

EXPLOSIVES ENGINEERING

The explosives engineering program in the department of mining & explosives engineering offers the master of science (M.S.) and doctor of philosophy (Ph.D.) degrees and a minor and certificate in explosives engineering for students with bachelor's degrees in engineering, science or technology. It also offers an explosives technology certificate and master of science (MS) for those with other bachelor's degrees. Due to the age profile of the explosives industry and attrition of personnel, as well as the rapid change in technology within this field, there is an immediate and growing need for highly trained explosives professionals in both the civilian explosive, mining and civil excavating fields and government and the defense industry. Employers are looking for engineers and scientists with sophisticated skills in the integration of explosives technology into complex systems in a wide range of applications. Employers are also seeking M.S. and Ph.D. graduates because they can move quickly into managerial positions.

Faculty involved in a variety of explosives related research programs teach and direct the program in conjunction with instruction by industry specialists in a wide range of applications. Students will have opportunities to assist the faculty, both in research and teaching, as well as working alongside faculty and graduate students in other engineering and science fields such as civil, architectural, mechanical, chemical, aerospace, electrical, geological, and materials engineering and geology, geophysics, chemistry and physics. The explosives engineering faculty and students are active in the leading professional societies such as the International Society for Explosives Engineers. A security background check is required for all students in the program.

Explosives Engineering

The M.S. program requires a minimum of 30 hours of graduate credit. The program requires students to take four core courses and encourages students to take related courses outside explosives engineering.

Degree Requirements

M.S. with thesis: The M.S. degree with thesis requires the completion of 24 hours of graduate course work and six hours of research (EXP ENG 6099) and the successful completion and defense of a research thesis. Four of the following core courses are required of all M.S. students in explosives engineering:

EXP ENG 5612	Principles of Explosives Engineering
or MIN ENG 5612	Principles of Explosives Engineering
EXP ENG 5622	Blasting Design And Technology
or MIN ENG 5622	Blasting Design And Technology
EXP ENG 5713	Demolition of Buildings and Structures
MIN ENG 4922	Tunneling & Underground Construction Techniques
EXP ENG 6412	Environmental Controls For Blasting
EXP ENG 6312	Scientific Instrumentation For Explosives Testing & Blasting

Students select 12 hours of ExpE and other appropriate elective courses. M.S. in explosives engineering candidates are advised to group out-of-department courses into a module that fits their special interest.

M.S. without thesis (by coursework): The M.S. degree without thesis requires the completion of 30 hours of graduate coursework with the same stipulations as above. The six hours of research is replaced by course work which may include an explosives related cooperative work experience (EXP ENG 6070) or industry project (EXP ENG 6080) with an

established company or government agency commonly using explosives and an additional explosives course.

Explosives Technology Degree Requirements

The M.S. program requires a minimum of 30 hours of graduate credit. A core of four courses is required of all students, and a module of allied courses in departments outside of explosives engineering is encouraged.

M.S. with thesis: The M.S. degree with thesis requires the completion of 24 hours of graduate course work and six hours of research (Exp Eng 6099), and the successful completion and defense of a research thesis. Four of the following core courses are required of all M.S. students in Explosives Technology:

EXP ENG 5612	Principles of Explosives Engineering	3
EXP ENG 5622	Blasting Design And Technology	3
EXP ENG 5711	Explosives in Industry	3
EXP ENG 5713	Demolition of Buildings and Structures	3
EXP ENG 5721	Specialty Uses of Energetic Materials	3
EXP ENG 5914	Explosives Manufacturing	3
EXP ENG 5922	Tunneling & Underground Construction Techniques	3
EXP ENG 6412	Environmental Controls For Blasting	3
EXP ENG 6312	Scientific Instrumentation For Explosives Testing & Blasting	3
EXP ENG 6112	Explosives Regulations	3

Students select 12 hours of Exp Eng and other appropriate elective courses. M.S. in explosives engineering and explosives technology candidates are advised to group out-of-department courses into a module that fits their special interest.

M.S. without thesis (by coursework): The M.S. degree without thesis requires the completion of 30 hours of graduate coursework with the same stipulations as above. The six hours of research is replaced by course work which may include an explosives related cooperative work experience (Exp Eng 6070) or industry project (Exp Eng 6080) with an established company or government agency commonly using explosives and an additional explosives course.

Ph.D. Degree Requirements

The Ph.D. degree requires a minimum of 3 years of full-time study beyond the bachelor's degree, including research work for the dissertation. Minimum requirements for Ph.D. candidates include completing 72 credit hours of graduate credit with at least 24 credit hours of dissertation research (Exp Eng 6099) and a minimum of 24 credit hours of coursework, with at least 15 credit hours of course work completed at Missouri S&T. Students are encouraged to enroll in at least 15 credit hours of 6000-level lecture courses and are required to pass the qualifying, comprehensive and final oral examinations for the Ph.D. research.

Explosives Engineering Certificate

This certificate program is designed to provide formalized education in the area of explosives engineering. Students will be exposed to the theoretical and practical approaches of explosives engineering. Students will learn analysis and design of explosive-related systems and both natural and built structure effects. The explosives engineering certificate program is open to all persons holding a B.S. (in an applied

science, technology or engineering), M.S., or Ph.D. degree and who have a minimum of 12-months of post-B.S. professional employment experience. Once admitted to the program, the student must take four designated courses as given below. In order to receive a graduate certificate, the student must have an average cumulative grade of 3.0 or better in the certificate courses. Students admitted to the certificate program will have non-matriculated status; however, if they complete the four-course sequence with a grade of B or better in each of the courses taken, they will be eligible to apply to the M.S. explosives engineering program upon application. The certificate credits taken by the student admitted to the M.S. program will count toward their master's degrees. Students who do not have all of the prerequisite courses necessary to take the course in the certificate program will be allowed to take "bridge" courses at either the graduate or undergraduate level to prepare for the formal certificate courses. Once admitted to a certificate program, a student will be given three years to complete the program so long as he or she maintains at least a B average in the courses taken.

The following courses are required:

EXP ENG 5612	Principles of Explosives Engineering
EXP ENG 5622	Blasting Design And Technology

Two more explosives designated classes on the approved list maintained by the explosives engineering program faculty.

3 hours of EXP ENG 6099 and EXP ENG 6000 may be substituted at the discretion of the program coordinators.

Other courses approved by the explosives engineering faculty may be substituted for any of the above listed courses on a case-by-case basis.

Explosives Technology Certificate

This certificate program is designed to provide formalized education in the area of explosives. Students will be exposed to the theoretical and practical approaches of explosives technology. Students will learn analysis and design of explosive-related systems and both natural and built structure effects.

The following courses constitute the graduate certificate in explosives technology:

Required-One of the following four courses:

EXP ENG 5612	Principles of Explosives Engineering
EXP ENG 5711	Explosives in Industry
EXP ENG 5721	Specialty Uses of Energetic Materials
EXP ENG 5914	Explosives Manufacturing

Choose any three courses from the list below:

EXP ENG 5112	Explosives Handling and Safety
EXP ENG 5512	Commercial Pyrotechnics Operations
EXP ENG 5513	Stage Pyrotechnics and Special Effects
EXP ENG 5514	Display Fireworks Manufacturing
EXP ENG 5555	Computer Fired Pyrotechnic Show Design and Firing System Operation
EXP ENG 5622	Blasting Design And Technology
EXP ENG 5713	Demolition of Buildings and Structures
MIN ENG 5922	Tunneling & Underground Construction Techniques
EXP ENG 6112	Explosives Regulations

Other courses approved by the explosives engineering faculty may be substituted for any of the above listed courses on a case-by-case basis.

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EXP ENG 5000 Special Problems (IND 1.0-3.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

EXP ENG 5001 Special Topics (LAB 0.0 and LEC 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

EXP ENG 5112 Explosives Handling and Safety (LEC 3.0)
Basic handling & safety for explosives, explosive devices and ordnance related to laboratory handling, testing, manufacturing & storage, for both civil and defense applications. Classroom instruction only. Prerequisite: Junior Standing or above.

EXP ENG 5512 Commercial Pyrotechnics Operations (LAB 1.0 and LEC 2.0)
Provide participants with training preparing for Missouri Licensed Display Operator (Outdoor) License and advanced lead pyrotechnic operator training. Class work will be complemented by practical training in laboratory sessions, culminating in a full pyrotechnic show, from start to finish. Prerequisites: Both Chem 1310 and Chem 1319 or their equivalent; US Citizen or permanent resident, Successful background check, resident enrollment at Missouri S&T.

EXP ENG 5513 Stage Pyrotechnics and Special Effects (LAB 2.0 and LEC 1.0)
Use of energetic materials in close proximity to audiences. Provide participants with training preparing for Missouri Pyrotechnics Display Operators License. Covers: close proximity indoor and outdoor pyrotechnics and special effects. Working with stage crews and talent, safety and permitting. Prerequisites: Both Chem 1310 and Chem 1319 or their equivalent; US Citizen or permanent resident, Successful background check, resident enrollment at Missouri S&T.

EXP ENG 5514 Display Fireworks Manufacturing (LAB 2.0 and LEC 1.0)

Theory and practice of manufacturing display fireworks. Focusing on safety, chemical interaction, color development, basic theory, state and federal law. The lab will include hands on building of ball and canister shells and other pyrotechnic effects. Prerequisites: Chem 1310, Chem 1319, Chem 1100; one of Econ 1100, Econ 1200, Eng Mgt 1210; Successful background check.

EXP ENG 5555 Computer Fired Pyrotechnic Show Design and Firing System Operation (LAB 2.0 and LEC 1.0)

Students will learn to use music editing, electronic firing system operation and Fire One pyrotechnic choreography and simulation software to design their own pyromusical show programs. Creation of a musical sound track, selecting the fireworks and choreographing to the musical score. Create, setup, diagnose and fire a pyrotechnic show. Prerequisites: Exp Eng 5512 or Exp Eng 5513 and successful background check.

EXP ENG 5612 Principles of Explosives Engineering (LAB 1.0 and LEC 2.0)

Theory and application of explosives in the mining industry; explosives, initiating systems, characteristics of explosive reactions and rock breakage, fundamentals of blast design, drilling and blasting, regulatory and safety considerations. Prerequisites: Min Eng 2126; successful background check. (Co-listed with Min Eng 5612).

EXP ENG 5622 Blasting Design And Technology (LAB 1.0 and LEC 2.0)

Advanced theory and application of explosives in excavation; detailed underground blast design; specialized blasting including blast casting, construction and pre-splitting. Introduction to blasting research. Examination of field applications. Prerequisites: Min Eng 5612. Student must be at least 21 years of age. Successful background check. (Co-listed with Min Eng 5622).

EXP ENG 5711 Explosives in Industry (LEC 3.0)

Overview of how explosives are applied in various industrial settings. Focus is placed on the general application, identification, and necessity of explosives in industry. Topics include explosive use in surface and underground mining, road development, construction, utility placement, demolition, oil, gas, and underwater.

EXP ENG 5713 Demolition of Buildings and Structures (LAB 1.0 and LEC 2.0)

Provide participants with basics and solid grounding in the equipment, techniques and processes required for the demolition and remediation of mine plant and processing equipment sites and non-mining structures such as buildings, factories, bridges, etc. Field trip required. Prerequisites: Preceded or accompanied by Civ Eng 2200 or Mech Eng 2340; US citizen or permanent resident; Successful background check.

EXP ENG 5721 Specialty Uses of Energetic Materials (LEC 3.0)

Overview of special, less common uses of energetic materials and how they can be applied as a functional tool. Topics include the use of energetics in aerospace, explosive ordnance, oil field development, welding, pyrotechnics, theatrics, and cinematic special effects.

EXP ENG 5914 Explosives Manufacturing (LEC 3.0)

History of industrial explosives from discovery to what is used today. Manufacturing processes for packaged and bulk explosives are explored along with specialty explosives such as detonating cord, cast boosters, detonators, shaped charges, and commercial fireworks. Field manufacturing of explosives by mixing or gassing is also covered. Prerequisites: Successful background check, consent of instructor.

EXP ENG 5922 Tunneling & Underground Construction Techniques (LAB 1.0 and LEC 2.0)

Mechanical and conventional excavation techniques in underground tunneling and construction. Topics include tunneling layouts design, equipment and performance modeling, ground control systems including support, drainage, and structural integrity. Construction specifications, advance rate and contractual and cost estimation. Prerequisite: Consent of instructor. (Co-listed with Min Eng 5922).

EXP ENG 6000 Special Problems (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

EXP ENG 6001 Special Topics (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

EXP ENG 6050 Continuous Registration (IND 1.0)

Doctoral candidates who have completed all requirements for the degree except the dissertation and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

EXP ENG 6070 Graduate Cooperative Experience (LAB 3.0)

Students on an approved internship will complete a project designed by the advisor and employer. The project selected must require that student apply critical thinking skills and discipline specific knowledge in the work setting. A major report and a formal presentation are required. Prerequisite: 12 hours Exp Eng coursework.

EXP ENG 6080 Industry Project (LAB 3.0)

Students who are currently employed may complete a project in their work setting designed by the advisor and employer. The project selected must require that student apply critical thinking skills and discipline specific knowledge. A major report and a formal presentation are required. Prerequisite: 12 hours Exp Eng coursework.

EXP ENG 6099 Research (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Prerequisites: Consent of instructor required.

EXP ENG 6112 Explosives Regulations (LEC 3.0)

Comprehensive coverage of the federal regulations governing the explosives industry, including those governing storage of explosives (ATF), transportation of explosives (DOT and TSA), the environment (EPA) and use of explosives (OSM, MSHA and OSHA). Prerequisite: Graduate standing.

EXP ENG 6212 Theory Of High Explosives (LEC 3.0)

Study of the application of chemical thermodynamics and the hydrodynamic theory to determine the properties of high explosives; application of detonation theory to steady-state detonations in real explosives; application of the above to the blasting action of explosives. Prerequisite: Graduate Standing; Math 1215, Chemistry 1310, Physics 1135, and either Exp Eng 5112 or Exp Eng 5612. (Co-listed with Min Eng 6632).

EXP ENG 6292 Research Methods (LEC 3.0)

Foundations, dimensions, and methods for designing and investigating research problems. Focus on fundamentals and applied research, research methods, literature review, experimental design and experimentation, dissertation composition, concepts of originality and intellectual property. Prerequisites: PhD students only. (Co-listed with Min Eng 6992).

EXP ENG 6312 Scientific Instrumentation For Explosives Testing & Blasting (LAB 2.0 and LEC 1.0)

Application of scientific principles, equipment description and operation for instrumentation of explosive events including blasting and high explosives. Topics: Set up and use of high-speed photography, motion detection and measurement, explosives properties testing, vibration measurement & analysis. Prerequisite: Exp Eng 5612 and Successful background check. Consent of instructor.

EXP ENG 6412 Environmental Controls For Blasting (LAB 1.0 and LEC 2.0)

Advanced blast mechanics; overbreak control including comprehensive coverage of perimeter and smoothwall specialist blasting techniques and geotechnical factors affecting blast vibration, limits analysis monitoring and control; air blast control including limits, monitoring and atmospheric and topographic effects. Prerequisites: Min Eng 5612, Successful background check. (Co-listed with Min Eng 6622).

EXP ENG 6464 Advanced Blast Vibration Analysis and Prediction (LEC 3.0)

Advanced Blast Vibration prediction methodologies. Includes typical methods including scaled distance, linear regression, signature hole analysis, and modern improved signature hole analysis. Structural response and damage criteria for blast vibrations including considerations for frequency spectra and amplitude. Prerequisite: Exp Eng 5612.

EXP ENG 6767 Special Explosive Applications (LAB 1.0 and LEC 2.0)

Advanced theory and special application of explosives other than for rock excavation. Students will be introduced to different industrial, military and government special uses such as avalanche control, explosive welding, forming, synthesis and hardening, aerospace, forest service, agriculture and oil industry applications. Prerequisites: Exp Eng 5612 or equivalent.
