Civil and Environmental Engineering

Ph.D. Program

Handbook

2021-2022 Academic Year

Note: This handbook provides detailed explanations about processes and policies established by the Civil and Environmental Engineering Graduate Faculty, should be used in conjunction with the SDSM&T Catalog.

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General information concerning the Graduate School and the Civil and Environmental Engineering (CEE) PhD program are presented in the South Dakota School of Mines and Technology Catalog. Detailed listings of graduate courses, as well as additional information concerning program and university graduate degree requirements are also presented in the catalog. All graduate students should familiarize themselves with this information.

The following guide relates to specific requirements of the CEE PhD program and is intended to supplement catalog information. CEE PhD students are responsible for understanding its contents.

I. Admission

All SDSM&T Graduate College admissions requirements apply to the Civil and Environmental Engineering (CEE) PhD program. In addition, a GPA of 3.00 or better is required of all applicants for the CEE PhD program, as is the Graduate Record Examination (GRE), except for South Dakota School of Mines and Technology (SDSM&T) graduates or those with an engineering BS from an ABET accredited institution. Prospective students who do not have English as their first and primary language will need a language proficiency exam (see the SDSM&T graduate website for additional details). Incoming students should have completed the courses presented in Table 1. Deficiencies in these areas must be remedied by taking the necessary coursework **prior to** enrollment in the doctoral program.

Table 1: Required Background Courses for All Students

Equivalent SDSM&T Course	Course Content
Math 123	Calculus I
Math 125	Calculus II
Math 225	Calculus III
Math 321	Differential Equations
Math 381	Probability and Statistics
Physics 211	University Physics I (calculus-based)
Chem 112/L	General Chemistry I and Lab
Chem 114	General Chemistry II

All CEE doctoral students are also expected to have completed the appropriate technical background and design courses for their intended research emphasis area (Tables 2 and 3). Transfer credits from other institutions may be evaluated by the student's graduate committee for equivalency with Tables 2 and 3. Additional subjects may be required by the student's graduate committee. These requirements will be documented as a formal component of the student's program of study.

For students with backgrounds other than Civil Engineering who do not wish to take Table 3 courses due to specifics of their research area, an SDSM&T campus inter-disciplinary PhD degree may be more appropriate for that student. Alternatively, if the PhD graduate committee agrees that the specific research area of the student differs significantly from the topics presented in Table 3, two of Table 3 courses may be substituted with more appropriate 500 level technical **design courses** as indicated by the committee. Design courses are engineering courses that have a significant design component.

Tables 2 and 3 do not show the areas of sustainability or construction management. Students pursuing dissertations in the areas of sustainability or construction management would identify the fields of study in Tables 2 and 3 that align best with their research topic and use that most closely aligned field of study to guide their selection of Table 2 and 3 courses.

Table 2: Required Background Courses by Emphasis Area

Equivalent SDSMT Course		Environmental	Water Resources	Geotechnical	Materials/ Structures
ME 221	Dynamics			X	X
EM 321	Mechanics of Materials			X	X
EM 331	Fluid Mechanics	X	X	X	
CEE 316	Engineering Materials			X	X
CEE 326	Environmental Engineering I	X			
CEE 327	Environmental Engineering II	X			
CEE 336	Hydraulic System Design		X		
CEE 337	Engineering Hydrology		X		
CEE 346	Geotechnical Engineering I	X	X	X	X
CEE 347	Geotechnical Engineering II			X	
CEE 353	Theory of Structures				X
CEE 456	Concrete Theory				X

Table 3: Required Technical Design Courses by Emphasis Area

Equivalent SDSMT Course	Environ-mental[1]	Water Resources[1]	Geotech.	Civil Engr. Materials	Structures[1]
CEE 525	X	X		X	
CEE 526	X				
CEE 527	X				
CEE 528	X				
CEE 529	X				
CEE/CBE 555	X				
CEE 533		X			
CEE 537		X			
CEE 547			X		X
CEE 548			X		
CEE 551					X
CEE 553					X
CEE 557					X
CEE 575		X	X		
CEE/AES 524		X			
CEE 652				X	X
CEE 655				X	X

[1] *3 of these courses required.*

II. Advising

The Civil and Environmental Engineering PhD program director serves as a temporary faculty advisor to each new graduate student until the student selects a major professor to supervise his/her graduate research. The program director will assist all new graduate students with course registration and provides information pertinent to the CEE PhD program. CEE faculty's research interests are described on the CEE web page.

III. Financial Assistance

Financial assistance is available to graduate students through a number of avenues, including graduate fellowships, graduate teaching assistantships (GTA), and graduate research assistantships (GRA). The CEE graduate committee will assign department GTA and GRA positions before May 10th each year for the following fall semester. Most doctoral students will be funded as GRAs on research projects led by CEE faculty members, awarded at the discretion of those individual faculty members. Policies regarding assistantships are discussed in detail on the SDSMT Graduate Education webpage.

IV. Program of Study

The program of study consists of the appointment of a graduate advisory committee, and a plan for coursework leading to the doctoral degree. The program of study form is due to the Office of Graduate Education at the end of the first semester of study. If the program of study is revised, a new form must be submitted with all approval signatures. The program of study form and additional instructions are available at the SDSMT graduate education website. If the Program of Study is not submitted to the graduate office prior to the first semester of study deadline, students may be required to take additional courses if the initial course selection was incorrect or sub-optimal for their path to graduation. Thus, it is essential for advisors and students to meet as soon as possible to set up the program of study and consult with the PhD program coordinator to ensure an optimal path to graduation has been set.

V. Curriculum

The curriculum consists of a minimum of 72 credits for students entering with a BS degree (Table 4) and a minimum of 42 credits for those students entering with an MS degree (Table 5). The student's graduate advisory committee will assess the student's academic transcripts and approve a combination of required (Tables 3 and 6) and elective coursework (Tables 7-10) and dissertation credits that meets all degree requirements. For qualified students entering the program after a BS degree, a minimum of 42 credit hours of coursework post-BS will be required. Students participating in an accelerated MS degree program who decide to switch to the PhD program should consult with the Department Chair for guidance on minimum required coursework credit hours, but in no case will any student be allowed to have less than 72 hours after their B.S. degree without an M.S.

For students pursuing research in the areas of sustainability, or construction management, there are no prescribed electives tables as with the other fields of study within CEE. For students pursuing research in sustainability or construction management, students choose the electives table (Tables 7 to 10) that most closely aligns with their research topic.

Table 4. Summary of the CEE PhD Degree Curriculum – No MS or ME

Degree Requirements for Students Entering with a Bachelor's Degree	Credit Hours
Required courses (Table 6), all students	8-9
Dissertation	21-34
Required (Table 3), Recommended[1] and other elective courses (Appendix B)	30-42
Graduate course credits at 600-level or higher	At least 15
CEE elective course credits	At least 18
Total required for the degree	**72**

[1]Elective courses will vary depending on the student's sub-discipline and research focus.

Table 5. Summary of the CEE PhD Degree Curriculum – With MS or ME

Degree Requirements for Students Entering with a Master's Degree	Credit Hours
Required courses (Table 6), all students[1]	8-9
Dissertation	15-22
Required (Table 3)[1], Recommended[2] and other elective courses (Appendix B)	12-18
Graduate course credits at 600-level or higher after BS	At least 15
CEE elective course credits after BS	At least 18
Total required for the degree[4]	**42**

[1]Required and/or elective courses completed during MS degree may be replaced by other electives.
[2]Elective courses will vary depending on the student's sub-discipline and research focus.

Table 6. Required Courses, All Students

Prefix & Number	Course Title	Credit Hours
Math 547[1,3]	Design of Experiments	2 to 3
CBE 588[1,3]	Applied Design of Experiments for the Chemical Industry	2 to 3
CEE790[2]	Seminar (1 credit hour per academic year)	3
CEE/AES/GEOE 808[3]	Fundamental Problems in Engr and Science	3

[1] One of these two courses required
[2] This requirement will be terminated for the 2022 Academic Year (AY) and the class will no longer be offered. This requirement as stated herein applies to the 2021 AY, and prior. Students in AY 2021 are expected to still enroll and complete the seminar course(s) for the 2021 AY. Students who need 1 or 2 more seminar credits after the 2021 AY who entered the program in the 2021 AY or prior may take seminars in other departments such as Atmospheric Science or Chemical Engineering to accrue the missing credits or may replace those missing credits with CEE 608 or CEE 610.
[3]If Course is not taught in the first 3 semester of the PhD program, the program of study will document an alternative course as substitute, through preference is given to similar course available through MATH, CBE, EE, or Physics.

Table 7. Recommended Electives - Environmental/Water Resources

Prefix & Number	Course Title	Credit Hours
GEO 521	Aqueous Chemistry	3
GEOE 663	Groundwater Geochemistry	3
CEE 615	Earth and Systems Modeling	3
CEE 634	Surface Water Hydrology	3
CEE 627	Advanced Wastewater Treatment	3
CEE 692	Aqueous Chemistry	3
CEE 692	Advanced Drinking Water	3
CEE 692	Renewable Energy	3
CEE 730	Statistical Methods in Water Resources	3
CEE 734	Vadose Zone Flow and Solute Transport	3
CEE 735	Sediment Transport	3
CEE 739	Tech of Surface Water Res. / Water Qual.	3
CEE 792	Life Cycle Assessment	3
CEE 792	ENVE Topic (Bioelectrical Treatment or Solid Waste)	3
CEE 792	Water Law and Policy	3
CEE 735	Sediment Transport	3

Table 8. Recommended Electives – Structures

Prefix & Number	Course Title	Credit Hours
CEE 641	Earthquake Engineering	3
CEE 651	Advanced Steel Design	3
CEE 655	Mechanics of Composite Materials	3
CEE 657	Advanced Structural Analysis	3
EM 680	Advanced Strength of Materials	3
ME 736	Advanced Finite Element Analysis	3
CEE 745	Advanced Foundations	3
CEE 792	Life Cycle Assessment	3

Table 9. Recommended Electives – Civil Engineering Materials

Prefix & Number	Course Title	Credit Hours
CEE 568	Highway Engineering	3
CEE 655	Mechanics of Composite Materials	3
CBE 589	Composites Manufacturing	3
EM 680	Advanced Strength of Materials	3
ME 736	Advanced Finite Element Analysis	3
CEE 743	Advanced Soil Mechanics	3
CEE 745	Advanced Foundations	3
CEE 746	Stability of Soil and Rock Slopes	3
CEE 757	Advanced Concrete Materials	3
CEE 792	Life Cycle Assessment	3

Table 10. Recommended Electives – Geotechnical

Prefix & Number	Course Title	Credit Hours
CEE 568	Highway Engineering	3
CEE 641	Earthquake Engineering	3
CEE 642	Ground Improvement	3
CEE 651	Advanced Steel Design	3
CEE 653	Reinforced Concrete Design	3
CEE 743	Advanced Soil Mechanics	3
CEE 745	Advanced Foundations	3
CEE 746	Stability of Soil and Rock Slopes	3
CEE 747	Earth and Earth Retaining Structures	3
GEOE 622	Analytical Methods in Groundwater	3
GEOE 768	Engineering Geology of Surficial Deposits	3
ME 736	Advanced Finite Element Analysis	3

A list of other cross-campus and interdisciplinary technical elective courses is provided in Appendix B. Courses shared between SDSM&T and SDSU via distance methods are identified as such.

VI. Selection of Research Topic

Within the first two months of graduate studies, all new students already not working on a research project should make appointments with graduate faculty involved in the CEE PhD program to discuss possible research topics. Each student will be matched with a major professor in accordance with his/her interests. At this time, the major professor becomes the student's advisor on all matters to guiding the student's academic and research progress.

VII. Master's Degree

The CEE PhD program is designed with the understanding that the PhD is the terminal degree for completion of the program. However, in cases in which a student has completed the requirements for the MS CEE degree but cannot complete the research and dissertation portion of the CEE PhD program, a terminal MS degree may be conferred.

VIII. GPA Requirements

Advanced degree and grade requirements are presented in detail in the catalog (http://ecatalog.sdsmt.edu). PhD students must obtain an average grade of "B" or better in the overall course of study and a "C" or better in any graduate level courses taken to fulfill graduate requirements. Once the student has selected a research topic, he/she will be expected to register for CEE 898 (doctoral research) for a number of credit hours agreed to by his/her major professor. CEE PhD students will be required to register for three times during his/her course of study for the 1-credit hour CEE 790 class. He/she is expected to regularly attend and participate in the seminar series throughout his/her doctoral studies. Students will be required to present their research to date during the CEE seminar series each year.

IX. Qualifying and Comprehensive Examinations

In addition to the degree requirements described above, successful completion of the CEE PhD includes satisfactory completion of a qualifying examination; and a comprehensive examination and admission to candidacy, at least two consecutive semesters of residence as a full-time student, and a dissertation

that conforms to standard American-English style and usage.

The Qualifying Examination

All CEE Ph.D. students must pass a qualifying examination, normally to be taken ***within the first two semesters* of enrollment**, or the semester after all background courses (Tables 2 and 3) have been completed. The qualifying exam must be completed at least one semester prior to the comprehensive exam. *The "Qualifying Exam" is a coursework-based exam to test and demonstrate the doctoral student's proficiency in the foundational material of his or her discipline.* A master's student who proposes to continue into a doctoral program should so advise his or her major professor in a timely manner. Thereupon, the student will be given an examination by the graduate student advisory committee to determine whether to permit the student to proceed to the doctoral level of graduate study. This qualifying examination may be scheduled in the semester during which it is expected that 30 hours of credit beyond the B.S. degree, (which are deemed acceptable toward the student's doctoral program) have accumulated. The examination for the master's degree may be used as the forum for the qualifying examination, at the discretion of the department/program. *Results of this Qualifying Exam must be filed with the Office of Graduate Education within a week of completion of the exam.*

To pass the qualifying exam, the student must 1) complete all undergraduate background deficiency requirements, 2) submit a valid PhD Program of Study to the CEE PhD program coordinator and the Graduate Office; 3) take a written open-book exam period with questions from each CEE department PhD advisory committee member based on the foundational material of his/her discipline; 4) present their written exam solutions to the student's advisory committee members for evaluation; 5) receive a failing evaluation from no more than one committee member on the written portion; 6) complete an oral exam with the committee based in part on responses from the written portion; and 7) receive a failing evaluation from no more than one committee member on the oral portion. Questions for the written portion of the exam may also be developed from qualified instructors of the foundational courses taken outside of the student's advisory committee. The oral exam must be within 2 weeks of completion of the written portion. If the student did not pass the written portion of the exam, no oral exam is scheduled. If the qualifying exam is not passed, it may be retaken the next semester. Only two attempts at the qualifying exam may be made. If the second attempt at the qualifying exam is failed, the student will not be retained in the PhD program. If the student does not pass the qualifying exam on first attempt, the student should take action to reinforce foundational materials so that the student is better prepared for the second attempt. These actions may include self-study, retaking a course, or auditing a course.

The written portion of the qualifying exam is an open book exam, 2 to 6 hours in duration. The oral exam is closed book, 1 to 3 hours in duration. The written exam material is foundational in nature at the discretion of the committee members and includes topics from Table 2 and three to five of the courses in Table 3. Additional topics of foundational material are presented below. The PhD advisor coordinates and proctors the written exam. The oral exam also focusses on core foundational topics to the student's discipline and research.

The following are typical foundational topics required for the Qualifying Exam, broken down by emphasis area according to the courses listed in Tables 2 and 3. Additional topics **may be** added by the committee or graduate advisor depending on the student's research or background.

- Structures
    - Design of structures, structural analysis, and engineering mechanics
- Materials

    - Concrete materials, asphalt materials, aggregates, steel and other metals, and engineering mechanics
- Water Resources
    - Fluid mechanics, hydraulics, hydrology, open channel flow, and watershed/floodplain modeling
- Environmental
    - Environmental Chemistry, water treatment, wastewater treatment, pollution, biological processes, geo-microbial systems, subsurface transport processes, and lifecycle cost analysis
- Geotechnical
    - Foundation analysis and design, slope stability, geotechnical explorations, soil shear strength, and seepage under dams.

The Comprehensive Examination and Admission to Ph.D. Candidacy

When the student's program of coursework has been substantially completed, she or he will undertake the comprehensive examination for admission to candidacy. This must be at least the following semester after the qualifying exam. The two exams cannot happen in the same semester. *The "Comprehensive Exam" is a wide-ranging exam to test and demonstrate the doctoral student's readiness to pursue doctoral research. It centers on the defense of their written dissertation proposal but may also include additional written or verbal exam components to demonstrate the student's proficiency in his or her field of study based partially on the student's coursework as a PhD student, at the discretion of the committee.* Any written comprehensive exam questions will be prepared by the graduate student advisory committee. The graduate student advisory committee schedules and arranges the written (if any) and oral portions of the examination. Review of the dissertation proposal and examinations will be accomplished as soon as possible by all members of the committee. The review of the dissertation proposal, written (if any) and oral examination portions should all take place within a two-week period. If the graduate student advisory committee and department head/program coordinator approve the application by certifying that the candidate has passed the comprehensive examination, the signed admission to candidacy form must be submitted to the dean of graduate education who, in turn, will admit the student to candidacy.

Satisfactory completion of the comprehensive examination requires that no more than one member of the graduate student advisory committee votes against passing. *Upon satisfactory completion of the comprehensive exam, the student is then eligible for admission to candidacy.* If the student passes with conditions, such as failure to pass a part of the examination, the committee shall inform the student promptly as to how and when the conditions may be removed. If, in the opinion of 2 or more members of the graduate student advisory committee, the student has failed the comprehensive examination, another such examination may not be attempted during the same semester. After failure to pass a second time, work toward the doctorate can be continued only with the consent of the graduate student advisory committee, the Council of Graduate Education, and the dean of graduate education. **The comprehensive examination, and subsequent admission to candidacy, should be completed *18-24* months before the dissertation is defended**. In no case can dissertation defense be held less than 11 ½ months after the completion of the comprehensive exam. This is to encourage both students and advisors to promptly complete both the qualifying and comprehensive exams. *Results of this Comprehensive Exam and admission to candidacy must be filed with the Office of Graduate Education within a week of completion of the exam.*

The written proposal should be no longer than 15 double-spaced, typewritten pages of text, not including references, figures, and appendices. Students should follow the general guidelines for the PhD

dissertation proposal presented in Appendix C. If the student has not previously taken CEE 808 at SDSM&T, he/she is encouraged to do so to assist him/her in completion of this task. This written document must be reviewed by the student's major professor prior to submission to the full committee. The full committee should receive the proposal two weeks in advance of the oral presentation in the comprehensive exam. The oral presentation by the student of his/her dissertation research proposal in the comprehensive exam should reflect the contents of the written proposal and should last no longer than 30 minutes, without interruptions. The majority of the presentation should be a detailed description of the student's proposed research program; background information should not exceed 20% of the allotted time. The originality and potential significance of the proposed research should be emphasized. Following the oral presentation, the student will be expected to respond to questions from the audience and attending faculty, after which the public will be dismissed, and the student and his/her advisory committee will continue a private meeting to discuss any needed changes to the proposal.

X. Dissertation

Dissertation Submission Requirements

The dissertation is expected to advance or modify knowledge and demonstrate the candidate's technical mastery of the field of study. The research results are expected to be of publishable quality. The student's major advisor can specifically require submission and/or publication of three or more peer-reviewed journal articles. For this case, in lieu of the conventional dissertation format, the dissertation can consist of a compilation of published and/or submitted journal manuscripts that are derived from the candidate's doctoral research and are either authored or co-authored by the candidate. Dissertations submitted in this form must have an introduction and conclusion to tie the journal papers into a cohesive manuscript. The final dissertation must be accompanied by an abstract of 250-350 words and the candidate's vitae.

The dissertation is written under the direction of the major professor, but the student should seek guidance from all members of the graduate student advisory committee. Before starting to write the dissertation, the student is urged to review the thesis and dissertation guidance documents available on the Graduate Education webpage: http://www.sdsmt.edu/Academics/Graduate-Education/Current-Graduate-Students/. In addition, the CEE department highly recommends *Enjoy Writing Your Science Thesis or Dissertation*, by D. Holtom, Imperial College Press (2000).

After successful defense of the dissertation (details provided below), the Graduate Dean requires that the graduate student's committee-approved draft of the dissertation be submitted to the Office of Graduate Education by the published deadline (approximately 2 weeks before graduation) to allow adequate time for grammatical review, corrections and revisions. This draft of the dissertation, after all revisions recommended by the committee have been made, must be signed by the author and approved, signed and dated by all committee members, and the department head/program director of the student's major department/program. The final unbound manuscript must then be reviewed and signed by the Dean of Graduate Education before any copies are made of any submissions for binding are done.

Dissertation Defense Requirements

The dissertation defense will be scheduled after 1) the student has completed the required coursework, 2) at least 11 months have passed since the comprehensive exam, and 3) after the graduate student advisory committee is satisfied that the dissertation is an acceptable manuscript, in terms of both technical quality and proper expression. A schedule of exam and defense deadlines is provided on the Graduate Education web page.

A final draft of the dissertation should be submitted by the student to each member of the graduate student advisory committee a minimum of 2 full weeks before the time and date of the student's scheduled defense. The dissertation defense may not be scheduled during the period of university final examinations. The student will be required to give an oral presentation (30-40 minutes), open to the public, on the major findings of his/her research. An oral examination will follow the presentation, led by the student's major professor with only the student's advisory committee in attendance. The student's advisory committee will question the student to test the quality and completeness of the research.

The student shall obtain and complete the appropriate form to schedule the defense, and in conjunction with the major professor, shall seek the approval of all committee members. The student shall return the form to the Office of Graduate Education no less than five working days before the defense date. The Office of Graduate Education will announce the defense to the campus community.

The student's graduate advisory committee constitutes the examining board for the dissertation defense. The major professor will head the session. The major professor is responsible for ensuring that a majority of the committee, as well as the graduate division representative, is present. The defense will not be held if these conditions cannot be met. A negative vote by any two or more members of the student's committee or a negative vote by the graduate division representative will signify failure of the defense, pending review by the graduate student advisory committee and the dean of graduate education.

Results of all written or oral examinations will be attested to by all committee members on a form furnished to the graduate division representative by the Office of Graduate Education. The original form with signatures and dates will be filed with the Office of Graduate Education and a copy with the department/program. If the student passes with reservation or pending correction, a copy of the form will be filed with both offices. The originals will be filed with both offices, with the appropriate affirming signatures, when final corrections have been made and accepted. If the candidate fails to satisfy the examiners on coursework or dissertation, written or oral examinations, the committee may schedule a re-examination over general background, dissertation, or both. The re-examination will be scheduled at the discretion of the graduate student advisory committee, normally 8 to 12 weeks after the date of the first examination. The student may petition his or her committee for re-examination prior to 8 weeks.

Appendix A: List of Optional Technical Electives

Table B.1: SDSMT and SDSU Shared Elective Courses for PhD Programs (Tentative)

	Course		Title
	Prefix	Number	
			400/500-Level Courses
SDSMT	CEE	425/525	Sustainable Engineering (distance)
SDSMT	CEE	428/528	Oil and Gas Development and the Environ.
	CEE	434/534	Hydrology (hybrid)
SDSU	CEE	435/535	Water Resources Engineering (distance)
	CEE	492/592	Sp.Tp: Fate & Transport of Contaminants
			600-Level Courses
SDSMT	CEM	608	Construction Contracts (OL)
SDSMT	CEM	610	Construction Project Management (OL)
SDSMT	CEM	619	Construction Company Management (OL)
SDSMT	CEE	634	Surface Water Hydrology
SDSMT	CEM	665	Construction Equipment Management (OL)
			700-Level Courses
SDSMT	CEM	706	Managing Sustainable Projects (OL)
SDSMT	CEM	710	Advanced Construction Management (OL)
SDSMT	CEM	715	Construction Operations (OL)
SDSMT	CEE	743	Advanced soil mechanics
SDSMT	CEE	746	Stability of soil and rock slopes
SDSMT	CEE	747	Earth and earth retaining structures
SDSU	CEE	754	Advanced Steel Design
SDSU	CEE	755	Advanced Reinforced Concrete Design
SDSU	CEE	769	Bridge Design
SDSU	CEE	759	Structural Dynamics
SDSMT	CEE	757	Advanced concrete materials
SDSMT	CEE	792	Life Cycle Assessment

Additional SDSMT Optional Elective Courses

Prefix	Num	Course Title	Credit Hours
CEE/GEOE	521	Aqueous Geochemistry	3
CEE/AES	524	Climate and Wx Resiliency	3
CEE	525	Sustainable Engineering	3
CEE	526	Envr Engr Phys/Chem Proc Design	3
CEE	527	Envr Engr Biological Proc Design	3
CEE	528	Oil and Gas Development and the Environment	3
CEE	529	Solid/Hazardous Waste	3
CEE	533	Open Channel Flow	3
CEE	537/L	Watershed/Floodplain Modeling	3
CEE	547	Foundation Engineering	3
CEE	548	Applied Geotechnical Engineering	3
CEE	551	Design of Wood Structures	3
CEE/CBE	555	Pollution and Process Design	3
CEE	568	Highway Engineering	3
CEE	574	Construction Engineering/Mgmt	3
CEE	575	Groundwater Hydrology	3
CEE/CEM	608	Construction Contracts	3
CEE	615	Earth Systems Modeling	3
CEE	627	Advanced Wastewater	3
CEE	634	Surface Water Hydrology	3
CEE	641	Earthquake Engineering	
CEE	644	Numerical Modeling in Geotechnical Engineering	3
CEE	651	Advanced Steel Design	3
CEE	652	Prestressed Concrete	3
CEE	655	Mechanics of Composite Materials	3
CEE	657	Advanced Structural Analysis	3
CEE	692	Aqueous Chemistry	3
CEE	692	Life Cycle Analysis	3
CEE	730	Stat Methods in Water Resource	3
CEE	734	Vadose Zone Flow	3
CEE	735	Sediment Transport	3
CEE	739	Tech of Surf Water Res/Water Q	3
CEE	743	Advanced Soil Mechanics	3
CEE	745	Advanced Foundations	3
CEE	746	Stability of Soil/Rock Slopes	3

CEE	747	Earth/Earth Retain Structures	3
CEE	753	Stability of Metal Structures	3
CEE	757	Advanced Concrete Materials	3
CEE	792	Sediment Transport	3
CEM	610	Construction project management	3
CEM	612	Construction estimating	3
CEM	614	Construction Scheduling	3
CEM	615	Construction Ethics	3
CEM	616	Codes and Standards	3
CEM	619	Construction company management	3
CEM	620	Leading and Managing Organizations	3
CEM	640	Temporary structures	3
CEM	665	Construction equipment management	3
CEM	706	Managing sustainable projects	3
CEM	710	Advanced construction management	3
CEM/CEE	715	Construction operations	3
CEM	750	Environmental permitting	3
CEM	751	Construction stormwater	3
CBE	544	Reactor Design	3
CBE	545	Oxidation & Corrosion of Metal	3
CBE	550	Systems Analy Applied to CHE	3
CBE	555	Pollution Phenom & Proc Design	3
CBE	574	Polymer Technology	3
CBE	574L	Exp Polymer Technology	3
CBE	575	Adv Process/Nanoengr Polymers	3
CBE	576	Organosilicon Polymers	3
CBE	584	Fund of Biochemical Engr	3
CBE	584L	Biochemical Engineering Lab	0
CBE	585	Renewable & Sustainable Energy	3
CBE	585L	Renew-Sustainable Energy Lab	0
CBE	588	Experiment Dsgn: Chem Industry	3
CBE	589	Composites Manufacturing	3
CBE	603	Molecular Biology - Engineers	3
CBE	612	Transport Phenomena: Momentum	3
CBE	613	Transport Phenomena: Heat	3
CBE	616	Computations Transport Phenom	3
CBE	621	Advanced Chem Engr Thermo I	3
CBE	714	Transport Phenomena: Mass	3
CBE	728	Heterogeneous Kinetics	3
CBE	735	Bioseparations	3
CBE	741	Microbial/Enzymatic Processing	3
GEOE	525/L	Engineering Geophysics II	3
GEOE	552/L	Geochemical Exploration	3
GEOE	566/L	Engr & Environmental Geology	3

GEOE	568/L	Geohazards	3
GEOE	582/L	Applied Geomorphology	3
GEOE	615	Adv Field Methods in Ground-Water	3
GEOE	641	Geochemistry	3
GEOE	662	Analytical Method Ground Water	3
GEOE	663/L	Ground-Water Geochemistry	3
GEOE	664/L	Advanced Ground Water	3
GEOE	682	Fluvial Processes	3
GEOE	691	Independent Study	3
GEOE	692	Topics	3
GEOE	700	Research Methods	3
GEOE	766/L	Digital Modeling Ground Water	3
GEOE	768	Engr Geol of Surficial Deposit	3
GEOL	512	Science/Engineering Field Apps	3
GEOL	516/L	Introduction to GIS	3
GEOL	517	Geospatial Databases	3
GEOL	519	Advanced Geospatial Analysis	3
GEOL	520	Introducing to Remote Sensing	3
GEOL	604	Advanced Field Geology	3
GEOL	621/L	Advanced Structural Geology	3
GEOL	622	Geotectonics	3
GEOL	632	Rocky Mountain Stratigraphy	3
GEOL	633/L	Sedimentation	3
GEOL	644	Petrology: Igneous/Metamorphic	3
GEOL	650	Seminar in Ore Deposits	3
GEOL	652	Problems in Ore Deposits	3
GEOL	656L	Scanning Electron Microscopy	3
GEOL	670	Principles: X-Ray Diffraction	3
NANO	521	Electromagnetism	3
NANO	545	Introduction to Nanomaterials	3
NANO	551	Classical Mechanics	3
NANO	571	Quantum Mechanics	3
NANO	575	Adv Process/Nanoengr Polymers	3
NANO	604	Nanophotonic Materials	3
NANO	636	Photovoltaics	3
NANO	701	Nano Materials	3
NANO	702	Theory/Appl Nanoscale Material	3
NANO	703/L	Instrum&Charact Nano-Material	3
NANO	704	Crystallog & Struct Nanomaterl	3
NANO	706	Diffr Meth - Nanomaterials Res	3
NANO	707	Defects in Nanomaterials	3
NANO	708	Nanomaterials - Photovoltaics	3
NANO	712/L	Electromag Prop Heterog Matls	3

NANO	715	Polymeric Nanomaterials	3
NANO	716	Printed Electronics: Mats/Proc	3
NANO	717	Nanochemistry	3
NANO	721	Electrodynamics I	3
NANO	735	Nanoelectrics	3
NANO	736	Advanced Photovoltaics	3
NANO	743	Statistical Mechanics	3
NANO	751	Theoretical Mechanics	3
NANO	771	Quantum Mechanics I	3
MATH	547	Design of Experiments	3
MES	603	Condensed Matter Physics	3
MES	604	Chemistry of Materials	3
MES	636	Photovoltaics	3
MES	670	Principles: X-Ray Diffraction	3
MES	678L	Micro X-Ray Comp Tomography	3
MES	712	Interfacial Phenomena	3
MES	713	Advanced Solid Mechanics	3
MES	716	Printed Electronics: Mats/Proc	3
MES	720	Synthesis/Character: Nanomats	3
MES	723	Luminescent Spectroscopy Mats	3
MES	728	Heterogeneous Kinetics	3
MES	736	Advanced Photovoltaics	3
MES	737	Organic Photovoltaics	3
MES	770	Continuum Mechanics	3
ME	532/L	Experimental Stress Analysis	3
ME	555/L	Adv App in Computational Mech	3
ME	612	Transport Phenomena: Momentum	3
ME	613	Transport Phenomena: Heat	3
ME	616	Computations Transport Phenom	3
ME	618	Conduction to Heat Transfer	3
ME	619	Convection Heat Transfer	3
ME	620	Radiation Heat Transfer	3
ME	623	Advanced Mechanical Vibrations	3
ME	625	Smart Structures	3
ME	673	Applied Engineering Analysis I	3
ME	680	Advanced Strength of Materials	3
ME	683	Advanced Mech System Control	3
ME	713	Advanced Solid Mechanics	3
ME	715	Advanced Composite Materials	3
ME	736	Adv Finite Element Methods	3
ME	770	Continuum Mechanics	3
ME	773	Applied Engineering Anal II	3
ME	781	Robotics	3

AES	808	Fundamental Prob in Eng and Science	3
ATM	501	Atmospheric Physics	3
ATM	503	Biogeochemistry	3
ATM	505	Air Quality	3
ATM	506	Global Environmental Change	3
ATM	560	Atmospheric Dynamics	3
ATM	612	Atmospheric Chemistry	3
BME	528/528L	Applied Finite Element Analysis	3
CHEM	560	Biochemistry	3
CHEM	582	Environmental Chemistry	3
EM	680	Advanced Strength of Materials	3
ENGM	620	Quality Management	3
ENGM	625	Innovation and Commercialization	3
ENGM	631	Optimization Techniques	3
ENGM	640	Business Strategy	3
ENGM	650	Safety Management	3
ENGM	655	Ergonomics for Managers	3
ENGM	661	Engineering Economics for Managers	3
ENGM	663	Operations Planning	3
ENGM	675	Legal and Ethical Issues Eng Management	3
ENGM	720	Statistical Process Control	3
ENGM	732	Stochastic Models in Operations Research	3
ENGM	742	Eng Mang and Labor Relations	3
ENGM	745	Forecasting for Business and Technology	3

NOTE: Graduate-level courses outside the major may be approved for elective credit by the student's graduate advisory committee.

Appendix B: Dissertation Research Proposal Guidelines

Overview

The primary goal of the dissertation proposal is to answer several questions about the work a student plans to complete. These questions include:

- What is the hypothesis?
- Why is the proposed work significant?
- How will your research address the stated hypothesis?

The proposal is written after consultation with your major professor and advisory committee, review of the pertinent literature, and possibly completion of some preliminary experiments. The length of the proposal will be approximately 15 pages, excluding figures and references. The proposal should be well organized (see suggested outline below), and carefully written with complete sentences and fully developed paragraphs. Much of the proposal may be used directly in your dissertation, therefore writing a well-crafted proposal serves two purposes – planning your doctoral research project *and* completing your final document.

The SDSM&T CEE department defines a dissertation as follows:

A doctoral dissertation describes independent research activity that includes a clear statement of a hypothesis or proposition, a comprehensive review of relevant literature, collection and analysis of data and scholarly evidence, and critical examination of the hypothesis or proposition in light of the data and evidence. The dissertation describes the study and results in clear and effective English and conforms to the standards of the SDSM&T Graduate Education Office.

Students may find David Holtom and Elizabeth Fisher's (2000) *Enjoy Writing your Science Thesis or Dissertation!* published by Imperial College Press (ISBN: 1860942075) very helpful. There are also a number of style guides available at the Devereaux Library.

Suggested Dissertation Proposal Contents

Abstract (~ 1 page):

The abstract is a concisely written summary of the project that includes the hypothesis statement, a brief discussion of background information, the scope and objectives of the proposed work, methods to be used, expected results, and the potential significance of the study. The abstract also states the student's original contributions to the body of work.

Introduction (~ 1-2 pages):

The introduction begins with a general discussion of the topic area and then a statement of your specific hypothesis. The significance of the question(s) to be addressed and the impact the proposed work will have on these questions should be addressed. The expected significance of the work should be stated. A short statement about how the rest of the proposal is organized is sometimes included in this section.

Background Section (~1-2 pages):

In this section, the background theory and information needed to solve your problem are presented. This section demonstrates to your major professor and advisory committee that you fully understand the subject matter and are competent to undertake the proposed study. Writing this section also helps you

solidify your understanding of the underlying principles and theories associated with your topic.

Literature Review (~ 3 pages):

This section provides a review of the literature that gives an overview of the topic and describes the proposed study in the context of what is already known, and what is not known about the topic. This section should include references from the seminal work in the field as well as the most recent research results related to your project. Journal articles will likely be the most common source cited in this section. This section should convince the reader that more research or study is necessary.

Scope (~ 1-2 pages):

This section describes what work will be done (and sometimes more importantly, what will not be done). The goals and the objectives of the work to be performed may also be described in this section. A clear and concise description of the student's proposed original contributions is presented here.

Materials and Methods (~5 pages):

This section describes the materials and experimental/numerical methods that will be used to complete your study, including a complete explanation of the methods of data collection, experimental set-ups, analysis/numerical methods, and statistical tools that will be used to analyze the data. A detailed description of all of the major steps of your study, the assumptions you will make, and the limitations of the methods you will use, should be included.

Expected Results (~1-2 pages):

A detailed discussion of any calculations or experiments you have already completed, as well as what new results are expected from your proposed study are presented in this section. The significance of the proposed work is restated here. The potential for extension to future work is also presented here.

Work Plan/Timetable (~1-2 pages):

This section includes a timetable predicting the duration of each step in the process of performing the work and writing the dissertation, including completion dates for each major step until you graduate. The plan will likely need modification, but establishing a plan from the outset can help identify potential problems and help you manage your time more effectively.

Required Resources (~1-2 pages):

This section lists the resources needed to complete the thesis or project work (equipment, supplies, etc.) and the potential sources of equipment and funding.

References:

References may be done in any format consistent with current civil engineering literature; the CEE department recommends that you follow the ASCE journal standards (see http://www.asce.org/Content.aspx?id=29605 and the SDSM&T "Thesis and Dissertation Writing Instructions" available on the SDSM&T graduate education web page: http://www.sdsmt.edu/Academics/Graduate-Education/Current-Graduate-Students/. The list of references should be listed alphabetically and formatted as described by ASCE or the SDSM&T guidelines.

Figures and Tables:

Figures should be clearly drawn, informative, and accompanied by informative captions and incorporated into the text immediately after they are cited. Every figure and table should be referred to by its proper number (for example: “See Figure 1 (or Table 1)” not “See figure (or table) below”). A numbered figure is always capitalized (Figure 1 (or Table 1)”, not “figure 1 (or table 1)”). You may wish to include maps of study areas or schematics of experimental setups as figures in the body of your proposal. Again, refer to SDSM&T “Thesis and Dissertation Writing Instructions” for details.

Evaluation Criteria

Your proposal will be evaluated by your major professor and advisory committee considering:

- Technical merit
- Contextual relevance to existing subject knowledge
- Originality
- Clarity and conciseness

Acknowledgements

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