CE 464A/564A – Spring 2019
Integrated Highway Bridge Design using LRFD Methodology

Lead Instructor: Brooks Keenan, P.E.

Office Hours By appointment only

Phone 520-909-9067

e-mail: BrooksKeenan@comcast.net

Class Meeting: Tuesday & Thursdays, 3:30 PM – 4:45 PM
Mines, Room 221

Web Site: www.d2l.arizona.edu

This course is taught by a team of volunteer professionals as listed below:

Lecturer	Subject	Affiliation	E-mail	Phone
Alejandro Angel, PE	Roadway & Geometry	PSOMAS	aangel@psomas.com	292-2300
Randy Post, PE	Geotech & Foundations	Golder Associates	randy_post@golder.com	332-1414
Brooks Keenan, PE (lead instructor)	Substructures & LRFD Methodology	Crown Engineering	BrooksKeenan@comcast.net	909-9067
Tom McGovern, PE	Roadway & Geometry	PSOMAS	tmcgovern@psomas.com	292-2300
Brooks Keenan, PE	Bridge Hydraulics	Crown Engineering	BrooksKeenan@comcast.net	909-9067
Ted Buell, PE	Superstructures	HDR	Ted.Buell@hdrinc.com	584-3632
Dave Zaleski, PE	Structures & Field Trips	Pima County DOT	dmzaleski58@yahoo.com	250-4950

Prerequisites:

CE 310 – Probability in Civil Engineering, not required
CE 323 – Hydraulic Engineering and Design
CE 343 – Geotechnical Engineering and Design
CE 363 – Transportation Engineering and Pavement Design
CE 335 – Structural Design in Concrete, concurrent

Course Objectives:

Understanding methods for the integrated design of components typically found in transportation structures including bridge superstructures and substructures, retaining walls, pavements, highway geometrics, traffic, drainage, geotechnical, etc.

1) Introduce students to concepts underlying the design of various components typically found in highway structures by using the Load and Resistance Factor Design (LRFD) methodology.
2) Emphasize quantification of uncertainties in design processes and importance of deformation-based design procedures.
3) Emphasize the importance of inter-disciplinary interaction for design of transportation structures.
4) Emphasize importance of considering construction procedures in design and vice versa.
5) Introduce national standards produced by the Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO).
6) Discuss brief case-histories using local projects with the objective of emphasizing concepts.

Reference Texts:

1) AASHTO LRFDUS-8 (2017). **AASHTO LRFD Bridge Design Specifications – 8th Edition**
2) FHWA NHI-06-088 (2006). **Soils and Foundations Reference Manual,** Volumes I and II - downloadable free of charge at www.ncsconsultants.com/downloads
3) FHWA-HIF-12-003 (2012). **Evaluating Scour at Bridges – 5th Edition**, Hydraulic Engineering Circular (HEC) 18. HEC 18
4) FHWA-HIF-12-004 (2012). **Stream Stability at Highway Structures – 4th Edition,** Hydraulic Engineering Circular (HEC) 20. HEC 20
5) FHW- NHI-09-111 and -112 (2009). **Bridge Scour and Stream Instability Countermeasures, Experience, Selection, and Design–Volumes 1 and 2 – 3rd Edition**, Hydraulic Engineering Circular (HEC) 23. HEC 23
6) **Guidelines for Establishing Scour and Freeboard for Bridges in Pima County,** (2012) PCRFCD/PCDOT. Pima County Scour and Freeboard

Topics Covered:

1 – Overview and Layout of Bridge Structures based on Traffic Projection, Roadway Geometrics, Site
2 – Bridge Hydraulics and Scour
3 – LRFD, Loads and Load Combinations
4 – Introduce the importance of considering construction methods in design and vice versa
5 – Methods for Bridge Superstructure Design
6 – Methods for Bridge Substructure Design
7 – Bridge Deck and Appurtenant Structures
8 – Constructability Evaluations, QA/QC, Plans, Specifications and Estimates
9 – Construction Management
10 – Course Summary, Introduction to Advanced Topics.

The attached schedule provides more detail on the weekly schedule of topics that will be covered and the responsible instructor.

Contribution to professional component: (Units)

Math and basic science:	0
Engineering topics:	0
Design experience:	3

Relationship to program outcomes:

This course contributes to satisfying program goals 1, 2, 3, and 4 as defined by our faculty. The course also contributes to satisfying ABET outcome criteria 3A, 3C, 3E, 3K, 3L and 3M to the degrees indicated on the Course Classification Form.

Weekly Quizzes/Homework Assignments:

There will be a quiz or homework assignment for each topic in the week following the topic lectures (approximately one homework assignment or quiz per week). You may take the quizzes online through the course website on D2L. Each quiz will be available from 8:00 am until 1:00 pm on Tuesday and from 6:00 pm until 11:00 pm on Wednesday. Missed quizzes cannot be made up. The instructors may select to assign a homework assignment instead of the weekly quiz. In that case, the homework will be due at the beginning of the following lecture after it was assigned. Homework will not be accepted after a lecture has begun. Each quiz or homework assignment will be worth 5% of the final grade for undergraduate students and 4% of the final grade for graduate students.

Field Trips and Construction Field Visit Reports

Two or three field trips to bridge construction sites or fabrication shops will be conducted. Attendance at one field trip and preparation of a field observation report is mandatory. Attending additional field trips and preparing field observation reports gains extra credit. Extra credit from additional field trips can boost a student's final grade.

Graduate Student (564A) Design Summary Report:

Graduate students enrolled in CE 564A are required to write a design summary report on any component of the case study bridge using LRFD, or prepare a report on another bridge design topic that is approved by one of the instructors listed for the course. This report will be a written synopsis that includes: identification of the bridge component, detailed description of the design process, assumptions of unknown variables, and an appendix of calculations. The proposed topic must be agreed upon with the instructor teaching that topic by **Thursday, February 14th**. A Draft Design Summary Report, including preliminary calculations, is due by **Thursday, March 28th** and the Final Design Summary Report is due by **Tuesday, April 25th**.

Grading Policy:

Task	CE 464A Undergraduates	CE 564A Graduates
Weekly Quizzes/Homework	70%	56%
Construction Field Observation Report	5%	5%
Graduate Student Design Summary Report		14%
Final Exam	25%	25%

Final grades are calculated using the percentages above. Once calculated the final course grade will be rounded to the nearest tenth percent and assigned the letter grade corresponding to the following ranges:

A – 100.0 – 90.0
B – 89.9 – 80.0
C – 79.9 – 70.0
D – 69.9 – 60.0
E – 59.9 – 0.0

Class schedule:

The course consists of 28, 75-minute lectures, held twice per week.

Lecture No.	Date	Topic	Instructor
1	Th 1/10	Course Overview and Introduction	Brooks Keenan
2	Tue 1/15	Introduction to LRFD Methodology	Brooks Keenan
3	Th 1/17	Bridge Design Process/Bridge Construction Plans	Dave Zaleski
4	Tue 1/22	Roadway Design & Geometry 1 of 2	Tom McGovern / Alejandro Angel
5	Th 1/24	Roadway Design & Geometry 2 of 2	Tom McGovern / Alejandro Angel
6	Tue 1/29	Bridge Hydraulics & Scour 1 of 2	Brooks Keenan
7	Th 1/31	Bridge Hydraulics & Scour 2 of 2	Brooks Keenan
8	Tue 2/5	Overview of Bridges/Bridge Selection Process/AASHTO LRFD Specifications 1 of 2	Dave Zaleski
9	Th 2/7	Overview of Bridges/Bridge Selection Process/AASHTO LRFD Specifications 2 of 2	Dave Zaleski
10	Tue 2/12	Comparison of ASD, LFD, and LRFD	Brooks Keenan
11	Th 2/14	LRFD Loads / Load Combinations [Deadline for Submitting Topics for Graduate Reports]	Brooks Keenan

12	Tue 2/19	Superstructure Design Overview & Case Study / Structural Analysis	Ted Buell
13	Th 2/21	Appurtenance Structures for Bridge Projects	Brooks Keenan
14	Tue 2/26	Reinforced Concrete Refresher / Superstructure Design Case Study (cont'd) 1 of 2	Ted Buell
15	Th 2/28	Reinforced Concrete Refresher / Superstructure Design Case Study (cont'd) 2 of 2 [Deadline for Submitting Draft Graduate Reports]	Ted Buell
	3/2-10	SPRING RECESS	NO CLASSES
16	Tue 3/12	Computer Lab – CONSPAN Girder Design 1 of 2	Ted Buell/Brooks Keenan
17	Th 3/14	Computer Lab – CONSPAN Girder Design 2 of 2	Ted Buell/Brooks Keenan
18	Tue 3/19	Substructures: Overview of Soil Mechanics 1 of 2	Randy Post
19	Th 3/21	Substructures: Overview of Soil Mechanics 2 of 2	Randy Post
20	Tue 3/26	Substructures: Shallow / Deep Foundations 1 of 2	Randy Post
21	Th 3/28	Substructures: Shallow / Deep Foundations 2 of 2	Randy Post
	Tue 4/2	**SCE STUDENT CONFERENCE TRAVEL**	**NO CLASS**
	Th 4/4	**SCE STUDENT CONFERENCE 4/3-6**	**NO CLASS**
22	Tue 4/9	Substructures Design Overview	Brooks Keenan
23	Th 4/11	Substructures – Abutment on Spread Footing	Brooks Keenan
24	Tue 4/16	Substructures – Pier on Deep Foundations 1 of 2	Brooks Keenan
25	Tue 4/18	Substructures – Pier on Deep Foundations 2 of 2	Brooks Keenan
26	Th 4/23	Construction Specifications for Bridges	Dave Zaleski
27	Tue 4/25	Bridge Construction Methods [Deadline for Submitting Graduate Reports]	Dave Zaleski
28	Th 4/30	Other Bridge Topics/Course Review	Instructor Team
	Wed 5/8	**Final Exam, 3:30 to 5:30 p.m., in Speech & Hearing Sciences Room 203**	Brooks Keenan / Dave Zaleski

Accessibility and Accommodations:
Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional

information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu**.**

Code of Academic Integrity:
Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog.
See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity

UA Nondiscrimination and Anti-harassment Policy:
The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Threatening Behavior Policy:
The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Subject to Change Statement:
Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.