general education requirement, discussed earlier.

A total of 52 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 science, and eight 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 multi-disciplinary teams and are required to present their work in written and oral format. In addition, they are required to participate in the campus Annual Design Fair in the spring semester.

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. Please see the following reference for more detailed information: Medlin, West, Kellar, Mitchell, and Kellogg, *"Improved Materials Science Understanding with Blacksmithing"*, Proceedings (AC 2009-2228) ASEE 2009 Annual Meeting, Austin, TX, June 2009.

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 310 (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. Many of the courses previously listed explain the importance of material performance when the other three topics are covered. 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.

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 is as 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 220L

In this course, the statistical content is presented primarily in two laboratories, sampling and sedimentation, which are usually the first and second assignments dealing with the collection and interpretation of data. In the sampling lab, Gy's sampling theorem is introduced and various types of error, primarily fundamental sampling error and sample heterogeneity, are discussed. Precision and accuracy as applied to data analysis are also covered. In the sedimentation laboratory, counting statistics, such as mean and standard deviation, are covered. Material not previously covered in MET 231 includes confidence interval determination and hypothesis testing.

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 and MET 220L 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 complete analysis of how the curriculum satisfies the ABET Program Criteria for Met Eng appears in § Criterion 9.

Pre-BS Metallurgical Engineering Program Assessment and Evaluation Operations
The BS Metallurgical Engineering Degree program samples almost exclusively from the upper-division courses to determine the level of achievement of the program outcomes. Sections 2, 3, and 4 describe the assessment and evaluation of program objectives and outcomes and the operation of the program's Continuous Improvement System (CIS). The program does meet periodically with math, science, humanities, and social science department faculty to offer feedback on the program's needs and suggestions. However, the program relies on the university's assessment and evaluation of general education and other course work in the freshman and sophomore years as well as the characteristics of incoming students. These tools have some relevance to the BS Metallurgical Engineering Degree program but typically they are too early and only indirectly useful. The tools are also used for other accreditation requirements (other than ABET) and as measures of added value, which is not part of ABET's quality assurance/continuous improvement process. These assessments are typically performed on large groups of students using standardized tools described below.

The primary system-wide measurement of students' achievement is the Collegiate Assessment of Academic Proficiency (CAAP) test. All students must take the CAAP at the completion of their sophomore year (i.e. completion of 48 credit hours) and must achieve a minimum score (i.e., system-wide "cut scores") in order to remain enrolled and continue with their academic careers.

Table 5-3 below shows the mean CAAP scores of SDSM&T students enrolled in the metallurgical engineering program over the past five years in comparison to all students in the South Dakota system and to all students nationwide enrolled in four-year public institutions who take the CAAP at the conclusion of their sophomore year. The breakout sub-scores for mathematical reasoning, reading, science reasoning, and writing are given.

In the area of mathematical reasoning, students enter the SDSM&T better prepared than students system wide or students nationally. In 2009, the average composite ACT score of entering students at the SDSM&T was 26.1, and the mean math sub-score was 26.7. Unsurprisingly, at the conclusion of their sophomore year when they take the CAAP test, approximately 13% of students at the SDSM&T test in the 99th percentile of students nationally and 94% (or more) of SDSM&T students test above the national mean score in math.

To better assess the actual gains in learning made by students regardless of their academic preparation upon entry, the "ACT Gains Analysis" is done by using students' incoming ACT in conjunction with CAAP exam scores for the same students. The "gains" measured are a better indication of learning gains than the CAAP scores alone.

ACT analyzes the "gains" made by the approximately 350-375 SDSM&T students who take the CAAP in any given year to the approximately 36,000 students in our national reference group and designates each student as making "lower than expected progress," "expected progress," or "higher than expected progress" in each of the four sub-score areas.

Over the last six years, between 12% and 27% of all SDSM&T students made "greater than expected" gains in math and less than 1% made "lower than expected" gains in math. Again, these "gains" are a measure of how much learning occurred between initial enrollment and the taking of the CAAP exam at the end of the sophomore year.

Similar "gains" are seen for SDSM&T students in the sub-score of science reasoning. In the areas of writing and reading, SDSM&T students do not out-perform students system wide or nationwide at the same high level as they do in math; however, 77% or more score above the national mean in writing and reading, and between 4 and 6% score in the 99th percentile nationally in these two areas.

Even though the CAAP scores primarily measure learning resulting from the general education curriculum, they are an indicator of student learning in areas key to ABET, such as math and writing.

Table 5-3 History of CAAP scores for Metallurgical Engineering Students in IPEDS Cohort since 2004

Term student enrolled[1]	**SDSM&T Students In Metallurgical Engineering**				**System-All Students**[2]				**Nat'l Four-Year Public Sophomores**			
	Math	Read	Sci Reas	Writ	Math	Read	Sci Reas	Writ	Math	Read	Sci Reas	Writ
Fall 2009[3]									58.8	62.8	62.0	64.2
Fall 2008	66.6	66.1	67.4	67.2	58.9	62.7	62.4	64.2	57.8	61.8	58.7	63.1
Fall 2007	65.0	65.6	65.9	67.2	58.7	63.7	62.8	64.4	58.5	62.8	61.7	64.2
Fall 2006[4]	64.0	64.6	65.7	66.7	58.8	63.0	62.6	64.4				
Fall 2005	63.9	66.8	65.8	65.7	58.9	62.9	62.7	64.5				
Fall 2004	65.9	65.4	66.8	67.8	58.5	63.8	62.8	64.5				

[1] *Includes all students in the Federal IPEDS cohort of first-time, full-time students enrolled in a degree program*
[2] SDSM&T *students are included in the calculation of system-wide mean scores*
[3] *No scores are given for students enrolling in fall 2009 as these students have not yet completed 48 hours and have not taken the CAAP test.*
[4] *National mean scores for 2004-2006 are not available*

Oral and written communication skills are addressed in the 'writing sequence" (i.e., ENGL 101 and ENGL 279 and 289, Technical Communications I and II). To continually improve writing and oral communication skills, faculty members who teach ENGL 101; the technical communication sequence, ENGL 279 and ENGL 289; and Speech 101, design and conduct assessments of key skills germane to general education outcomes 1 and 2.

For example, in AY2008-2009 instructors in ENGL 101, 279, and 289 randomly selected 28 papers to evaluate for competence in use of references, sources and in-text documentation. Each paper was evaluated by two faculty members, and all faculty members teaching these courses met to analyze the results in conjunction with National Survey of Student Engagement (NSSE) scores and input gathered from employers regarding students' communication skills at the annual career fairs held on campus.

Similarly, a metric-based assessment of students' oral communication skills was performed in Speech 101 and ENGL 279, Technical Communication I, in AY2008-09. An oral presentation rubric was used in pre- and post-assessments of 81 students for the first attempt at a speech and the final version of the same speech. Six dimensions of rubric scored (i.e., content, organization, style/tone, preparation, presentation, and ethics).

The results of these writing and oral communication assessments as well as the conclusions and ideas for improvement can be seen at <http://academics.sdsmt.edu/assessment/>; however, the general conclusion was that the goal of fully preparing engineering and science students in oral and written communication requires unflagging effort and the support of all faculty members across campus.

To reinforce and support the achievement of outcomes for written communication, a “writing intensive” requirement was implemented in 2006 whereby each academic program designated one or more courses at the junior or senior level to as “writing intensive” and designed the curriculum to ensure each student exercises the skill of writing in the context of his or her discipline. For more details on the writing-intensive courses in the engineering programs, please see Appendix D, Section K on Academic Supporting Units.
General education learning in the area of global understanding and global issues is reinforced once students move into their major areas of study through a “global-intensive” requirement. All engineering programs at the SDSM&T designate courses at the 300 level or above as “global-intensive” and design the curriculum to prompt students to consider global and contemporary issues in the context of their discipline. The placement of the global-intensive courses at the junior or senior level supports the integration of general education outcomes into learning in the major and helps support the attainment of ABET outcomes (h) and (j). For more details on the global-intensive courses in the engineering programs, please see Appendix D, Section K on Academic Supporting Units.

A2. <u>BS Metallurgical Engineering Curriculum Credit Hour Distribution</u>

The minimum credit hour distributions for the program are satisfied. Table 5-1 shows that of the136 total program credit hours 40 are math and basic science, which exceeds the 25% requirement by 6 credit hours. The required engineering topics requirement is to be 37.5% of the total 136 credit hours, which is 51 credits. The program exceeds this by 13 credits with a total of 64 credits required in engineering topics.

A3. <u>Design in the BS Metallurgical Engineering Curriculum</u>

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 and a specific metallurgical engineering problem. During the last several semesters multiple student teams have worked on the 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.

Another design team project unrelated to the Samurai Sword was the Lunar Regolith Simulant Team, or sometimes referred to as the Moon Dust Team. The goal of the Lunar Regolith Simulant Team is to produce a lunar regolith simulant in a more efficient method than the current processes. The project employed a complete spectrum of skill elements of the mineral processing branch of metallurgical engineering. This will be accomplished by separating the pyroxenes from the plagioclase. The primary customer for this project is the NASA Marshall Space Flight Center and additional contracted companies concerned with vehicles, travel on, and settling of the lunar surface. The customer requirements are designing a separation process resulting in high concentrations (about

80%) of the minerals found on the lunar surface. The process must be reproducible on a large scale and cost efficient.

A4. Alignment of Curricular Components with Program Outcomes and University and Program Objectives

The relationship of program outcomes to program objectives and them to university objectives is mapped in Table 2.1 in §Criterion 2 and Table 3.1 in §Criterion 3. The preferred means of relating program curriculum to program outcomes is with a Quality Function Deployment Matrix (QDFM). Figure 5-1 shows the QFDM for the BS Metallurgical Engineer 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 course 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 their plan in 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.

The seven General Education Goals described above are related to program outcomes. Notwithstanding variation from student selection of different courses to fulfill the General Education requirements, the specificity of the goals focuses each goal attainment into determinable relationships with program outcomes. The alignment of learning outcomes in the General Education program with the ABET a-k outcomes can be represented since a large majority of students take a readily identifiable sub-set of high enrollment courses. Table 5-4 to Table 5-10 show how each General Education learning maps with the ABET a-k outcomes.

Engineering programs typically have more difficulty inculcating their students with the *soft skills* of professional, ethical, social, health and safety, and economic awareness than with the *hard 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.

Outcome Criteria	MET 110	MET 220	MET 220L	MET 231	MET 232	MET 310	MET 310L	MET 320	MET 321	MET 330	MET 330L	MET 332	MET 351	MET 352	MET 422	MET 433	MET 440	MET 440L	MET 443	MET 445	MET 464	MET 465	Math sequence	H&SS curriculum	Elective Courses	PE, Music, Band, MS	ENGL Sequence	Met Electives	Chem/Physics Seq	Number of "high importance"
(a) Apply mathematics, science and engineering principles	3	5	3	3	5	5	3	5	3	5	5	5	1	1	5	5	3	3	5	5	1	1	5		3			3	3	12
(b) Ability to design and conduct experiments and interpret data	3	3	5	1		3	5	3	3	3	5		1	1	3		3	5		3	1	1	3					1	3	4
(c) Ability to design a system, component, or process to meet design	1				3	3	3	3	5				5	5	5	3	3	3	3	1	5	5	1					3		6
(d) Ability to function on multidisciplinary teams	5	1	3	5		1	1				5		3	5			1	3	3	1	5	5		1		3	1	1	1	6
(e) Ability to identify, formulate, and solve engineering problems	1	5	3	3	3	3	3	3	5	5	5	5	3	5	5	1	5	3	3	1	5	5	3		1			3	1	10
(f) Understanding of professional and ethical responsibility	5	3	1	1		3	1	1	5	1	3		3	3			3	1		1	3	3		1				1		2
(g) Ability to communicate effectively	5	3	5	3		3	5	1	3		3		3	5			3	5	1	1	5	5	1	1			5	1		8
(h) The broad education necessary to understand the impact of engineering		3		5		3	1	1			3													5				1		2
(i) Recognition of the need for and an ability to engage in life-long learning				3		3	1				3						1				1	1		1	2			3		0
(j) Knowledge of contemporary issues		3		1		1	1		5	1	1						1							5				1		2
(k) Ability to use the techniques, skills, and modern engineering tools necessary	3	1	5	3		5	5	3			5		3	5	3	5	3	3	3	1	5	5						1		8
	26	27	25	28	11	33	29	20	29	15	38	10	22	30	21	14	26	26	18	14	31	31	13	14	6	3	6	19	8	

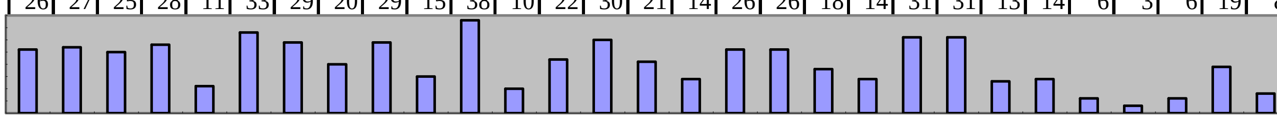

Figure 5-1.Quality Function Deployment Matrix for Metallurgical Engineering Students

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

The department has a plasma screen TV and a digital display board to help with student professional awareness. The plasma TV runs informational videos from professional societies (TMS/ASM), industry, and alumni testimonials as well as other topical areas specific to the program. The display board is updated regularly and contains 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, TMS/ASM student 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.

Table 5-4 Map of General Education Goal#1 to Program Outcomes

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 289/289L - Technical Communications II				■		■	■				■

Table 5-5 Map of General Education Goal#2 to Program Outcomes

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

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

Table 5-6 Map of General Education Goal#3 to Program Outcomes

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 that meet Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
PSYC 101 - General Psychology						■		■	■	■	
SOC 100 - Introduction to Sociology						■		■	■	■	
SOC 150 - Social Problems						■		■	■	■	
SOC 251 - Marriage and the Family				■			■		■	■	
HIST 151/152: American History I and II						■		■	■		

Table 5-7 Map of General Education Goal#4 to Program Outcomes

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 that meet 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						■		■	■	■	
PHIL 200 - Introduction to Logic						■		■	■		

Table 5-8 Map of General Education Goal#5 to Program Outcomes

GEP Objective #5: *Students will understand and apply fundamental mathematical processes and reasoning.*

ABET Outcomes → **High-Enrollment GEP courses that meet Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
MATH 102/102L - College Algebra	■										

Table 5-9 Map of General Education Goal#6 to Program Outcomes

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 that meet Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
Chemistry 112/112 Lab	■										
Physics 111	■										
Physics 213 Lab	■	■									
Physics 213/213 lab	■										
Physics 211/211 lab	■										

Table 5-10 Map of General Education Goal#7 to Program Outcomes

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 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 289/289L - Technical Communications II				■		■	■				■

Every student enrolled in MET 310, Aqueous Extraction, Concentration and Recycling, will write an essay on Global Impacts of Metal Extraction Processes and another essay on Professional Ethics. 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.
- The Women in Metallurgical Engineering get together during the semester to do a variety of activities including blacksmithing, jewelry making, and glassblowing.
- 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:

- 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.
- All of the 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.

5-5 <u>Professional Cooperative Opportunities</u>

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
The department has two primary professional societies: A joint student chapter of ASM/TMS (Materials Advantage) and student chapter of SME. Most students are members of Materials Advantage. The membership for the SME chapter is primarily mining 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 ASM meeting. The department actively supports the TMS/ASM chapter by paying 50% of all new member dues. Roughly 75% of all students in the program are members of Materials Advantage. Dr. Howard is the advisor for the Joint Student ASM/TMS Chapter.
In 2008 Dr. West initiated a student chapter of the American Welding Society. His involvement with the AMP Center and the large number of undergraduate projects involving friction stir welding and other joining processes justified another student organization on campus.

Student Materials Advantage Chapter
Dr Howard serves as the chapter advisor. The students meet monthly and engage in a variety of professional and community service projects. The chapter has sponsored the following industrial and university speakers:

- Dr. Raymond Peterson, 2009 TMS President
- Dr. Alan Pelton, Nitinol Devices and Components
- Mr. Michael Blakely, Dynamic Materials
- Mr. Robert Mudge, RPM and Associates
- Mr. William Arbegast, Advanced Materials Processing Center

Professional Practice
As mentioned earlier, many of the students in the program have at least one intern 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.

Many metallurgical engineering students participate in large campus-wide CAMP Program designing competitive systems such as the Super mileage Vehicle, The Mini Indy Racer, Aeroteam, and the Mini Baja. Most of the students participate in these competitions under the auspices of the Center for Advanced Manufacturing and Production or the Advanced Materials Processing (CAMP) Laboratory.

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 strongly encouraged to take the Fundamentals in Engineering Examination. Topic review sessions are offered by the university. The metallurgical engineering faculty routinely teaches the Materials Science review session for all students at SDSM&T. Two program faculty members (Howard and Medlin) have been active within TMS in writing PE exam questions for the previous PE Metallurgical Engineering Exam and the new Materials Engineering Exam.

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. For example, shown in Table 5-11 are the intern experiences from 2008-2010 for students in the program. This list only shows the students that took a co-op position for course credit (CP 297, CP 397, CP 497). A majority of students do not opt to pay to tuition to allow earning of credit for their co-op experience. Students 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 (Dr. Kellar) 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 Dr. Kellar to receive credit for the coop/intern experience. Hallway displays are kept current and relevant to the program. For example, a

Table 5-11. 2008-2010 Metallurgical Engineering Student Intern Summary

Company/Agency	Intern Name (last, first)	
National Science Foundation (REU)	Baker	Anastasia
SDSM&T	Beattie	Ashley
Spirit Aerosystems	Brausen	Ayla
Barrick Gold	Cooper	Brandon
Freeport McMoRan	Dinger	Kalli
Nucor-Yamato Steel	Fischer	Logan
Eaton	Freese	Max
Nucor Steel	Goebel	Shawn
Nucor	Gray	Kevin
Vishay Dale	Hicks	Matt
Nucor Steel	Juhl	Emilia
SDSMT	Kelley	Drew
South Texas Project	Krebsbach	Martha
Nucor-Yamato Steel Co.	Nordby	Derek
Newmont Mining	O'Bryan	Brooke
Cardalis	Well	Adam

display case of relevant journals is updated to allow students to browse and borrow technical journals of interest. The department also makes full use of email to keep students aware of co-op opportunities.

A-6 <u>Other Course Materials Available for Review</u>

The plan for displaying course materials, student work, and Continuous Improvement System (CIS) assessment and evaluation documents is shown in Table 5-1.3. A similar plan for support course documentation (i.e. – "***<u>By Course</u>***") will be observed.

B. Prerequisite Flow Diagram

Figure 5-2 shows the Curriculum Flow Diagram for the BS Metallurgical Engineering for the 2010-11 academic year.

C. Course Syllabi

Appendix A contains complete syllabi for all courses employed in the BS Metallurgical Engineering Degree curriculum. Table 5-12 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 5-12 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.

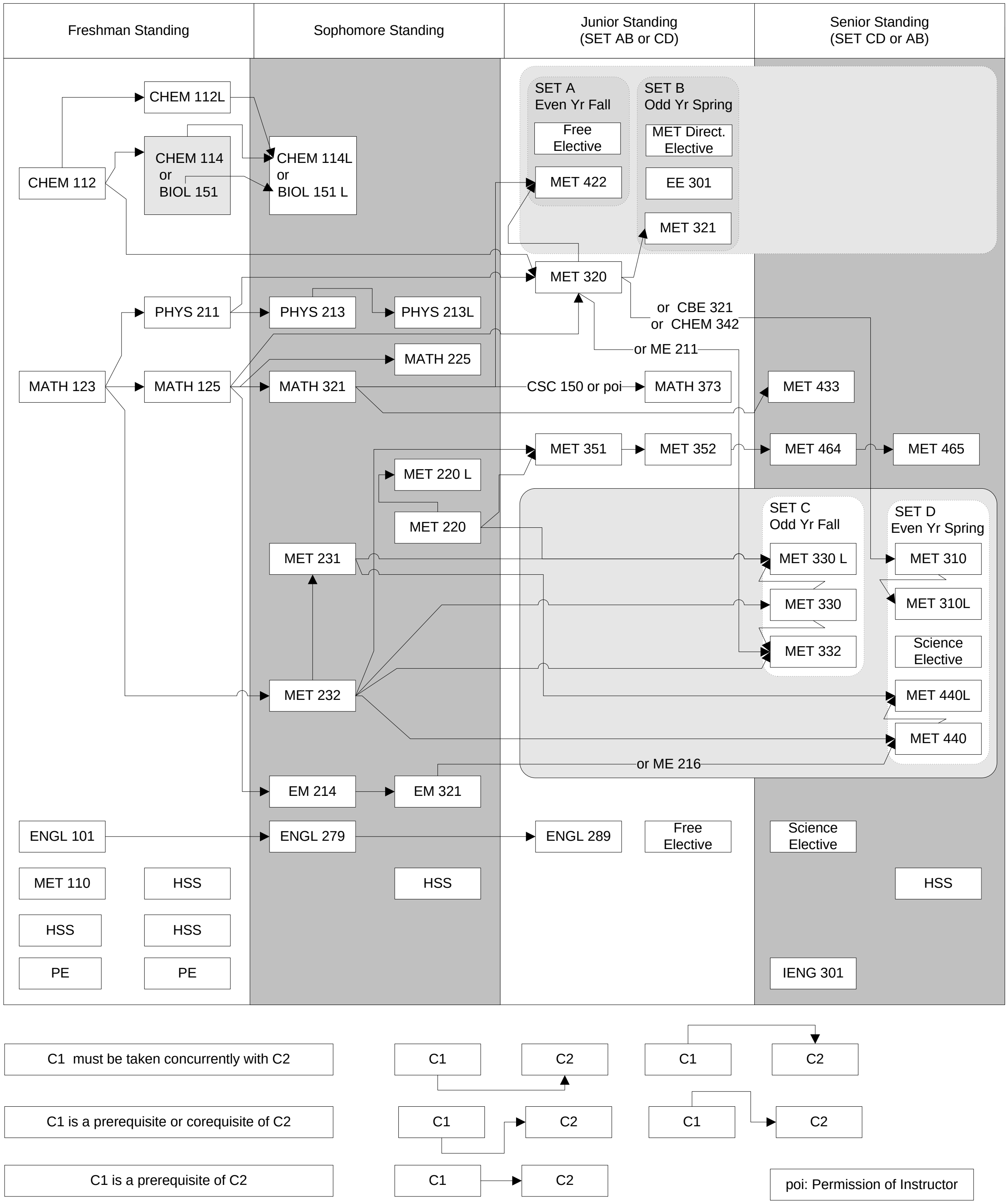

Figure 5-2 Curriculum Flow Diagram for BS Metallurgical Engineering Degree: 2010-11

Table 5-13 Table of Contents for Appendix A: Course Syllabi