Metallurgical Engineering

Undergraduate Program Handbook

2019-2020

The University of Utah
Department of Materials Science and Engineering

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The Metallurgical Engineering B.S. program
at the University of Utah is accredited by ABET, Inc.

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Introduction

This guide is intended to help students understand the undergraduate program in Metallurgical Engineering at the University of Utah. This guide is a supplement to the *University of Utah General Catalog* or Bulletin, which remains the official document of the required program leading to a Bachelor of Science Degree in Metallurgical Engineering.

Brief Overview of Metallurgical Engineering

Metallurgical Engineering involves the study, design, implementation, and improvement of processes that transform rocks and minerals into metal and mineral products that make our life better. Metallurgical engineering students take courses in: *particle separation technology,* which focuses on particle separation, processing, and recycling, and includes particle characterization, comminution, size separation, flotation, coal preparation, remediation of nuclear materials, automatic control and process engineering of particles including metal powders, energy-related minerals, pigments, and ceramics; *chemical metallurgy*, which focuses on metal removal, processing, and recycling into a purified metal and includes heterogeneous reaction kinetics, transport phenomena, computer modeling, leaching, solution purification, ion exchange, solvent extraction, precipitation, roasting, reduction, smelting, ironmaking and steelmaking; and *physical metallurgy*, which focuses on metal casting, forming, joining, and metal property evaluation and optimization and includes phase transformations, powder metallurgy, metallography, functionally graded materials, composites, magnetic materials, thin film processing, fatigue, positron annihilation, rapid solidification, metal failure analysis, and corrosion. (For additional information, please see http://www.mse.utah.edu/)

Financial Aid and Scholarship Information

The Department of Materials Science and Engineering offers a variety of scholarships. Students are encouraged to apply for these scholarships. Scholarship applications are available in the department office, 412 WBB, ph (801) 581-6386, or online at www.mse.utah.edu/. Students should also consider applying for other scholarships offered by professional societies, as well as general University of Utah scholarships. Student loans, grants, and need-based scholarships are also available through the financial aid office at 105 SSB – ph (801) 581-6211. See financialaid.utah.edu for FASFA and other scholarships.

Career Opportunities

Metallurgical Engineers play a key role in the nation's well-being because of the importance of metals and minerals in modern society. The broad use of metals and mineral in our society leads to a wide array of job opportunies. Our graduates work for companies such as Lockheed-Martin, BHP Steel, Rio Tinto, Nucor Steel, Aker Kvaerner, Freeport McMoRan, Chevron, GSC Foundries, Westinghouse, US Nuclear Regulatory Commission, Boart Longyear, Barrick, 1M Flash Technologies, Williams International, Newmont Gold, IBM, National Semiconductor, MEMC Electronics, Fluor Daniel, Samsung, Parker Aerospace, Johnson Matthey, Idaho National Engineering and Environmental Laboratory, etc. The average starting salary for students graduating with a bachelor's degree in Metallurgical Engineering is approximately $60,000/yr. Job placement for metallurgical engineers is typically near 100%.

Coursework

Standard Schedule

Year	*Fall*	*Spring*
1	CHEM 1210 General Chemistry I (4) CHEM 1215 General Chemistry Lab I (1) MATH 1210 Calculus I (4) MET E 1630 Intro. to Metallurgical Eng. I (3) MET E 4990 Undergraduate Seminar (0.5) Gen Ed (Writing - WR2 requirement) 3 *Total Credits 15.5*	CHEM 1220 General Chemistry II (4) CHEM 1225 General Chemistry Lab II (1) MATH 1220 Calculus II (4) MET E 1640 Intro. to Metallurgical Eng. II (3) Gen Ed (3) *Total Credits 15*
2	MATH 2210 Calculus III (3) MET E 3070 Statistical Methods (3) MET E 4990 Undergraduate Seminar (0.5) PHYS 2210 Physics for Sci. and Eng. I (4) PHYS 2215 Physics for Sci. and Eng. Lab I (1) Gen Ed/Electives 5 *Total Credits 16.5*	MATH 2250 ODEs and Linear Algebra (4) MET E 2300 Strengths of Materials (2) MET E 3610 Thermodynamics I (3) PHYS 2220 Physics for Sci. and Eng. II (4) Gen Ed/Emphasis/Electives 3 *Total credits 17*
3	MET E 3630 Thermodynamics II (3) MET E 4990 Undergraduate Seminar (0.5) MET E 5260 Physical Metallurgy (3) MET E 3200 Computational Methods (3) Gen Ed/Emphasis/Electives 6 *Total Credits 15.5*	MET E 5670 Mineral Processing I (3) MET E 5750 Transport and Rate Phenomena (3) MET E 5700 Low Temp. Chem. Proc. (3) Gen Ed/Emphasis/Electives 6 *Total Credits 15*
4	MET E 4990 Undergraduate Seminar (0.5) MET E 5450 Mechanical Behavior of Metals (3) MET E 5710 High Temp. Chem. Proc. (4) Gen Ed/Emphasis/Electives 9 *Total Credits 16.5*	MET E 5760 Process Design and Economics I (3) MET E 5780 Metals Manufacturing Processes (3) Gen Ed/Emphasis/Electives 11 *Total Credits 17*

Note that a minimum of 24 credit hours of general education are required, assuming that the diversity (DV) and international (IR) requirements are fulfilled by an intellectual exploration (IE) course that can be double counted for IE and (DV/IR) credit.

Students are required to take 5 courses in an area of emphasis (minimum of 13 credit hours).

Students are required to take 9 credit hours of technical elective credit. (The minimum credit hour calculation assumes students take a professional writing class for one of their technical electives.)

Undergraduate Metallurgical Engineering Course Descriptions

(*see also* https://catalog.utah.edu/#/programs/EJCUtxb0Z?bc=true&bcCurrent=Metallurgical%20Engineering&bcItemType=programs)

MET E 1630 - Introduction to Metallurgical Engineering Part 1 (particle & chemical processing)
Lecture, 3 Credits
Co-requisites: CHEM 1210 *OR* Equivalent.
Introduction to metallurgical processing fundamentals and applied technology that are to separate minerals and chemically process minerals to produce high purity metals as well as the application of these principles and technologies in areas such as biomedical devices and sensors, energy conversion and storage, and nuclear material processing.

MET E 1640 - Introduction to Metals / Metallurgical Engineering
Lecture & Laboratory, 3 Credits
Basic principles of chemistry and physics applied to structure of materials, especially metals and alloys. Phase diagrams, physical and mechanical behavior of solids.

MET E 2300 - Strength of Materials
Lecture, 2 Credits
Prerequisites: (MET E 1620 *OR* Equivalent) & MATH 1210.
This course is designed to introduce analytical techniques for simple mechanics problems and to advance students' capability for formulation and design of simple structures. During the course, the following concepts will be covered: two and three-dimensional force systems, the concept of equilibrium, analysis of trusses and frames, centroids, bending moment, shear diagrams, and thermal stresses.

MET E 3070 - Statistical Methods in Earth Sciences and Engineering
Laboratory & Lecture, 3 Credits
Recommended Prerequisite: College Algebra.
Probability density functions, fundamental sampling distributions, one- and two-sample estimation problems. Selected examples from mining, geology, metallurgy, and meteorology will be used to illustrate statistical methods. Lab exercises will use examples from earth sciences and engineering.
Designation: Quantitative Reasoning (Statistics/Logic)

MET E 3200 - Computational Methods in Metallurgical Engineering
Lecture, 3 Credits
Prerequisites: C or better in MET E 3610
Corequisites: C or better in MATH 2250
This course is about the use of modern computation methods and techniques in solving metallurgical engineering problems. Nowadays, in most cases, a necessary condition to become a competent engineer is to have a minimum level of knowledge of computers and their effective utilization. However, although computers can help the user to substantially improve their productivity, computers will never replace the need of understanding the fundamental principles of the problem being solved. The main goal of this course is to introduce you to some modern computer applications and computational methods for problem solving.
There are a number of computer software available, each with their own capabilities, specific applications, and limitations. The goal of this course is to give an introduction to some software packages and how to use them in solving metallurgical engineering problems.

MET E 3610 - Metallurgical Thermodynamics I
Lecture, 3 Credits
Recommended Prerequisite: CHEM 1220 and MATH 1210.
Introduce the concepts and techniques required to make chemical/metallurgical process calculations and determine required inputs and outputs. Introduce the First, Second, and Third Laws of Thermodynamics and related concepts. Demonstrate techniques for making energy and combined mass-and-energy balances for a process.
Designation: Quantitative Intensive BS

MET E 3630 - Metallurgical Thermodynamics II
Lecture, 3 Credits
Prerequisites: CHEM 1220, MATH 2250, AND METE 3610.
Continuation of Metallurgical thermodynamics I in which changes in Gibb's free energy and chemical potential are used to work with phase and chemical reaction equilibrium problems. Covers single phase equilibrium, multicomponent phase equilibrium, non-ideal gas equations of state, ideal and non-ideal solutions,

chemical reactions involving gaseous and condensed phases, construction and interpretation of phase diagrams, electrochemistry, and equilibrium behavior of ionic solutions.

MET E 5260 - Physical Metallurgy I
Lecture, 3 Credits
Recommended Prerequisite: MET E 1620.
Phase transformations in metals and alloys: Elementary physical chemistry of phases, phase diagrams and phase rule application, diffusion in solids, structure of interfaces, nucleation and growth, solidification, pearlitic, bainitic, massive and order-disorder transformations, precipitation, elementary treatment of martensitic transformation, iron-carbon system, and heat-treatment of steels. Laboratory sessions illustrate principles developed in lectures.
Designation: Quantitative Intensive BS

MET E 5450 - Mechanical Behavior of Metals
Lecture, 3 Credits
Recommended Prerequisite: MET E 1620 and MET E 2300.
Stress and strain analysis, Mohr's circle, yield criteria, elastic and plastic deformation, deformation of single and polycrystals, dislocations, strengthening mechanisms, fatigue, creep and fracture of metals. Also involves a design problem of material selection for gas-turbine blades on the basis of mechanical property requirements.
Designation: Quantitative Intensive BS

MET E 5670 - Mineral Processing I
Lecture & Laboratory, 3 Credits
Recommended Prerequisite: MATH 2250 and MET E 3500.
Laboratory fee assessed. One laboratory period. Particulate technology, particle size distribution, sizing methodology, size reduction and classification processes, solid-liquid separation methods, flotation, gravity separation, and magnetic separation.
Designation: Quantitative Intensive BS

MET E 5700 - Low Temperature Chemical Processing
Lecture & Laboratory, 3 Credits
Recommended Prerequisite: MET E 3620.
Laboratory fee assessed. Laboratory sessions every other week. Thermodynamic and kinetic fundamentals of commercially important metal utilization, extraction, recovery, refining, and removal processes in aqueous media.
Designation: Quantitative Intensive BS

MET E 5710 - High-Temperature Chemical Processing
Lecture & Laboratory, 4 Credits
Recommended Prerequisite: MET E 3620 *OR* Equivalent.
Laboratory fee assessed. One laboratory period. Fundamentals of commercially important nonferrous and ferrous pyrometallurgical extraction. Thermodynamics and kinetics of high-temperature processes.

MET E 5750 - Transport and Rate Phenomena
Lecture, 3 Credits
Recommended Prerequisite: MATH 3150 *OR* Equivalent.
Treatment of heat and mass transfer problems in metallurgical engineering. Interaction of chemical kinetics, and transport processes in metallurgical reactions.
Designation: Quantitative Intensive BS

MET E 5760 - Process Design and Economics I
Lecture, 4 Credits
Recommended Prerequisite: MG EN 5170 and MET E 5260 and 5670 and 5700 and 5710.
Metallurgical process synthesis, flow sheet development, and associated economic analysis.

MET E 5780 - Metals Manufacturing Processes
Lecture & Laboratory, 3 Credits
Recommended Prerequisite: MET E 1620, 5260, and 5450.
Primary and secondary metal-shaping processes: casting and solidification of metals, powder metallurgy, machining and joining of metals. Emphasis will be on process design. Laboratory illustrates principles developed in lecture.
Attribute: SUSC

MET E 4990 - Undergraduate Seminar
Seminar, 0.5 Credits
Total Completions Allowed: 99. Total Credit Allowed: 999.
Required of all undergraduate students in metallurgical engineering.

MET E 5055 - Microsystems Design and Characterization
Lecture, 3 Credits
Prerequisite: ME EN 5050 and ECE 5211 *OR* MSE 5211 and upper division undergraduate status in engineering.
Third in a 3-course series on Microsystems Engineering. This course generalizes microsystems design considerations with practical emphasis on MEMS and IC characterization/physical analysis. Two lectures, one lab per week, plus 1/2 hour lab lecture. Must also register for ME EN 6056 (0-credit lab with fees).
Cross-listed Course(s)
ECE5225 - Microsystems Design and Characterization
ME EN5055 - Microsystems Design and Characterization
MSE5055 - Microsystems Design and Characterization

MET E 5210 - Nuclear Materials: Processing, fabrication, use and disposal

Lecture, 3 Credits

Prerequisite: Introductory level metallurgy or materials science course.

The course will provide an in-depth coverage of the metallurgy of the materials used in the nuclear reactor core, power generation, reprocessing, transport, and waste disposal systems.

MET E 5240 - Principles and Practice of Transmission Electron Microscopy

Lecture & Laboratory, 3 Credits

Prerequistie: Engineering/College Physics Course or permission of instructor.

The course will cover the basic principles of electron diffraction in materials and the operation of transmission electron microscope. Hands on experience with preparation of samples of various materials and structures in a TEM will be provided in laboratory sessions to illustrate the principles and practice of various TEM techniques. The course will consist of 2 lecture sessions and 1 laboratory session per week.

MET E 5270 - Powder Metallurgy

Lecture & Laboratory, 3 Credits

Recommended Prerequisite: MET E 1620 and 5260.

Powder preparation, rapid-solidification processing principles, powder characterization, theory of compaction, sintering, full-density processing, powder metallurgy component design, compact characterization, application of powder metallurgy processing to structural, electrical, magnetic, and biomedical components. The laboratory sessions are a integral part of the course. Participation by students is mandatory. The credit hour for the laboratory portion is 1.0. Laboratory schedule and location will be determined during the semester.

MET E 5280 - Magnetic Materials and Devices

Lecture, 3 Credits

To provide an in-depth understanding of the magnetism, processing and characterization of magnetic materials, and structure property-performance relationships in magnetic materials used in a number of engineering devices/applications.

MET E 5290 - Principles and Practice of Nanoscience and Technology

Lecture, 3 Credits

Prerequisite: Introductory level metallurgy or materials science course.

The course will cover the principles of material behavior and synthesis at the nanoscale, and its application to a wide range of industrial and biotechnology applications. A historical development and an overview of the nanotechnology is first provided followed by treatment of the basic physics of behavior at the nanoscale. This is followed by (i) synthesis of particle and structure at the nanoscale using vapor phase, physical vapor deposition, commination and electrochemical approaches for use in metallurgical, pharmaceutical, cosmetic, medical, electronic, ceramic, agricultural, and other applications, (ii) processing and mechanical behavior of nano-scale structures, (iii) electrochemical synthesis and characterization in nanostructures including micro- and nano-machining, (iv) magnetism at the nanoscale and principles and fabrication of nanoscale magnetic devices, (v) biochemical processing, and (vi) Nanoscale characterization using AFM, STM, MFM, TEM and other techniques.

MET E 5300 - Alloy and Material Design

Lecture, 3 Credits

Prerequisites: MET E 5260 and MET E 5450.

Design of microstructure for control of materials properties, electronic structure and properties of metals, strengthening mechanisms, microstructural origins of strength in high-strength steels, aluminum and titanium alloys, microstructural factors controlling creep in structural alloys and composites, microstructure design of cermets.

MET E 5600 - Corrosion Fundamentals and Minimization

Lecture, 3 Credits

Recommended Prerequisite: CHEM 1220.

Basic principles of corrosion, including forms and mechanisms of corrosion; corrosion evaluation using electrochemical, microscopic, and other tools; minimization theory, prediction, practice, and economic assessment.

MET E 5610 - Proton Exchange Membrane Fuel Cells
Lecture, 3 Credits
Prerequisite: MET E 3620, CH EN 3853 or equivalent.
Fuel cells hold the promise of providing clean energy for many applications. In this course, the theory, practice technology of proton exchange membrane fuel cells will be presented. Topics to be covered are fuel cell electrochemistry, thermodynamics and mass transfer and cell design, construction and operations. Additionally, stack and system design will be discussed for various applications.

MET E 5660 - Surfaces & Interfaces
Lecture, 2 Credits
Recommended Prerequisite: MET E 3620 and CHEM 3060.
Capillarity, films on liquids, Gibbs adsorption, surface spectroscopy, electrical phenomena at interfaces, solid surfaces, wetting, nucleation.

MET E 5770 - Electrometallurgy
Lecture, 2 Credits
Recommended Prerequisite: MET E 3620.
Principles of electrodeposition and electrowinning, including modern practices.

MET E 5790 - Metal Failure Analysis
Lecture, 2 Credits
Recommended Prerequisite: MET E 1620.
Metal-failure analysis, metal-failure modes. Methods and procedures of analysis.

MET E 5800 - Special Topics in Metallurgical Engineering
Special Topics, 3-5 Credits
Total Completions Allowed: 99. Total Credit Allowed: 999.

MET E 5830 - Senior Project
Special Projects, 3-5 Credits
Total Completions Allowed: 99. Total Credit Allowed: 999.
Senior students investigate research or design problem and submit report or thesis.

MET E 5910 - Selected Topics
Special Topics, 1-4 Credits
Total Completions Allowed: 99. Total Credit Allowed: 999.
Lectures or seminars on topics of current interest.

Technical Emphasis Options

Biomedical Devices and Sensors Emphasis

Metals are used in a wide variety of high-tech devices such as those that replace essential human physiology functions, such as heart valves, artificial hips, pace makers, etc. Understanding the durability and biocompatibility of these devices relies upon fundamental metallurgical engineering subjects such as corrosion, surface chemistry, physical metallurgy, and strengths of metals. This emphasis gives students an advanced understanding of these applications and how to apply knowledge gained from their core curriculum to prepare students for careers in such high technology fields.

Required for BD&S Emphasis	Two of the Following Courses
MET E 5520 Biomedical Devices and Sensors MET E 5600 Corrosion MET E 5690 Process Engineering Statistics	MET E 5320 Materials and Environment MET E 5770 Electrometallurgy MSE 5040 Intro to Modern Biomaterials BIOEN 1020 Fund. of Bioengineering

Chemical Processing Emphasis

Extraction of metals from minerals or waste materials and subsequent purification requires a fundamental understanding of chemical processes and principles. Students who pursue this emphasis will strengthen their education in chemical processing to support pursuit of careers in metals recycling, purification, and extraction. Completing this emphasis should give the student the educational background to pursue career opportunities also open to chemical engineers and extractive metallurgists.

Required for Chemical Processing Emphasis	Three of the Following Courses
MET E 5600 Corrosion *OR* MET E 5770 Electrometallurgy	CHEM 2310 Organic Chemistry CHEM 3100 Inorganic Chemistry CH EN 3353 Fluid Mechanics MET E 5210 Nuclear Materials MET E 5330 Renewable Energy Conversion & Storage MET E 5520 Biomedical Devices and Sensors MET E 5800 Molten Salt Engineering
MET E 5790 Process Design and Economics II *OR* MET E 5690 Proc. Eng. Statistics	

Energy Conversion and Storage Emphasis

This emphasis provides in-depth instruction on the application of metallurgical engineering fundamentals to advanced energy production and storage systems-including renewable energy and nuclear energy. Students will learn about types of metals needed for these systems and requirements for developing advanced metal alloys to improve energy conversion and storage efficiency.

Required for EC&S Emphasis	Three of the Following Courses
MET E 5330 Renewable Energy Conversion & Storage	MET E 5320 Materials and Environment MET E 5600 Corrosion MET E 5690 Proc. Eng. Statistics MET E 5210 Nuclear Materials NUCL 3000 Nuclear Princ. In Eng. Sci. MSE 3210 Electronic Prop. Of Solids
MSE 5074 Photovolt. Materials & Solar Cells *OR* MET E 5770 Electrometallurgy	

Mineral/Particle Processing Emphasis

Mineral processing is the study of practical methods for concentrating methods from ores. It teaches methods such as communition/grinding, flotation, gravity separation, sorting, and dewatering. This field serves as a bridge between mining engineering and metallurgical engineering. Students who study this emphasis will be particularly well qualified to pursue careers and the mining industry.

Required for Mineral Processing Emphasis	Three of the Following Courses
MET E 5680 Mineral Processing II MET E 5790 Process Design &Economics II	MET E 5320 Materials and Environment MET E 5690 Process Engineering Statistics MET E 5800 Image Analysis MG EN 3010 Intro to Mining GEO 3070 Mineralogy and Petrology for Eng. CH EN 3353 Fluid Mechanics

Nuclear Emphasis

Metals play a huge role in nuclear energy systems, making up the fuels, structural materials, and even coolants. Selection of optimal metals for nuclear energy systems requires understanding of physical properties, neutron interaction parameters, corrosion properties, cost, and fabricability. This is an ideal emphasis for a metallurgical engineering student wishing to pursue a graduate degree in nuclear engineering or pursue a career related to nuclear energy, nuclear waste, or research into advanced nuclear systems and processes.

Required for Nuclear Emphasis	Two of the Following Courses
MET E 5210 Nuclear Materials MET E 5600 Corrosion	ENVST 3368 Energy Choices or the 21st Century MET E 5690 Process Engineering Statistics MET E 5770 Electrometallurgy MET E 5800 Molten Salt Engineering MET E 5800 Amorphous Materials NUCL 3200 Radiochemistry
MET E 5800 Nuclear Safeguards *OR* NUCL 3000 Nuclear Principles	

Physical Metallurgy Emphasis

Physical metallurgy is the study of the physical properties and processing methods for metals and alloys-including strength/hardness, microscopic structure, and phase properties. It studies the effect of both metal composition and processing methods on these properties. Alloy design is an important element of physical metallurgy that results in entirely new metals with targeted properties. Material characterization skills are key elements of the physical metallurgy emphasis. Students who study this emphasis can pursue careers in a wide range of industries in which metal properties are key for success of the products.

Required for Emphasis	Three of the Following Courses
MET E 5270 Powder Metallurgy *OR* MET E 5300 Alloy and Material Design	MET E 5320 Materials and Environment MET E 5330 Renewable Energy Conversion & Storage MET E 5520 Biomedical Devices & Sensors MET E 5600 Corrosion MET E 5690 Process Engineering Statistics MET E 5800 Magnetic Materials MET E 5800 Amorphous Materials MET E 5800 Solid state Thermodynamics MET E 5800 Image Analysis ME EN 2650 Manufacturing for Engineering Systems MSE 3210 Electronic Properties of Solids
MET E 5460 Advanced Characterization *OR* MSE 3011 Materials Characterization	

Advising Information for Math Courses

Finishing MATH 1210 and 1220 during the first year is very important for students desiring to complete a B. S. degree in metallurgical engineering in four years. The University of Utah requires a recent (within two years) ACT, SAT, Accuplacer, or AP/IB Calculus exam score, or a recent concurrent enrollment (college-level course) grade to evaluate your math proficiency before deciding which math course you are allowed to take. Transfer students can satisfy prerequisites with transfer math classes. If you have not had a math course or placement test within two years, you will be required to take the Accuplacer exam.

If taking the Accuplacer exam, make sure you prepare well because your score determines your placement. Free practice exams are often available on the web through simple search engine queries. The Math department's math boot camps (MATH 10 and MATH 15) are accelerated review courses sometimes offered in one-week sessions. There are on-line prep tools such as ALEKS for a fee. The additional resources are particularly helpful for those who have not had a recent math course. Please see the Math Department's website (http://www.math.utah.edu/) for more information on placement and study resources.

Students who will take a leave of absence or are nontraditional/part-time should consider their math course schedules carefully. The Math Department has indicated that if students take MATH 1210 or higher before taking a leave of absence, it is generally easy to receive instructor approval to continue with the next math course, provided the previous grade was good, and it has not been more than three or four years since taking the previous course. In contrast, if students complete only a lower-level math course such as MATH 1050 before a leave of absence, they will be required to pass the Accuplacer exam at a sufficient level before registering for the next math class upon returning.

Math Placement Guide

Math ACT Score(s)	Math SAT Score(s)	Accuplacer Scores*	Course Placement
17 or lower	420 or lower	AR < 120 or EA < 54	Math 990 Elementary Algebra
18-22	430-530	54 <= EA or CLM < 50	Math 1010 Intermediate Algebra**
23-27	540-620	CLM >= 50	Math 1030 Quantitative Reasoning Math 1040 Statistics & Probability Math 1070 Statistical Inference
		CLM >= 60	Math 1050 College Algebra Math 1060 Trigonometry
24-27	58-620	CLM >= 65	Math 1080 Precalculus
28 or higher	630 or higher	CLM >= 80	Math 1100 Quantitative Anslysis
		90 <= CLM <= 94*** 95 <= CLM <= 120	Math 1210 Calculus I Math 1310 Engineering Calculus I

*AR = Arithmetic Test. EA = Elementary Algebra Test. CLM = College Level Math Test.

**If a student places into Math 1100, the student should take both Math 1050 and 1060 instead of 1100, since 1050 and 1060 are the prerequisites for Math 1210.

***Permission code required.

Chemical Placement

Placement in CHEM 1210 General Chemistry I requires one of the following: Accuplacer CLM of 75+, Math ACT of 25+, Math SAT of 600+, or AP Calc AB/BC of at least 2.

Technical Electives

Generally, technical electives are advanced courses that will build a stronger technical background for the future engineer. Upper-division courses (3000-level or above) offered in the colleges of Engineering, Mines and Earth Sciences, and Science, that do not duplicate other required courses, are generally appropriate. The following are some pre-approved technical electives:

CH EN 3453, 3553, 3603
CHEM 3000, 3070
GG 3080
MSE 3210, 3310, 3410, 5010, 5035
MATH 5610
MET E 3080, 5210, 5270, 5600, 5290, 5640, 5610, 5660, 5770, 5790, 5800, 5910
MG EN 5020, 5030, 5070, 5080, 5340
WRTG 3400 (recommended as one technical elective)

Other courses may also be acceptable — please contact the departmental advisor for additional courses.

Course Schedules/Registration Information

The current class schedule can be accessed through the web (http://www.utah.edu/students/catalog.php), at the Olpin Union Service Desk (no charge with valid student ID), or by contacting the Scheduling Office (201 S. 1460 E. Room 40, University of Utah, Salt Lake City UT 84112-9056).

Grades and Repeating Courses

Students must receive a grade of C– or better in each of the required courses. Students are allowed to repeat required courses one time only. To repeat more than once, you must submit a petition to the department for the course to count towards your requirements.

Other University Requirements

Please see the Overview of Requirements and the *University of Utah Bulletin* (http://undergradbulletin.utah.edu/) for general requirements.

Transfer Credit

Transfer credit will be granted for a course(s) taken at another accredited institution so long as a grade of C– or better was received and the course content was equivalent to the content of a corresponding required course in the Metallurgical Engineering curriculum. The grade will not transfer. Transfer credits must be approved by the department.

AP Credit

Please refer to the AP Placement Guide, page 12, or contact the department advisor.

CLEP Credit

College credit may also be obtained by passing College Level Entrance Placement (CLEP) tests to fulfill certain general education requirements. Please contact the Academic Advising office for additional information (450 SSB – (801) 581-8146).

Policy for Internship Technical Elective Credit

Students may earn 0.5 to 2 semester hours of technical elective credit for internship-related work experiences in industry or research labs, provided that the following criteria are met:

1) The student must be mentored by a company engineer.
2) The student must be primarily involved in testing/data analysis or process improvement/development activities where the student has the opportunity to practice and develop engineering skills.
3) The company must send in writing: a) verification that the student was involved in appropriate engineering activities; b) confirmation that the student was mentored by an engineer; and c) a general evaluation of the student's performance.
4) The student must register for Special Topics credit during the internship.
5) The student must write and submit a final report of 10 to 30 double-spaced pages, depending upon desired credit, that includes:

   Literature Survey of General Project Topic(s)
   Experimental Information
   Data Presentation and Analysis
   Project(s) Conclusions

   Students need to include some data they have acquired as well as an analysis of their data as it relates to their project. However, students should omit proprietary details. Terms like process A or compound X should be used to protect sensitive company information. The report should not be submitted to the department until the company has had the opportunity to review it.
6) The student may be required to make an oral presentation in addition to writing the report.

The course credit will be determined based upon the duration of the internship and the extent of the report. A final grade will be given based upon the final report and the company evaluation of the student's performance.

Faculty Mentoring Program for Undergraduate Students

The Metallurgical Engineering program offers a mentoring program for undergraduate students with a declared major of metallurgical engineering. Each student will be assigned to a specific faculty member, who will serve as mentor for various academic issues as needed by the student. Some of the functions of this mentor/student relationship include but are not limited to the following.

* Recommendations regarding selection of technical electives
* Advice regarding career and internship options
* Advice regarding extracurricular professional-related activities and attendance at technical society meetings
* Discussion of academic performance difficulties and potential remediation options

The purpose of having an official program is to guide undergraduate students towards the appropriate individuals in the department to provide the best possible assistance. Functions that will continue to be served by the Undergraduate Advisor, Brenda Wicks, include the following.

* Questions about degree requirements
* Obtaining permission codes for courses and requests for exceptions/substitutions
* New student orientation
* Mandatory advising (MAPS) as required during orientation, freshman year, and sophomore year
* Transferring credits
* Verifying enrollment for external entities

There is no requirement that students meet with their faculty mentors. The mentors are assigned to serve as a supplemental resource for the students. Students should initiate any requested meetings by contacting the faculty member via phone, e-mail, or personal contact. Appointments are encouraged, as the faculty are not expected to have open office hours for advising. E-mail contact should be made to either Ms. Wicks or the assigned faculty mentor via your UMail account.

Any student may request a change in their mentor, but such changes will be reviewed by the Department Chair before being approved. A request should be submitted in writing via e-mail or letter to Prof. Manoranjan Misra (mano.misra@utah.edu). The request should include a reason for the requested change, which will be handled confidentially. No faculty other than the Department Chair will be privy to these requests.

Related Professional Societies with Student Membership

Students are encouraged to participate in professional societies as both members and leaders. Professional societies provide valuable opportunities for leadership, service, social interaction, and industrial exposure. Societies with student chapters in the metallurgical engineering area include:

ASM – International
Society for Mining, Metallurgy, and Exploration (SME)
The Minerals, Metals, and Materials Society (TMS)

Please see the Department of Materials Science and Engineering for additional information about membership in these societies.

To earn a bachelor's degree from the University of Utah you must complete the following requirements and meet minimum academic standards.

IMPORTANT NOTE: The minimum grades are noted for each requirement. However, if a course is also required for your major it MUST be taken for a letter grade and a higher grade may be required.

Academic Standards

1. **Total Semester Credit Hours**

   A minimum of 122 semester credit hours is required for a bachelor's degree.

2. **Upper Division Credit Hours**

   At least 40 of the required 122 semester hours must be at the 3000 level or above. (BUS degrees require 56.) Credits from 2-year schools will not count toward upper division hours.

3. **Residency Hours**

   a) A minimum of 30 semester hours must be completed at the University of Utah.

   b) 20 of the last 30 semester hours must be completed at the University of Utah.

   Telecourses, Online courses and courses at satellite campuses count as hours in residence. Independent Study correspondence courses, petitioned courses and exam credits do not.

4. **Minimum 2.0 Cumulative GPA**

   A 2.0 is the minimum GPA to stay in Good Standing at the University of Utah. Some departments may require higher GPAs.

5. **Apply for Graduation**

   At least two semesters before graduation you must file an application to graduate at the Graduation window on the second floor of the Student Services Building.

General Education Requirements

1. **American Institutions (AI) (D- or CR)**

   One course from the approved list

2. **Lower Division Writing (WR2)**

   (C- Must be taken for a letter grade)

   Most students will take the Writing 1010/2010 series to complete this requirement. Students for whom English is their second language take the ESL 1040/1050/1060 series. Honors program students can take HONORS 2211.

3. **Quantitative Reasoning (QA and QB) (D- or CR)**

   (QA) Math 1030 or higher except Math 1040, 1060, or 1070

   (NOTE: A grade of C or higher is required for any necessary prerequisite(s) to the QA requirement.)

   (QB) One course in statistics or logic from the approved list.

   (NOTE: A course in calculus or higher math satisfies both QA and QB.)

4. **Intellectual Exploration (IE) (D- or CR)**

   Take two courses from approved lists in each of the following four areas:

   Fine Arts (FF)

   Humanities (HF)

   Physical, Life and Applied Science (SF) (AS)

   Social and Behavioral Science (BF)

(You are not required to take IE courses in the area of your major. See p. 4 to identify the area of your major.)

Bachelor's Degree Requirements

1. **Upper Division Communication/Writing (CW) (C- or CR)**

   Choose one course from the approved list. Some departments require a specific course. Meet with your departmental advisor before choosing a course.

2. **Diversity (DV) (C- or CR)**

   Choose one course from the approved list.

3. **Upper Division International Requirement (IR) (C- or CR)**

   Choose one course from the approved list or participate in an approved study abroad program (see page 19-IR requirements). Required of all students beginning their enrollment at the U Fall 2007 or after. (Not required of students who took a course at the U prior to Fall 2007 as long as they graduate by summer 2013. Beginning Fall 2013, all students will be required to complete this requirement regardless of their entrance date.)

4. **Bachelor of Science and Bachelor of Social Work Upper Division Quantitative Intensive Requirement (QI) (C- or CR)**

   Choose two upper division courses from the approved list. Some departments require specific courses. Meet with your departmental advisor before choosing courses.

5. **Bachelor of Arts Language Requirement (C- or CR)**

   Fourth semester proficiency in a foreign language or American Sign Language

6. **Bachelor of Fine Arts, Bachelor of Music**

   (Exempt from BA language, BS Quantitive Intensive, and QB Statistics Requirements)

Requirements for a Major

When you enter the University of Utah you are listed as being in premajor status. This is not the same as being declared into a major. To officially declare your major you must meet with the deparmental advisor. A list of departmental advisors can be found on page 5.

1. **Major Coursework**

   See your departmental advisor or run a DARS for a list of requirements for your major.

2. **Other Departmental or College Requirements**

   Some departments have additional requirements for graduation such as passing comprehensive exams. Check with your departmental advisor.

Second Bachelor's Degrees

Students who have completed a bachelor's degree recognized by the University and now wish to earn a second bachelor's degree must fulfill the following requirements:

1. All requirements for the major
2. Residency Hours Requirement
3. American Institutions*
4. Lower Division Writing*
5. Upper Division Communication/Writing*
6. Diversity*
7. International Requirement*
8. Current requirements for BS, BA, BFA, BMus, BUS*

**Not required if completed in the first bachelor's degree*

Associate's Degrees

Associate of Arts (AA) and Associate of Science (AS) degrees automatically clear some General Education requirements depending on which school awarded them.

Schools in the Utah System of Higher Education (USHE) and LDS Business College:

All General Education requirements are cleared with the possible exception of American Institutions (AI), which is checked separately by the Admissions Office.

Private schools in Utah and all out of state schools:

Lower Division Writing and all Intellectual Explorations (IE) requirements are cleared automatically. The Admissions Office checks American Institutions (AI), Quantitative Reasoning (QA and QB).

NOTE: an Associate of Applied Science (AAS) degree will not automatically clear any General Education.

Course Numbering System

Noncredit Courses
0001-0999

Lower Division Courses (Freshman and Sophomore)
1000-2999

Upper Division Courses (Junior and Senior)
3000-5999

Graduate Courses
6000-7990

NOTE: *These courses cannot be taken by undergraduate students without special permission from the department.*

Minimum Grades for General Education and Bachelor's Degree Requirements

American Institutions	D- or CR
Lower Division Writing	C-
Quantitative Reasoning	
QA	D- or CR
QB	D- or CR
Intellectual Explorations (8 courses)	D- or CR
Bachelor's Degree Grade Requirements	
Upper-division Communication/Writing	C- or CR
Diversity	C- or CR
International Requirement	C- or CR
Bachelor of Arts	C- or CR
Bachelor of Science	
Quantitative Intensive I	D- or CR
Quantitative Intensive II	D- or CR

Note: Must get a C- or better in required courses.

UNIVERSITY OF UTAH AP CREDIT AND GENERAL EDUCATION GUIDE

AP EXAMINATION	SEMESTER HOURS AWARDED	SCORE REQUIRED	GENERAL EDUCATION WAIVERS	REMARKS
AMERICAN HISTORY	6	3	American Institutions	Waives American Institutions
ART HISTORY	6	3	1 Humanities IE	
BIOLOGY	6	3	1 Science IE	
CALCULUS AB	6	3*	QA/QB Requirement	Placement by dept
CALCULUS BC	6 8	3-4* 5*	QA/QB Requirement QA/QB Requirement	Placement by dept
CHEMISTRY	6 8	3-4 5	1 Science IE 1 Science IE	Placement by dept
COMPUTER SCIENCE AB COMPUTER SCIENCE A	6 3	3 3	1 Science IE	If a student completes both Comp Sci AB and A, a maximum of 8 hours is awarded.
ECONOMICS - Macro - Micro	3 3	3 3	1 Social Science IE	
ENGLISH - Comp/Reading - Comp/Lit - Language	6 6 6	4** 4** 4**	Writing 2010 Writing 2010 Writing 2010	Waives lower division Writing Requirement
ENVIRONMENTAL SCIENCE	3	3	1 Science IE	
EUROPEAN HISTORY	6	3	1 Humanities IE	
GEOGRAPHY: HUMAN GEOGRAPHY	3	3	1 Social Science IE	
GOVERNMENT & POLITICS				
- American	3	3	1 Social Science IE	
- Comparative	3	3	1 Social Science IE	
LANGUAGES - Chinese Lang & Culture	6 8	3-4 5		Placement by dept
- Chinese Lit	6	3	1 Humanities IE	
- French	6 8	3-4 5		Placement by dept
- French Lit	6	3	1 Humanities IE	
- German	6 8	3-4 5		Placement by dept
- German Lit	6	3	1 Humanities IE	
- Italian Lang & Culture	6 8	3-4 5		Placement by dept
- Japanese Lang & Culture	6 8	3-4 5		Placement by dept
- Latin	6 8	3-4 5		Placement by dept
- Latin Lit	6	3	1 Humanities IE	
- Spanish	6 8	3-4 5		Placement by dept
- Spanish Lit	6	3	1 Humanities IE	
MUSIC - Listening & Lit - Theory	6 6	3 3	1 Fine Art IE 1 Fine Art IE	Placement by dept
PHYSICS B	6	3	1 Science IE	Placement by dept
PHYSICS C: MECH	3	3	1 Science IE	Placement by dept
PHYSICS C: E & M	3	3	1 Science IE	Placement by dept
PSYCHOLOGY	3	3	1 Social Science IE	
STATISTICS	3	3	QB Requirement	Waives Math 1070
STUDIO ART	6	3	1 Fine Art IE	Placement by dept
STUDIO ART 2-D	6	3	1 Fine Art IE	Placement by dept
STUDIO ART 3-D	6	3	1 Fine Art IE	Placement by dept
WORLD HISTORY	6	3	1 Humanities IE	Placement by dept

◆ IE=Intellectual Exploration ◆ QA/QB=Quantitative Reasoning

*A score of 2 on the Calculus AB or Calculus BC will waive the QA Requirement but no credit hours will be awarded.
**Effective Spring 2007 a score of 4 or higher on English Comp/Rdg, Comp/Lit, and Engl Language will be required to waive Writing 2010. A score of 3 will waive Writing 1010.

- When a student has both AP and CLEP credit, AP is counted first and is considered as course work when evaluating General Education requirements. In addition, if college credit has been awarded and duplicates the AP course work, the AP credit will be reduced by the amount of credit previously earned.
- When computing General Education Requirements, the entire area is waived with two Intellectual Exploration courses earned in one General Education area.
- A student must be a matriculated student at the University of Utah to have AP credit recorded. AP scores and General Education waivers are evaluated according to the current policy at the time the request is made for an evaluation.

ADMISSIONS OFFICE 8/31: Effective September 30, 2007 (Spring 2007 for Writing)
Subject to change without notice