The University Of Toledo

New Graduate Course Proposal

* denotes required fields

1. College*: College of Engineering

   Department*: Civil Engineering

2. Contact Person*: Serhan Guner Phone: 530-8133 (xxx - xxxx) Email: serhan.guner@utoledo.edu

3. Alpha/Numeric Code (Subject area - number)*: CIVE - 8490

4. Proposed title*: Nonlinear Modeling of Reinfo

   Proposed effective term*: 201740 (e.g. 201140 for 2011 Fall)

5. Is the course cross-listed with another academic unit? ○ Yes ◉ No

   Approval of other academic unit (signature and title)

   Is the course offered at more than one level? ○ Yes ◉ No

   If yes, an undergraduate course proposal form must also be submitted. If the undergraduate course is new, complete the New Undergraduate Course Proposal; if the undergraduate course is existing, submit an Undergraduate Course Modification Proposal.

6. Credit hours*: Fixed: 3 or Variable: to

7. Delivery Mode:

	Primary*	Secondary	Tertiary
a. Activity Type *	Lecture	--SelectType--	--SelectType--
b. Minimum Credit Hours *	3		
Maximum Credit Hours *	3		
c. Weekly Contact Hours *	3		

8. Terms offered: ☐ Fall ☑ Spring ☐ Summer

   Years offered: ○ **Every** ◉ **Alternate**

Year **Years**

9. Are students permitted to register for more than one section during a term? ○ No ◉ Yes

   May the courses be repeated for credit? ○ No ◉ Yes Maximum Hours

10. Grading System*:
    - ◉ Normal Grading (A-F, S/U, WP/WF, PR, I)
    - ○ Satisfactory/Unsatisfactory (A-C, less than C)
    - ○ Grade Only (A-F, WP/WF, PR, I)
    - ○ Audit Only
    - ○ No Grade

11. Prerequisites (must be taken **before**): i.e. C or higher in (BIOE 4500 or BIOE 5500) and C or higher in MATH 4200

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C or higher in  CIVE3420
C or higher in  CIVE 6310-8310 or MIME 4280-5280
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◉ PIN (Permisson From Instructor) ○ PDP (Permission From Department)

Co-requisites (must be taken **together**):

12. Catalog Description* (**75 words Maximum**)

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Theories of elasticity and plasticity as applied to reinforced concrete,
mechanical properties of concrete and reinforcing bars, linear and nonlinear
elastic models, shear response, compression field and smeared crack models,
their implementation and application into nonlinear finite element analysis,
and performance assessment of plane frame structures.
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13. Attach a syllabus - a syllabus template is available from the University Teaching Center. Click here for the Center's template.

File Type	View File
Syllabus	View

14. Comments/Notes:

Department Approval:
The course was unanimously approved in the Department meeting on April 12, 2017.

Course Instructor:
Dr. Serhan Guner is a new tenure-track faculty member in the Department of Civil Engineering. He completed his PhD degree at the University of Toronto, Canada, under the supervision of Dr. Frank Vecchio, who is one of the pioneers in the field of nonlinear analysis of reinforced concrete. With the proposed course, Dr. Guner aims to bring his expertise to UT.

Previous Offerings:
This course was offered twice before. Spring 2016 with 6 student, and spring 217 with 12 students. Student feedback was very good. They found the content unique and not covered in any other classes. They expect that the material covered will give them an advantage in the workplace when working as a structural engineering.

15. Rationale:

Design of concrete buildings have traditionally been conducted using “linear-elastic approaches,” which are covered in CIVE 3420. These methods do not consider true material behavior and does not permit adjusting the design performance as per pre-set requirements. These requirements may be resilience to earthquakes or hurricanes, available funds, and owner’s requirements. To rectify this limitation, the latest building design codes are adopting a “Performance-Based Design Methodology,” which uses pre-defined performance criteria for each building. Nonlinear analysis methods are an indispensable component of the Performance-Based Design. There is no graduate course in UT’s curriculum for the performance-based design of structures. The proposed course will provide timely and essential information to our students to better understand the performance-based building design principles. In addition, this course satisfies the graduate math requirement.

Course Approval:

Department Curriculum Authority:	douglas nims	Date	2017/04/13
Department Chairperson:	Ashok Kumar	Date	2017/04/13
College Curriculum Authority or Chair:	Efstratios Nikolaidis	Date	2017/04/18
College Dean:	Mohamed Samir Hefzy	Date	2017/04/18
Graduate Council:	Constance Schall, GC mtg 5/2/17	Date	2017/05/03
Dean of Graduate Studies:	Amanda C. Bryant-Friedrich	Date	2017/05/04
Office of the Provost :	marcia king-blandford	Date	2017/05/15

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Administrative Use Only

Effective Date:	2016/08/22 (YYYY/MM/DD)
CIP Code:	14.0801
Subsidy Taxonomy:	doctoral
Program Code:	
Instructional Level:	

Registrar's Office Use Only

Processed in Banner on:	
Processed in Banner by:	
Banner Subject Code:	
Banner Course Number:	
Banner Term Code:	
Banner Course Title:	

Nonlinear Modeling of Reinforced Concrete

The University of Toledo
Department of Civil Engineering, College of Engineering
CIVE 8490 Proposed Syllabus

Instructor: Serhan Guner
Email: serhan.guner@utoledo.edu
Office Hours: Tue & Fri 4.00-5.00 pm
Office Location: NI 3021
Office Phone: 419-530-8133

Term: Spring 2017

Class Location: Palmer Hall 2700
Class Day/Time: Tue 5.30 pm
Lab Location: N/A
Lab Day/Time: N/A
Credit Hours: 3

COURSE/CATALOG DESCRIPTION

Theories of elasticity and plasticity as applied to reinforced concrete, mechanical properties of concrete and reinforcing bars, linear and nonlinear elastic models, shear response, compression field and smeared crack models, their implementation and application into nonlinear finite element analysis, and performance assessment of plane frame structures.

COURSE OVERVIEW

This course presents various theories for numerically modeling the axial, flexural, and shear behavior of reinforced concrete elements. The main objective is to provide students with a basic understanding of the available approaches and tools for estimating the performance of reinforced concrete elements. The focus will be to numerically estimate the load capacity, displacement capacity, deformations under service loads, and the failure mode. It will be demonstrated that when modeling reinforced concrete structures with different approaches, conflicting results may be obtained; knowledge, experience and caution are required to make a proper judgement. It should be noted that:

- The analysis procedures taught in this course should be expected to have an accuracy of no better than ± 20% in the analysis of typical reinforced concrete structures.
- Typically, there are several different theoretical approaches applicable to the analysis of reinforced concrete structures. Different approaches should be investigated to bracket the solution.
- The analysis methods and software introduced in this course are merely tools. A tool in the hands of Michelangelo will give a masterpiece; a tool in the hands of a novice may yield a mess.
- There is no substitute for good engineering judgment, intuition, and common sense.

STUDENT LEARNING OUTCOMES (SLOs)

The primary objective is to develop an understanding of the fundamentals behind the behaviour and constitutive modeling of reinforced concrete elements. This course will help students to develop skills to:

The primary objective is to develop an understanding of the fundamentals behind the behaviour and constitutive modeling of reinforced concrete elements. This course will help students to develop skills to:

1. Understand the behavior of reinforced concrete, and apply numerical solution techniques to model these behaviours. (PhD Program SLO: a)
2. Perform stress, strain, and crack analysis of reinforced concrete. (a)

3. Perform finite element modeling of reinforced concrete structures, and interpret analysis results using computer programs. (b)
4. Present analysis results in written reports using engineering notation and standards. (c)

TEACHING STRATEGIES

The topics will be primarily covered on the board. Overhead projector will also be used to show images and diagrams. Related study material will be posted on the course web site in advance; please come prepared by downloading, printing, and studying the posted material. Careful note taking from the board will be required. The topics will be covered in a discussion format and many questions will be raised throughout. Please participate in the discussion as much as possible. You will have many opportunities during the class to ask your questions and state your opinion. Every topic covered will be included in a homework assignment. On-time completion of these assignments are critical to your success. Making mistakes when solving these assignments are okay as long as you correct and learn from your mistakes once you receive your marked assignments. All topics are connected to each other; it is critical that you understand the topics as we go along. Please ask for help if you have difficulty understanding any particular topic.

PREREQUISITES AND COREQUISITES

All students are considered to have formally taken and successfully passed the exams of the following courses, or equivalents as approved by the course instructor.

Reinforced Concrete Design I (CIVE 3420)

Material properties of concrete and reinforcing bars
Limit states design principles
Behaviour and design of flexural elements
Beams in shear
Behaviour and design of short columns
Bond and development

Finite Element Methods (CIVE 6310/8310 or MIME 4280/5280)

Matrix Algebra
Stiffness (Displacement) Method
Trusses
Plane frame elements including rigid end offsets
Two-dimensional isoparametric elements
Plane stress and plane strain cases
Practical considerations in finite element modeling

TEXTS AND ANCILLARY MATERIALS

Required:

1. Lecture notes (to be copied from the board during lectures)
2. Guner, S. and Vecchio, F.J., "*User's Manual of VecTor5*," University of Toronto, Online publication, 2008, 88 pp. Download
3. Wong, P. S., Vecchio, F. J., and Trommels, H., "*VecTor2 and FormWorks User's Manual*," Second Edition, University of Toronto, Online publication, 2013, 318 pp. Download

Recommended:

4. Maekawa, K., Pimanmas, A., and Okamura, H., "*Nonlinear Mechanics of Reinforced Concrete*," CRC Press, 2003, 721 pp.

References:

5. Boresi, A. P., and Schmidt, R. J., "*Advanced Mechanics of Materials*," 6th Ed., John Wiley & Sons, Inc, 2003, 681 pp.
6. Ugural, A. C. and Fenster S. K., *Advanced Mechanics of Materials and Applied Elasticity*, Prentice Hall, 5th Ed., 2011, 704 pp.
7. Gere, M. G. and Goodno, B. J., *Mechanics of Materials*, 8th ed., CENGAGE Learning, 2013, 1152 pp.
8. Hibbeler, R. C., Structural Analysis, 8th Ed., Prentice Hall, 2012, 720 pp.
9. Wight, J. K., *Reinforced Concrete: Mechanics & Design*, Prentice Hall, 7th Ed., 2015, 1168 pp.
10. Logan, L. D., "*A First Course in the Finite Element Method*," 5th Ed., Cengage Learning, 2012, 976 pp.
11. Chandrupatla, T. R., Belegundu, A. D., "*Introduction to Finite Elements in Engineering*," 4th Ed., Pearson, 2012, 448 pp.

TECHNOLOGY REQUIREMENTS

A calculator capable of matrix calculations is required. As a minimum, Casio FX-9750GII is recommended as an inexpensive (approx. $40 online) and highly-capable model. Search online

UNIVERSITY POLICIES

Policy Statement on Non-Discrimination on the basis of Disability (ADA)

The University is an equal opportunity educational institution. Please read The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance.

Academic Accommodations

The University of Toledo is committed to providing equal access to education for all students. If you have a documented disability or you believe you have a disability and would like information regarding academic accommodations/adjustments in this course, please contact the Student Disability Services Office.

Bullying

Bullying is hostile, destructive behavior, intentional and persistent in nature, directed at another individual. It can be perpetrated by a single individual or a group. Bullying can take on many forms; physical, verbal, relational and cyber. Bullying will not be tolerated.

If you think that you may be subjected to bullying, discrimination, or harassment, please report here.

Other university policies can be found here.

ACADEMIC POLICIES

Dishonesty

You should not engage in any type of dishonesty including plagiarism (i.e., claiming of words, ideas, artistry, drawings or data of another person), cheating, misrepresentation of personal identity or performance, submission of false information, unauthorized copying or use of copyrighted materials, and violations of departmental policies or professional behaviour. Dishonesty will not be tolerated. Related policies are found here.

Proper reference information should be given for all work obtained from elsewhere including internet, textbooks, and computer software. Web addresses can also be used as a reference.

Assignments and Exams
You are required to individually complete your own homework assignments. If you have difficulty in understanding a topic, you may consult me during the office hours and/or seek help from your classmates.

The exams are to be completed individually with no assistance given or received. Possession of materials or devices not explicitly allowed during an exam, test or a quiz is prohibited. Examples of such materials or devices include cell or smart phones, laptops, handheld devices, and calculators.

Exams must be taken as schedules on this syllabus and as announced in class. Exceptions for absences will only be made in documented, extenuating circumstances and at the discretion of the instructor. Make-up exams, if awarded, will differ from those given in class, but will cover the same material.

COURSE EXPECTATIONS

General
- All required course submissions will be assessed on technical and academic merit, and the quality of communication skills exhibited.
- Attendance at lectures and tutorials is expected. Any information conveyed in class – in the notes or verbally – is included in the exams. Careful note taking from the board is required during lectures.
- Smartphone use is not permitted during lectures and tutorials. Due to privacy requirements, picture taking or voice recording is not permitted during lectures and tutorials without prior written permission of the instructor.

Assignments
- On time and successful completion of all assignments is essential for the successful completion of the course. Each student must complete the assignments individually.
- Late assignments will receive a mark of zero.
- All assignments must include the standard cover page posted on the course web site. It must be electronically completed, printed and signed by the student in ink prior to submission of the work. Submissions without a cover page will not be marked.
- A clear and neat presentation of solution is required for each problem. Engineering paper posted on the course web site must be used. Title block of each sheet must be filled out in ink. You may use a pdf editor.
- The question sheet must be attached at the end of the solutions. All sheets must be stapled from the top left corner. A plastic cover or binder is not required.
- For each non-conformance to the requirements above, one mark out of 10 will be deducted.

GRADING

Midterm exam	30%
Assignments	20%
Final exam	50%

Assignment Grading
Assignments will be graded out of 10. Major calculation mistakes and the marks deducted will be indicated on the assignment papers. Grades will be announced to each student in the course web site. Assignment

marks are a good indicator of the final course marks. Students with higher assignment marks typically obtain the higher course averages.

Midterm Grading
The midterm exam will include the entire material covered up to the exam date. Exam grades will be announced to each student in the course web site. Class grade statistics will also be posted to assist students with determining where they stand academically in the class. I will send a friendly notification email to students with marks below the satisfactory performance level.

Final Grading
The final exam will include the entire course material with more weight for the topics covered after the midterm exam. The final exam has a significant weight; however, it is uncommon for students with low term marks to achieve a significantly higher final exam grades. Therefore, please focus on your term performance by studying regularly and completing all assignments successfully.

Grade Scale

A	93	100		B +	87	89		C +	75	79		D +	63	66		F	0	57
A -	90	92		B	83	86		C	70	74		D	60	62				
				B -	80	82		C -	67	69		D -	57	59				

COMMUNICATION GUIDELINES

- You are required to regularly monitor the course web site for the posted marks and announcements. Many important announcements will be made through the course web site. In the case of a discrepancy in a posted mark, you must inform the instructor in two weeks from the date the mark is posted.
- Due to long and mathematical nature of the topics covered, technical consultation via email is not possible. Please use my office hours, lecture breaks, or the end of lectures to ask any technical question.

STUDENT SUPPORT SERVICES

University Libraries
To search for textbooks and research papers, please refer to the University Libraries.

The Counseling Center
Transitioning to the graduate school or maintaining a healthy well-being can be difficult. If you or a friend ever feel overwhelmed adjusting to college or in need of crisis intervention or mental health services, please contact the Counseling Center.

COURSE SCHEDULE

Week	Date	**Topic** (Schedule is tentative.)	Learning Outcome	Homework Assignment
1	Jan 10	Introduction: Nonlinear Analysis of RC, Material Properties	1 (a)	A1
2	Jan 17	Linear and Nonlinear Elastic Models for Plain Concrete	2 (a)	A2
3	Jan 24	Nonlinear Elastic Analysis of Reinforced Concrete Elements	2 (a)	A3
4	Jan 31			
5	Feb 7	Modified Compression Field Theory	1, 2 (a)	A4
6	Feb 14			
7	Feb 21	Finite Element Implementation	3 (b)	A5
8	Feb 28	Midterm exam	1, 2, 3 (a, b)	-
-	Mar 6	No class (spring break)	-	-
9	Mar 14	Nonlinear Finite Element Modeling of Frame Elements	3 (b)	A6
10	Mar 21	Advanced Behaviour Modeling	1, 2 (a)	A7
11	Mar 28			
12	Apr 4	Assessment of Structural Performance	3, 4 (b, c)	A8
13	Apr 11	Strut-and-Tie Modeling	1, 2 (a)	A8
14	Apr 18			
15	Apr 25	Advanced Topics & Course Review	3, 4 (b, c)	-
-	May 2	Final Exam	1, 2, 3, 4 (a, b, c)	-

PhD Program Student Learning Outcomes

(a) Ability to solve advanced-level problems in Infrastructure Engineering.
(b) Ability to demonstrate proficiency in Infrastructure Engineering.
(c) Ability to successfully communicate the results of engineering research in oral and written forms.