**Earth Science and Engineering Ph.D.**

**Handbook**

**Fall 2023**

**(work in progress)**

* **General info**

***In brief:***

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| --- | --- | --- |
|  | **Minimun:** |  |
| Coursework | **24** credits | Must include:  - 15 Credits must be at 500 level,  - 9 credits must be Science\*  - 9 credits must be Engineering\*  \* Refer to the table below for the approved classification |
| Seminar Courses | **2** credits | ESE Seminar 1 (1 credit) should be taken during semester 1  ESE Seminar 2 (1 credit) should be taken during semester 3 |
| Dissertation | **34** credits | Can be:   * Introduction, 3-4 chapters, Conclusion * 3 publishable papers linked together with an Introduction and a Conclusion |
| **TOTAL** | **60 credits** |  |

Transferable: a student entering with a Master’s can transfer up to 24 applicable course credits to apply to the 60 credit total

Timeline in brief:

**\*\*\*\*The dissertation defense must be conducted no later than ten (10) years after matriculation into the doctoral program.\*\*\*\*\***

|  |  |  |
| --- | --- | --- |
| * Qualifying exam | Year 1-2 | Research proposal unrelated to your study + general earth science and engineering knowledge evaluation |
| * Candidacy exam | End of Year 2 | Your dissertation research proposal |
| * Defense | At completion | Your research |

Advisor change (see Montana Tech Advisor change policy)

**Engineering and Earth Science Content Courses**

**Note: All courses listed are already being taught at Montana Tech. If you want to take a course that is not listed below, ask the instructor if it would be described as Engineering or Science, and cc the ESE Faculty Director, Alysia Cox, to approve it.**

|  |  |
| --- | --- |
| **Engineering Content**  GeoE 403 Structural Geol. for Engineers  GeoE 420 Hydrogeology for Engineers  GeoE 422 Groundwater Flow Modeling  GeoE 440 Engineering Geology  GeoE 541 Advanced Engineering Geology  GeoE 542 Slope Stability Analysis & Design  EENV 460W Energy & Sustainability  EENV 445 Hazardous Waste Treatment  EENV 430 Soil & Subsurface Remediation  EENV 421 Risk Analysis  EENV 402 Surface Water Hydrology  EENV 403 Water & Wastewater Treatment  EENV 504 Surface Water Quality  EENV 587 EnvE Laws & Regulations  EENV 514 Land & Stream Restoration  EMET 401 Hydrometallurgy & Aqueous Processes  EMET 402 Hydrometallurgy & Thermal Processing  EMET 405 Extractive Metallurgy Lab  EMET 525 Computer Application for Process Engineers  EMAT 471 Materials Characterization & Analysis  EMAT 523 Advanced Thermodynamics  EMAT 530 Energy Issues Analysis  EMAT 571 SEM/EDX  EMET 534 Flotation  EMET 541 Flowsheet Development & Design  EMET 501 Advanced Extractive Metallurgy I  EMET 502 Advanced Extractive Metallurgy II  EMET 504 Fire Assay  EMET 511 Materials Handling Design  EMET 531 Hazardous and Toxic Species Remediation  EMET 555 Advanced Flotation  EMET 582 Processing of Energy Resources  EMET 583 Processing of Precious Metals  EMET 595 Special Topics: Advanced Processing  MIN 544 Environmental Management and Design of Mines  MIN 467 Geomechanics (with lab)  MIN 5200 Numerical Modeling in Finite Element Method in Geomechanics  MIN 418 Ore Reserve Estimation (with lab)  MIN 560 Mine Management 11  MIN 572 Mine Design – Coal  MIN 5090 Geomechanics II  MIN 5100 Advanced Engineering Economic Analysis  MIN 5120 Simulation of Engineering Systems  MIN 5180 Advanced Geostatistics  MIN 5300 Aggregate Mine Design  MIN 5500 GPS Surveying  MIN 5610 Design & Construction of Dump Sites  MIN 5750 Tunneling & Underground Construction  PET 404 Reservoir Engineering  PET 526 Adv. Reservoir Characterization  PET 595 Reservoir Geomechanics  PET 452 Natural Gas Engineering | **Earth Sciences Content**  GeoE 406 Geomorph/Photogeology  GeoE 409 Field Geology/Geophysics  GeoE 501 Montana Geology  GeoE 410 Mining Geology  GeoE 411 Metallic Ore Deposits  GeoE 429 Field Hydrogeology  GeoE 520 Advanced Hydrogeology  GeoE 528 Contaminant Transport  GeoE 411 Metallic Ore Deposits  GeoE 521 Acid Rock Drainage  GeoE 533 Hydrogeochemistry  GeoE 534 Isotope Geochemistry  GeoE 585 GIS in Natural Resources  CHMY 540 Environmental Chemistry  CHMY 542 Environmental Organic Chemistry  CHMY 591 Geochemical Modeling  CHMY 501 Advanced Inorganic Chemistry  CHMY 590 Biogeochemistry  GEOP 508 Seismic Prospecting  GEOP 450 Inversion – Exp. Design & Interpret.  GEOP 5XX Engineering Computing  GEOP 509 Problems in Gravity & Magnetic Prospecting  GEOP 510 Problems in Electrical Prospecting  GEOP 401 Intro. to Seismic Processing  GEOP 510 Problems in Electrical Prospecting  GEOP 446 Applied Linear Systems  GEOP 5xx Remote Sensing  GEOP 5xx Petrophysics  GEOP 5xx Seismic Data Interpretation  BIO 5xx Restoration I: Theory & Practice  BIO 531 Restoration II: Applications  BIO 595W Restoration Field Practicum  BIO 5XX Restoration Capstone |

**SCHEDULE**

**Year 1**

* Select a field of study and an advisor
* Complete the Research Ethics Training (Semester 1)
* Select a committee

        • fill in the Graduate Committee Appointment form and return to Alysia. Ideally, meet with your committee every 6 months to update them on progress and receive support.

* Fill in Graduate Student Program Planning Form

You can use this form for the classes you need to transfer from your master.

        • confirm your committee’s approval of your planned coursework

        • once approved, return to Alysia

* Work on taking classes – ask Jesse Taylor or your advisor to register you for classes
* You can start registering for research credits using the “Pre-exam dissertation” credits

**Year 2**

* Finish taking your courses
* Prepare for your Qualifying Exam before you start/get too far into your research

        • Confirm that your independent proposal topic is different from your dissertation research with your committee

        • Present your proposal to your committee

        • Print the Qualifying exam form (result + signed by advisor), return to Alysia

* Prepare your Candidacy Exam

        • prepare a dissertation research proposal including research that has been started

        • present proposal to committee

        • print the Candidacy exam form (result + signed by committee), return to Alysia

**Year 3**

* Finish your Qualifying and Candidacy Exams if you have not already
* Research

Register for “Dissertation Credits” once both exams are done

* + Dissertation- Introduction, 3 -4 chapters, Conclusion
  + 3 publishable papers (compiled with an intro and conclusion added)

**Year 4**

* Research

Register for “Dissertation Credits” once both exams are done

* + Dissertation- Introduction, 3 -4 chapters, Conclusion
  + 3 publishable papers (compiled with an intro and conclusion added)

**Year 5**

        • Defense

See guidelines from the Graduate Handbook page 17

* + 15 days prior to defense, notify Committee (vote to allow defense)
  + notify the graduate school program manager of the date, time, location, and title of the defense. The graduate school will advertise the defense presentation/exam.
  + Register to 1 credit of research minimum
  + To pass: no more than 2 committee member voting no

**Advice from Previous Students**

1. Immediately create a master PowerPoint in which you’ll create and update ALL your figures. You’ll be able to keep the latest updates in the same place and copy and paste as figure the ones you need in your diverse files (presentations, word documents…). This will avoid updating figures as you go in different files and forgetting which one has the latest update.
2. Use Grammarly – it has a free version, which is absolutely worth it – but even the paid version is worth the money when you write constantly. Your advisor will thank you! Make sure to download the application to use directly in word, powerpoint, your emails…
3. Download Mendeley Reference Manager (and install Mendeley Cite for Microsoft Word) or other reference manager software. Update regularly.

***Program Details:***

Students will be required to earn at least 60 credits beyond the bachelor’s degree. The curriculum requires a minimum of 26 credits of course work (2 credits of Earth Science and Engineering seminar + eight 3 credit courses). At least five of the courses (15 credits) must be at the 500 level, and no credits can be accepted below the 400 level. Students entering with a master’s degree would be allowed to petition to transfer up to 24 applicable course credits (no research credits and no seminar credits) toward the PhD, subject to approval by the faculty. Within the curriculum at least three courses (9 credits) must feature engineering content and skills and at least three courses (9 credits) must feature science content and skills. All PhD students must take a 1-credit Earth Science and Engineering seminar during their first semester, at which participating faculty introduce and present their research. ESE-PhD students can also take Montana Tech’s graduate writing seminar. Current 400- and 500-level courses applicable to the ESE-Ph.D. are listed in Table A-1. Students will complete and defend orally a dissertation presenting the results of significant and original research that advances knowledge in earth science and engineering. The minimum enrollment in dissertation is 18 credits. Students may take additional courses or additional research credits beyond the minimum amount required.

The program will have three key examinations to evaluate student progress and successful completion of the PhD program: the Qualifying Exam, the Candidacy Exam and the final Dissertation Defense. The Qualifying and Candidacy Exams can happen in the first two years. The Qualifying Exam tests the student’s ability to be an independent thinker and scholar, as well as demonstrate knowledge breadth and depth in earth science and engineering. The student will write an independent research proposal unrelated to their dissertation research topic and present and defend it to their dissertation committee. During the oral defense, the student will be questioned on their proposal as well as breadth of knowledge in earth science and engineering. The Candidacy Exam is a dissertation proposal defense by the qualified student to the dissertation committee. This oral defense is designed to help the student have a plan to execute successful and original research. The final examination is the dissertation defense, comprised of a written dissertation presenting original and significant research with an oral defense.

Admissions Criteria comply with Montana Tech’s graduate admissions criteria. Briefly, students must have an earned bachelor’s degree from a regionally accredited institution of higher education (or a recognized international equivalent) with a cumulative undergraduate GPA of at least 3.0 on a 4.0 scale. They must take and submit scores for the GRE General Test, provide three letters of recommendation, transcripts from all universities attend, and a statement of purpose for pursuing the degree. GRE scores will be considered holistically in combination with the other materials. Students educated outside the United States must in addition provide the materials (such as officially evaluated transcripts and English Proficiency Scores from IELTS (score of at least 7.0) or TOEFL (score of at least 84).

Admitted students are assigned an initial advisor in the admissions offer. Not later than the third semester, they will form a graduate committee, with at least five members. The Graduate Committee collaborates with the student to design, manage, and oversee the student’s curriculum and progression through the program. The committee chair would be their research advisor. Two other committee members will be faculty affiliated with the ESE-Ph.D. program. At least one of the three program faculty on the committee will be an engineer, and at least one member will be a scientist. The fourth member of the committee is the “Graduate School Representative,” a faculty member NOT involved with the ESE-PhD. The fifth member is an expert in the area of the student’s research interests, who is NOT a faculty member at Montana Tech. Each member of the Graduate Committee must have a Ph.D. and at least four members of the Committee, including the external member, must be on the student’s dissertation committee. The dissertation committee will be expected to meet once every six months to help the student maintain progress.

The program will have an external advisory board that will meet to evaluate the program and provide recommendations.