



Graduate School

250 University Hall
230 North Oval Mall
Columbus, OH 43210-
1366

April 15, 2013

Phone (614) 292-6031
Fax (614) 292-3656

Dr. Mark McCord
Professor, Civil Engineering Grad Studies Chair
College of Engineering

PhD in Civil Engineering

Mark,

The graduate school curriculum committee (GSCC) met on April 11th and, among its agenda items, considered the revised proposal to change curriculum in the Civil Engineering PhD degree (originally considered in November 2012). The proposal seeks to reduce the total credit hours of the doctoral program from 90 to 80 credit hours by removing the “PhD minor” requirement. Previously the GSCC requested some clarity on the content of the material to be removed from the curriculum as well as the use of the term “PhD minor”, which seemed inconsistent with the Graduate School’s definition of “minor”.

The GSCC thanks you for responding to its queries. Answers to their questions were more than satisfactorily explained in your resubmission. The GSCC was appreciative of your careful explanation of the reduction of hours in your Table A and Table B requirements for the degree. Further, we know understand that the term “PhD minor” was a local usage differing from the Graduate School’s definition of a minor.

The proposal will next be submitted to the Graduate Council for their review. Subsequently, the Graduate School will release the proposal to the Committee on Academic Affairs for their review. You will likely be invited to the CAA meeting at which it is considered.

Please don’t hesitate to contact me with questions or clarifications.

Many thanks,

A handwritten signature in black ink that reads 'Scott Herness'.

Scott Herness
Associate Dean
The Graduate School

THE OHIO STATE UNIVERSITY
**GRADUATE
SCHOOL**
Advancing graduate education for over 100 years



Department of Civil, Environmental and Geodetic Engineering

470 Hitchcock Hall
2070 Neil Avenue
Columbus, OH 43210-1275

Phone (614) 292-2771
Fax (614) 292-3780

ceg.osu.edu

18 March 2013

Prof. Scott Herness
Associate Dean
Graduate School
The Ohio State University
250 University Hall, 230 North Oval Mall
CAMPUS

Dear Prof. Herness:

Thank you for your comments on the proposed changes to our PhD civil engineering graduate program in semesters. To address the two questions that you previously raised, the following response is provided:

- The request being made is to reduce the number of credit hours from the prior quarter-based PhD program of 135 hrs (90 semester hrs) to the university standard of 120 hrs (80 semester hrs).
- Under the quarter-version of our PhD program, we required our students to take a number of courses from Table A – a list of courses approved by faculty in a given specialization area that are advanced courses that provided *depth* to the graduate program – a number of courses from Table B – a list of courses approved by faculty in a given specialization area that provided *breadth* to the program – and a number of courses outside of the department – what we referred to as a minor area of coursework concentration. These courses were intended to broaden the student’s background by learning fundamental principles applied in a scientific or engineering discipline outside the civil engineering graduate program.

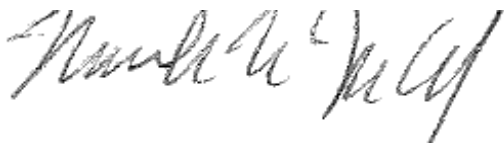
In our revision of the PhD program, we still maintain the Table A/Table B concept. However, we no longer require a minor coursework specialization. Rather, we now use the term *balance of coursework* for courses selected by the student and his/her adviser, subject to the approval by the by the student’s advisory committee and the Civil Engineering Graduate Studies Chair. There are five areas of specialization

within the civil engineering graduate program. These five areas include (1) construction engineering and management, (2) geoinformation and geodetic engineering, (3) structural engineering, (4) transportation engineering, (5) water resources and environmental engineering. The faculty members in these specialization areas decide on the list of courses that constitute Tables A and B and review the list annually. A comparison of the quarter-based PhD program vs. the semester-based PhD program is shown below:

| | PhD Qtr Hrs | PhD Qtr to Semester Hrs | PhD Semesters Proposed Hrs |
|---|-------------|-------------------------|----------------------------|
| Minimum post-BS credit hrs: | 135 | 90 | 80 |
| | | | |
| - Dissertation research | 45 | 30 | 30 |
| - Post-BS coursework credit hrs: | 90 | 60 | 50 |
| • Table A | 24 | 16 | 12 |
| • Table B | 16 | 10.6 | 8 |
| • Minor coursework | 20 | 13.3 | n/a |
| • Balance | 30 | 20 | 30 |
| | | | |
| - MS credit hrs – max total that can apply to PhD program | 45 | 30 | 30 |
| | | | |
| Minimum total post-MS coursework and dissertation research | 90 | 60 | 50 |
| | | | |
| Minimum post-BS credit hrs | 135 | 90 | 80 |

If there are any further questions, please feel free to contact me.

Sincerely,



Mark R. McCord, Professor
Civil Engineering Grad Studies Chair



Graduate School

250 University Hall
230 North Oval Mall
Columbus, OH 43210-1366

Phone (614) 292-6031
Fax (614) 292-3656

November 16, 2012

Dr. Ed McCaul
Secretary, COE Committee on Academic Affairs
College of Engineering

PhD in Civil Engineering

Ed,

The graduate school curriculum committee (GSCC) met yesterday to consider the proposed changes to the PhD degree in Civil Engineering. The goal of our committee is not only to consider the proposed changes in the academic content of existing degrees but also to strengthen the proposal for the subsequent steps in the approval process. After approval by the GSCC, the proposal will be submitted to the Graduate Council for its consideration followed by its submission to the Council on Academic Affairs for its approval. The GSCC's comments are offered in this spirit of facilitating this process as much as possible.

Overall, there was confusion about the proposal and the committee is requesting additional information. I summarize their discussion below:

- The proposal would be greatly improved with a simply stated cover letter of the request being made. It was assumed (but unclear) that the only change requested is reduction of the overall credit hours from 90 to 80. If so, then since the only change to be made involves the PhD program, the sixteen pages of description of the Master's program can be eliminated from the proposal.
- The elimination of the PhD minor is confusing. First, graduate programs do not contain minors within their curriculum (though they do contain specializations or tracks). By definition, minors are available only to students outside the program. Second, it was further difficult to understand what the PhD minor is as no description of it or of the eliminated material from the curriculum was presented. A side by side comparison of the old curriculum with the new curriculum would be helpful. Minimally, a description of the "PhD minor" is needed for the GSCC's evaluation.

Please resubmit the proposal to me or my assistant, Dena Myers (myers.663@osu.edu), at your convenience. After we receive it, I will schedule it for review at the next upcoming GSCC meeting. Subsequently, the proposal will be submitted to the Graduate Council and

to the Committee on Academic Affairs. Throughout this process I will be working to shepherd this proposal through all these steps.

Please don't hesitate to contact me with questions or clarifications.

Many thanks,



Scott Herness
Associate Dean
The Graduate School



Program Proposal: Civil Engineering

GENERAL PROGRAM INFORMATION

Identify the name of the program (current and proposed names, if different)

PhD in Civil Engineering

Identify the degree title (current and proposed names, if different)

Doctoral of Philosophy in Civil Engineering

Identify the academic unit(s) responsible for administrating the program

Department of Civil, Environmental and Geodetic Engineering

Specify the type of program

Graduate degree program

Select the appropriate semester conversion designation

Converted with minimal changes to program goals and/or curricular requirements

PROGRAM REQUIREMENTS

List program learning goals

Program Learning Goals

The objective of the Civil Engineering Doctoral program is to offer our students an enriching intellectual environment enhanced by unique research experiences in state-of-the-art laboratory, computational, and experimental testing facilities. We provide a challenging environment designed to provide our students with resources to pursue their goals and interests in various areas of civil, environmental and geodetic engineering. The program is designed to prepare graduates for careers in teaching, research or professional practice in Civil Engineering, Environmental Engineering and Geodetic Engineering.

List the semester courses (department, title, credit hours) that constitute the requirements and other components of the program.

A total of 80 credit hours (post-BS) is required to complete the semester-based PhD program. Of these 80 credit hours, at least 50 hours are to be comprised of coursework, and at least 30 hours are to be comprised of dissertation research. A student who has completed an MS degree will receive 30 hours to be counted toward the 80 credit hour total unless fewer hours are requested by the Graduate Studies Committee when reviewing the student's application for admission.

There are no required courses in the PhD program. In consultation with his or her academic advisor and committee members, the student selects an area of specialization and develops an individualized plan of study. Areas of specialization include (1) construction engineering and management, (2) geoinformation and geodetic engineering, (3) structural engineering, (4) transportation engineering, (5) water resources and environmental engineering. Faculty members associated with each area of specialization determine a set of courses to be listed as that area's "Table A" courses and another set of courses to be listed in that area's "Table B" courses. Table A courses are intended to represent "advanced" courses, and Table B courses are intended to be offer "breadth" to the program. (Lists of Table A and Table B courses by area of specialization are reviewed and approved by the Graduate Studies Committee.) At least 12 of the student's coursework hours must come from Table A courses, and at least 8 of the student's additional coursework hours must be come from Table B courses. A student in one area may use Table A courses from another area to fulfill his or her Table A requirements if approved by the student's advisory committee, and similarly for Table B courses. A student may also petition to add other courses to fulfill Table A or Table B requirements. The petition must be approved by the student's academic adviser and Graduate Studies Committee Chair.

A plan of study listing the courses and distribution of hours to be used to fulfill the 80 credit hour total is to be approved by the student's advisory committee and the Civil Engineering Graduate Studies Chair.

Append a current (quarter-based) and proposed (semester-based) curriculum advising sheet for the program, formatted to meet the unit's standards.

A current (quarter-based) PhD advising sheet appears in Appendix A, and the proposed (semester-based) PhD advising sheet appears in Appendix B. Appendix C provides a list of Table A and Table B courses to be offered by the department in the semester format. Areas of specialization within the graduate program may refine their lists of Table A and Table B courses in the future.

Provide a curriculum map that shows how, and at what level (e.g., beginning, intermediate, advanced), the program's courses facilitate students' attainment of program learning goals. A table format is recommended.

Not applicable to the Graduate Program.

Provide a rationale for proposed program changes (either significant or minimal) and a description of how the changes will benefit students and enhance program quality. Include date of last significant program revision. [Word limit: 750]

Other than a reduction in equivalent semester hours, described next, no changes are proposed to the Civil Engineering PhD program. The last significant program revision took place in 2009 in which the “geoinformation and geodetic engineering” area of specialization was added to the program.

Provide a table to aid the Council on Academic Affairs reviewers as they check for credit hour changes.

| | Number of qtr-cr-hrs in current program | Calculated result for 2/3 of current qtr-cr-hrs | Number of sem-cr-hrs required for proposed program |
|---|---|---|--|
| Total cr-hrs required for completion of program | 135 | 90 | 80 |
| Pre-requisite cr-hrs required for admission to program which are not counted toward total hrs | 0 | 0 | 0 |
| Required cr-hrs offered by the unit | 0 | 0 | 0 |
| Required cr-hrs offered outside the unit | 0 | 0 | 0 |

Provide a rationale for a change in credit hours if the difference is more than 4 semester credit hours between the values listed in columns B and C for any row in the table above. [Word limit: 500]

The decrease in the number of semester hours from the calculated quarter-to-semester equivalent hours was made to align the total with the university standard of 80 semester hours. This reduction was approved at the CEGE faculty meeting on March 2, 2012.

TRANSITION POLICY

Include a policy statement from the chair of the department / unit that assures those students who began their degree under quarters that the transition to semesters will not delay their graduation nor disrupt progress toward a degree. This may include a description of how individual transition advising plans will be developed and possible use of bridge courses. It should address students in the program and students taking service courses offered by the department / unit.

“No Ph.D. Civil Engineering student who began their degree program under quarters will have progress toward graduation impeded by the transition to semesters. Graduation requirements beginning Summer 2012 will be those in force for Civil Engineering PhD program under

semesters; but every quarter-credit-hour that would have counted toward the Ph.D. Civil Engineering degree under the quarter-based curriculum will count (as 2/3 of a semester-credit-hour) toward the requirements for graduation under the semester-based Civil Engineering PhD curriculum.

- Carolyn Merry, Chair of Civil, Environmental and Geodetic Engineering

The overarching objective of our transition policy is to ensure that student progress toward graduation will not be impeded by the conversion process. As in all previous curriculum changes, transition issues will be anticipated and planned for as a part of the conversion process. Our transition policy is based on the following principles:

All students who graduate under semesters, even during the first semester, will do so by meeting the requirements of the semester program.

Each semester program requirement may be met either by taking an appropriate semester course (or sequence) or by substituting a substantially equivalent quarter course (or sequence) for the corresponding semester course (or sequence).

Excess equivalent credit-hours resulting from such substitutions—either positive or negative—will be credited against the balance of credits required for the degree.

ASSESSMENT CONVERSION

Summarize how the program's current quarter-based assessment practices will be modified, if necessary, to fit the semester calendar [Word limit: 150]. (*Note: For example, if there are embedded assessments in selected courses, a modified assessment plan may identify the new semester courses which will include testing student attainment of program goals.*) **All undergraduate degrees and majors should have an assessment plan on file with the Office of Academic Affairs; preliminary assessment planning (item #15.b. i through iii) is encouraged for all other programs.**

We do not envision any modifications to the assessment practices presently in place and being developed for the semester-based system.

Indicate, for an undergraduate degree program or major proposal, whether the program has a plan on file with the Office of Academic Affairs

Not applicable to the graduate program.

Appendix A
Current (quarter-based) PhD Advising Sheet

STUDY PLAN FOR PH.D. IN CIVIL ENGINEERING
(please type or print clearly)

STUDENT _____ **SPECIALIZATION** _____

Tentative Dissertation Topic: _____

Place * beside any course not taken at OSU-transfer credit petition required

Place ** beside any MS hours petitioned under Graduate School Rule 6.7.2 to be counted toward fulfilling the **90** credit hours required to be taken post-MS

| CSE NO. | COURSE TITLE | FINAL GRADE | Credit Hours Taken in | |
|--|--------------|-------------|-----------------------|---------|
| | | | MS Prog. | Post-MS |
| Table A (must total at least 24 hours) | | | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| Total Table A = _____ | | | | |
| Table B (with excess from Table A, must be at least 16 hours) | | | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| Total Table B = _____ | | | | |

| CSE NO. | COURSE TITLE | FINAL GRADE | Credit Hours Taken in | |
|---|--------------|-------------|-----------------------|---------------|
| | | | MS Prog. | Post-MS |
| Minor (must total at least 20 hours) | | | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| Total Minor = _____ | | | | |
| Balance (do not list 999 hours) | | | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| _____ | _____ | _____ | | |
| Total Balance = _____ | | | | |
| MS Thesis Total = | | | 9 | XXXX |
| MS Course Total = | | | 36 | XXXX |
| Post-MS Courses Program Total = | | | XXXX | |
| Dissertation Total = | | | XXXX | 45 (at least) |
| Final Program Total = | | | _____ | |
| | | | (at least 135 hours) | |

Advisory Committee Approval* (at least three members of the Advisory Committee must be from Civil Engineering, unless invoking Rule 6.10.5.C1 (second minor)).

Signature

_____ **ADVISOR**

_____ **Minor**

_____ **CHAIR (Graduate Studies Committee)**

_____ **Date**

Appendix B
Proposed (semester-based) PhD Advising Sheet

Study Plan for Ph.D. in Civil Engineering
(Please type or print clearly)

Student Name _____ Specialization _____

Tentative Dissertation Topic: _____

Place * beside any course not taken at OSU – transfer credit required
(See Graduate School Handbook: Section IV.2 Transfer Credit)

Place ** beside any MS hours petitioned under Graduate School Rule VII.2 to be counted toward
fulfilling the 50 semester credit hours required to be taken post-BS.

| TABLE A (must total at least 12 hours) | | FINAL | Credit Hours Taken In | |
|--|--------------|-------|-----------------------|---------|
| Course Number | Course Title | GRADE | MS Program | Post-MS |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

TOTAL TABLE A: _____

| TABLE B (with excess from Table A, must be at least 8 hours) | | FINAL | Credit Hours Taken In | |
|--|--------------|-------|-----------------------|---------|
| Course Number | Course Title | GRADE | MS Program | Post-MS |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

TOTAL TABLE B: _____

| BALANCE (do not list research hours) | | FINAL | Credit Hours Taken In | |
|---|---------------------|--------------|------------------------------|----------------|
| Course Number | Course Title | GRADE | MS Program | Post-MS |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

TOTAL BALANCE: _____

| | | |
|--|--|--------------------------------|
| MS Degree Total = | | 30 <i>(at most)</i> |
| Post-MS Courses Program Total = | | |
| Total MS and Post-MS Course Total = | | 50 <i>(at least)</i> |
| PhD Dissertation Research Total = | | 30 <i>(at least)</i> |
| FINAL PROGRAM TOTAL = | | 80 <i>(at least)</i> |

Advisory Committee Approval Signatures

(at least 4 members are required for the Advisory Committee, with at least 3 members from Civil, Environmental and Geodetic Engineering)

_____ Advisor

_____ Committee Member

_____ Committee Member

_____ Committee Member

_____ **CHAIR, Graduate Studies Committee**

_____ **Date**

Form 9 (PhD) revised 3/11/2013

Appendix C

Table A and Table B Courses by Specialization Area

Construction Engineering and Management Specialization Area

| TABLE A | Title | Credits |
|----------------|--|---------|
| CE 8810 | Construction Intelligent System and Simulation I | 3 |
| CE 8811 | Construction Intelligent System and Simulation II | 3 |
| ISE 7700 | Cognitive Systems Engineering: Advanced Topics | 3 |
| ISE 7710 | Cognitive Systems Engineering: Research Practicum | 3 |
| ISE 7720 | Cognitive Systems Engineering: Models and Methods | 3 |
| TABLE B | | |
| ARCH 5110 | History of Architecture I | 4 |
| ARCH 5120 | History of Architecture II | 4 |
| CIVILEN 5001 | Introduction to Geographic Information Systems | 4 |
| CIVILEN 5130 | Applied Hydrology | 3 |
| CIVILEN 5168 | Introduction to the Finite Element Method | 3 |
| CIVILEN 5310 | Matrix Structural Analysis | 3 |
| CIVILEN 5370 | Prestressed Concrete Design | 3 |
| CIVILEN 5410 | Engineering Survey | 3 |
| CIVILEN 5441 | Introduction to GPS: Theory and Applications | 3 |
| CIVILEN 5561 | Principles of Soil and Rock Mechanics | 3 |
| CIVILEN 5571 | Principles of Foundation Analysis and Design | 3 |
| CIVILEN 5810 | Construction Safety and Forensics | 3 |
| CIVILEN 5820 | Construction Estimating | 3 |
| CIVILEN 5830 | Construction Scheduling | 3 |
| CIVILEN 5840 | Construction Contracts and Claims | 3 |
| CIVILEN 5850 | Construction Student Seminar | 2 |
| CSE 5521 | Survey of Artificial Intelligence I: Basic Techniques | 2 |
| CSE 5522 | Survey of Artificial Intelligence II: Advanced Techniques | 3 |
| CSE 5526 | Introduction to Neural Networks | 3 |
| CSE 5531 | Introduction to Cognitive Science | 3 |
| CSE 5539 | Intermediate Studies in Artificial Intelligence | 2 |
| CSE 5545 | Advanced Computer Graphics | 3 |
| CSE 5559 | Intermediate Studies in Computer Graphics | 2 |
| CSE 5913 | Capstone Design: Computer Animation | 4 |
| HISTORY 5700 | Special Topics in the History of Environment, Technology & Science | 3 |
| HISTORY 7705 | Graduate Readings in the History of Technology | 1 - 6 |
| HISTORY 7710 | Graduate Readings in the History of Science | 1 - 6 |

Geoinformation and Geodetic Engineering Specialization Area

| TABLE A | Title | Credits |
|----------------|---|----------------|
| CE 5001 | Introduction to Geographic Information Systems | 4 |
| CE 5420 | Remote Sensing of Environment | 3 |
| CE 5421 | Spatial Analysis Techniques for Civil Engineering | 3 |
| CE 5441 | Introduction to GPS: theory and applications | 3 |
| CE 5461 | Geospatial Numerical Analysis | 4 |
| CE 6431 | GIS and Cartographic Engineering | 4 |
| CE 6451 | Introduction to photogrammetry | 4 |
| CE 7432 | Advanced spatial data structures and databases | 4 |
| CE 7433 | GIS Analysis and projects | 3 |
| CE 7442 | Fundamentals of GPS and Reference Systems | 4 |
| CE 7452 | Spatial Geometry and Spectral Analysis | 4 |
| CE 7453 | Photogrammetric computer vision | 3 |
| CE 7461 | Advanced geospatial numerical analysis | 3 |
| CE 8420 | Radiometric measurements and modeling | 3 |
| CE 8421 | Integrating Remote Sensing with Engineering Databases | 3 |
| CE 8434 | Advanced planetary mapping and exploration | 3 |
| CE 8443 | Advanced topics in GPS | 3 |
| CE 8454 | Videogrammetry | 3 |
| CE 8462 | Advanced geospatial sensors and methods | 3 |
| GEODSCI 5637 | Topics in Mapping | 3 |
| GEODSCI 5652 | Adjustment Computations | 5 |
| GEODSCI 6786 | Geospatial Data Structures for Computer Mapping and GIS | 3 |
| GEODSCI 7745 | Inertial Navigation/Positioning Analysis | 4 |
| GEODSCI 7765 | Analysis and Design of Geodetic Networks | 2 |
| GEODSCI 8871 | Advanced Physical Geodesy | 3 |
| GEODSCI 8873 | Advanced Satellite Geodesy | 3 |
| Table B | | |
| Earth Sci 5642 | Geomathematical Analysis | 3 |
| MATH 4568 | Linear Algebra for Engineering Graduate Students | 3 |
| MATH 4578 | Discrete Mathematical Models | 4 |
| MATH 5601 | Essentials of Numerical Methods | 3 |
| MATH 5602 | Computational Partial Differential Equations | 3 |
| MATH 5603 | Numerical Linear Algebra | 3 |
| MATH 6601 | Numerical Methods in Scientific Computing I | 4 |
| MATH 6602 | Numerical Methods in Scientific Computing II | 4 |
| STAT 6450 | Applied Regression Analysis | 4 |
| STAT 6540 | Applied Stochastic Processes | 3 |
| STAT 6550 | Statistical Analysis of Time Series | 2 |

| | | |
|--------------|--|---|
| STAT 6560 | Applied Multivariate Analysis | 3 |
| STAT 6570 | Applied Bayesian Analysis | 2 |
| STAT 6950 | Applied Statistics II | 4 |
| CSE 5523 | Machine Learning and Statistical Pattern Recognition | 3 |
| CSE 5524 | Computer Vision for Human-Computer Interaction | 3 |
| ECE 5460 | Image Processing | 3 |
| ECE 6001 | Probability and Random Variables | 3 |
| ECE 7001 | Stochastic Processes, Detection, and Estimation | 3 |
| ECE 7866 | Computer Vision and Multisensor Integration | 3 |
| GEODSCI 5660 | Geometric Reference Systems | 4 |
| GEODSCI 6776 | Physical Geodesy | 4 |
| GEODSCI 7763 | Advanced Adjustment Computations | 4 |
| GEODSCI 8862 | Adjustment Computations for Random Processes | 2 |
| MATH 4568 | Linear Algebra for Engineering Graduate Students | 3 |
| MATH 4578 | Discrete Mathematical Models | 4 |
| MATH 5601 | Essentials of Numerical Methods | 3 |
| MATH 5602 | Computational Partial Differential Equations | 3 |
| MATH 5603 | Numerical Linear Algebra | 3 |
| MATH 6601 | Numerical Methods in Scientific Computing I | 4 |
| MATH 6602 | Numerical Methods in Scientific Computing II | 4 |
| STAT 6450 | Applied Regression Analysis | 4 |
| STAT 6540 | Applied Stochastic Processes | 3 |
| STAT 6550 | Statistical Analysis of Time Series | 2 |
| STAT 6560 | Applied Multivariate Analysis | 3 |
| STAT 6570 | Applied Bayesian Analysis | 2 |
| STAT 6950 | Applied Statistics II | 4 |

Structural Engineering Specialization Area

| TABLE A | Title | Credits |
|----------------|---|----------------|
| CIVILEN 5162 | Introduction to Laminated Composite Materials | 4 |
| CIVILEN 5168 | Introduction to the Finite Element Method | 3 |
| CIVILEN 5310 | Matrix Structural Analysis | 3 |
| CIVILEN 5320 | Intermediate Structural Steel Design | 3 |
| CIVILEN 5350 | Intermediate Reinforced Concrete Design | 3 |
| CIVILEN 5360 | Bridge Engineering | 3 |
| CIVILEN 5370 | Prestressed Concrete Design | 3 |
| CIVILEN 7330 | Earthquake Engineering | 3 |
| CIVILEN 7332 | Advanced Behavior and Design of Metal Structures | 3 |
| CIVILEN 7350 | Advanced Reinforced Concrete | 3 |
| MECHENG 7250 | Vibration of Discrete Systems | 3 |
| MECHENG 5139 | Applied Finite Element Method | 3 |
| TABLE B | | |
| AEROENG 8873 | Computational Fluid Dynamics | 3 |
| CIVILEN 5390 | Knowledge-Based Systems in Engineering | 2 |
| CIVILEN 5561 | Principles of Soil and Rock Mechanics | 3 |
| CIVILEN 5571 | Principles of Foundation Analysis and Design | 3 |
| CIVILEN 8810 | Construction Intelligent System and Simulation I | 3 |
| CONSYSM 5670 | Green Building and Sustainable Construction | 3 |
| CSE 5243 | Introduction to Data Mining | 3 |
| CSE 5249 | Intermediate Studies in Databases | 2 |
| CSE 5361 | Numerical Methods | 3 |
| CSE 5441 | Introduction to Parallel Computing | 3 |
| CSE 5449 | Intermediate Studies in Parallel Computing | 2 |
| CSE 5521 | Survey of Artificial Intelligence I: Basic Techniques | 2 |
| CSE 5522 | Survey of Artificial Intelligence II: Advanced Techniques | 3 |
| CSE 5523 | Machine Learning and Statistical Pattern Recognition | 3 |
| CSE 5526 | Introduction to Neural Networks | 3 |
| CSE 5531 | Introduction to Cognitive Science | 3 |
| CSE 5539 | Intermediate Studies in Artificial Intelligence | 3 |
| CSE 5559 | Intermediate Studies in Computer Graphics | 2 |
| CSE 6441 | Parallel Computing | 3 |
| CSE 6449 | Advanced Studies in Parallel Computing | 1-3 |
| CSE 6539 | Advanced Studies in Artificial Intelligence | 1-3 |
| ECE 5460 | Image Processing | 3 |
| ECE 5551 | State-Space Control Systems | 3 |
| ECE 5750 | Linear Systems Theory | 3 |
| ECE 5754 | Nonlinear Systems Theory | 3 |

| | | |
|---------------|--|---|
| ECE 6200 | Signal Processing | 3 |
| ECE 6202 | Stochastic Signal Processing | 3 |
| ECE 7854 | Nonlinear and Adaptive Control | 3 |
| ECE 7858 | Intelligent Control | 3 |
| ECE 7868 | Pattern Recognition and Machine Learning | 3 |
| ECE 8201 | Advanced Topics in Signal Processing | 3 |
| ISE 5200 | Linear Optimization | 3 |
| ISE 5850 | Operations Research Models and Methods | 3 |
| ISE 6200 | Fundamentals of Optimization | 3 |
| ISE 6210 | Integer Optimization | 3 |
| ISE 7100 | Advanced Simulation | 3 |
| ISE 7200 | Algorithms for Nonlinear Optimization | 3 |
| ISE 7210 | Large Scale Optimization | 3 |
| MATH 5101 | Linear Mathematics in Finite Dimensions | 3 |
| MATH 5102 | Linear Mathematics in Infinite Dimensions | 3 |
| MATH 5201 | Introduction to Real Analysis I | 5 |
| MATH 5202 | Introduction to Real Analysis II | 5 |
| MATH 5401 | Applied Differential Equations I | 3 |
| MATH 5402 | Applied Differential Equations II | 3 |
| MATH 5451 | Calculus of Variations and Tensor Calculus | 3 |
| MATH 5603 | Numerical Linear Algebra | 3 |
| MATH 6251 | Theory of Probability I | 3 |
| MATH 6411 | Ordinary Differential Equations I | 3 |
| MATH 6451 | Partial Differential Equations I | 3 |
| MATH 6601 | Numerical Methods in Scientific Computing I | 4 |
| MATH 6602 | Numerical Methods in Scientific Computing II | 4 |
| MATH 7412 | Ordinary Differential Equations II | 3 |
| MECHENG 5134 | Introduction to Vibrations of Deformable Solids | 3 |
| MECHENG 5144 | Engineering Fracture Mechanics | 3 |
| MECHENG 5320H | Digital Signal Processing with Mechanical Engineering Applications | 3 |
| MECHENG 5339 | Simulation Techniques for Control System Analysis and Design | 3 |
| MECHENG 5374 | Smart Materials and Intelligent Systems | 3 |
| MECHENG 5539 | Applied Computational Fluid Dynamics and Heat Transfer | 3 |
| MECHENG 6505 | Intermediate Fluid Dynamics | 3 |
| MECHENG 7040 | Elasticity | 3 |
| MECHENG 7100 | Introduction to Continuum Mechanics | 3 |
| MECHENG 7101 | Constitutive Models in Continuum Mechanics | 4 |
| MECHENG 7163 | Advanced Strength of Materials for Design | 3 |
| MECHENG 7250 | Vibration of Discrete Systems | 3 |
| MECHENG 7290 | Digital Control Engineering | 3 |
| MECHENG 7380 | Lumped Parameter Modeling and System Analysis | 3 |

| | | |
|--------------|--|---|
| MECHENG 7506 | Advanced Fluid Dynamics | 3 |
| MECHENG 7511 | Computational Fluid Dynamics | 3 |
| MECHENG 8038 | Advanced Topics in Finite Element Method | 2 |
| MECHENG 8042 | Nonlinear Finite Element Method | 2 |
| MECHENG 8250 | Vibration of Continuous Systems | 3 |
| MECHENG 8320 | Digital Signal and Random Data Analysis for Mechanical Systems | 3 |
| STAT 5301 | Intermediate Data Analysis I | 4 |
| STAT 5302 | Intermediate Data Analysis | 3 |
| STAT 5550 | Introductory Time Series Analysis | 3 |
| STAT 5740 | Introduction to SAS Software | 2 |
| STAT 6201 | Mathematical Statistics | 4 |
| STAT 6302 | Theory of Statistical Analysis | 3 |
| STAT 6450 | Applied Regression Analysis | 4 |
| STAT 6520 | Applied Statistical Analysis with Missing Data | 3 |
| STAT 6550 | Statistical Analysis of Time Series | 2 |
| STAT 6560 | Applied Multivariate Analysis | 3 |
| STAT 6570 | Applied Bayesian Analysis | 2 |
| STAT 6610 | Applied Nonparametric Statistics | 3 |
| STAT 6730 | Introduction to Computational Statistics | 2 |

Transportation Engineering Specialization Area

| TABLE A | Title | Credits |
|----------------|--|----------------|
| CE 7730 | Transportation Demand Modeling | 3 |
| CE 7740 | Urban Transportation Network Analysis | 3 |
| CE 7760 | Transportation Management Systems | 3 |
| CE 7770 | Infrastructure Systems Analysis | 3 |
| GEOG 8300 | Theory of Transportation Geography | 3 |
| CRPLAN 7200 | Static Optimization Methods in Planning Research | 3 |
| CRPLAN 7210 | Dynamic Optimization Methods in Planning Research | 3 |
| TABLE B | | |
| CE 5700 | Urban Transportation Demand Forecasting | 3 |
| CE 5720 | Transportation Data Studies | 3 |
| CE 5730 | Highway Location and Design | 3 |
| CE 5740 | Design and Operation of Road Traffic Facilities | 3 |
| CE 5750 | Instrumentation, Signals, and Control in Transportation Applications | 3 |
| CE 5760 | Network Metrics and Control in Transportation Systems | 3 |
| CE 5770 | Urban Public Transportation | 3 |
| GEOG 5300 | Geography of Transportation | 3 |
| CRP (TBD) | Topics in Urban Transportation and Planning | 3 |
| CRP 6810 | Non-motorized Transportation Planning | 3 |
| ISE 5200 | Linear Optimization | 3 |
| ISE 6200 | Fundamentals of Optimization | 3 |

Water Resources and Environmental Engineering Specialization Area

| TABLE A | Title | Credits |
|-----------------|---|----------------|
| EnE 5110 | Environmental Biotechnology | 3 |
| EnE 5120 | Advanced Env. Biotechnology | 3 |
| CE 5130 | Applied Hydrology | 3 |
| CE/ME/Math 5168 | Intro. to Finite Element Method | 3 |
| EnE 5170 | Sust. & Poll. Prev. Practices | 3 |
| EnE 5180 | Ecological Eng | 3 |
| EnE 5210 | Adv. Phys/Chem Treat. Proc. | 3 |
| CE 5230 | Trans. Phen. In WR Eng | 3 |
| EnE 5410 | Haz Waste Mgmt & Rem | 3 |
| EnE 5430 | Risk Assessment | 3 |
| EnE 5880 | Env. Eng. Seminar | 1 |
| EnE 5850 | Advanced Topics in Env Eng. | 1 |
| EnE 6100 | Env. Eng. Analytical Methods | 3 |
| EnE 6200 | Fundamentals of Env Eng | 3 |
| EnE 6210 | Env. Eng. Unit Operations | 3 |
| CE 6230 | Num. Models in WR Eng | 3 |
| EnE 7217 | Applied Mathematical Ecology | 3 |
| EnE 7218 | Meas. & Modeling of Bnd Lyr Met. | 3 |
| EnE 7220 | Coll. & Interface Processes in Aq Sys | 3 |
| TBD | Seepage in Permeable Materials | 3 |
| TBD | Open Channel Flow | 3 |
| TBD | Advanced Techniques in Env. Eng. | 1+ |
| TBD | Critical Reviews in Env. Engineering | 1+ |
| TABLE B | | |
| ChBE 3521 | Elements of Chem Eng: Transport Phen II | 4 |
| ChBE 5772 | Principles of Sustainable Engineering | 3 |
| ChBE5771 | Air Pollution | 3 |
| Chem 4200 | Physical Chemistry I | 3 |
| Chem 4210 | Physical Chemistry II | 3 |
| Chem 6550 | Atmospheric Chemistry | 3 |
| EarthSci 5651 | Hydrogeology | 4 |
| EarthSci 5717 | Critical Issues in World Freshwater Resources | 4 |
| EarthSci 5718 | Aquatic Geochemistry | 3 |
| EarthSci 5719 | Environmental Organic Geochemistry | 3 |
| EarthSci 5751 | Quantitative Groundwater Modeling | 4 |
| EarthSci 5752 | Contaminant Hydrogeology | 4 |
| EEOB 5420 | Aquatic Ecosystems – Ecology of Inland Waters | 1.5 – 4 |

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|----------------|---|-------|
| EEOB 6210 | Ecotoxicology | 2 - 4 |
| ENR 5240 | Environmental Molecular Sciences | 2 |
| ENR 5262 | Soil Chemical Processes and Env. Quality | 3 |
| ENR 5273 | Environmental Fate and Impact of Contaminants in Soil and Water | 3 |
| ENR 5274 | Computer Simulation of Soil Hydrological and Biogeochemical Processes | 2 |
| ENR 7520 | Environmental Science and Law | 3 |
| Microb 4000 | Basic and Practical Microbiology | 4 |
| Microb 4100 | General Microbiology | 5 |
| Microbiol 5155 | Environmental Microbiology | 3 |