CE 301: Structural Analysis

Term: Fall 2026
Credits: 3.0
Lecture Times & Location: Tuesday & Thursday 9:30–10:45 a.m., Rowan Engineering Center 110
Modality: In-Person

Instructor Information

- **Instructor:** Dr. Samir Rashid (Associate Professor of Civil & Environmental Engineering)
- **Email:** srashid@university.alkimi.ai
- **Office:** Rowan Engineering Center 308
- **Office Hours:**
  - Tuesday & Friday: 11:30 a.m.–1:00 p.m. (In person, Rowan Engineering Center 308)
  - Wednesday: 2:00–3:00 p.m. (Virtual via Zoom; link posted in Canvas)
  - Also available by appointment.

Course Description

Loads on structures, analysis of statically determinate and indeterminate beams, trusses, and frames, influence lines, and matrix and computer methods. CE 301 provides a thorough treatment of structural behavior, load paths, and analytical methods for determinate and indeterminate civil engineering systems. Building on mechanics of deformable bodies, students analyze beams, trusses, and rigid building frames under dead, live, and environmental loads per ASCE 7. The course investigates influence lines for moving bridge loads, classical energy methods (virtual work and Castigliano's theorem), and classical indeterminate frameworks (consistent deformations, slope-deflection, moment distribution), concluding with the matrix stiffness method implemented computationally.

Prerequisites

CE 202 and MATH 240.

Measurable Student Learning Outcomes

Upon successful completion of CE 301, students will be able to:

1. **Compute Environmental and Gravity Loads:** Calculate design dead loads, live loads, snow loads, and wind pressures on building structures and bridge systems using ASCE 7-22 load combination standards.
2. **Construct Influence Lines:** Determine influence lines for determinate beams, floor girders, and trusses using equilibrium and the Müller-Breslau principle, and calculate maximum shear and moment envelopes under moving AASHTO truck loads.
3. **Calculate Structural Deflections:** Compute elastic deflections and rotations of trusses, beams, and frames using the principle of virtual work (unit load method) and Castigliano's second theorem.

4. **Solve Statically Indeterminate Structures:** Analyze indeterminate beams and frames using the force method (consistent deformations) and displacement methods (slope-deflection equations and moment distribution).
5. **Implement Matrix Stiffness Analysis:** Formulate global stiffness matrices, assemble element equations, and solve for nodal displacements and member end actions in trusses and continuous beams using computational tools.

Required Course Materials & Approximate Costs

1. **Hibbeler, Russell C. *Structural Analysis*. 10th ed., Pearson, 2018.** Approx. $85 digital rental ($195 purchase; reserve copies available in Alkimi Library).
2. **RISA-2D Educational Software and MATLAB (available on campus computer lab workstations).** Free educational access provided through department licensing.
3. **Total estimated cost:** Approx. $0 (library reserve & campus software) to $85 (textbook rental).

Generative AI Policy (AI Level 2: AI Permitted with Disclosure for Specified Tasks)

In accordance with Alkimi University Academic Policies (Student Handbook §5.8), CE 301 operates under **AI Level 2**.

- **What is permitted:** Students may use AI tools to generate MATLAB or Python code for assembling structural stiffness matrices, cross-check ASCE 7 load combination formulas, and visualize deflected structural shapes.
- **What is prohibited:** AI models must not be used to complete assigned hand calculations for indeterminate structures, solve slope-deflection or moment distribution problems on problem sets, or formulate influence lines without independent derivation. AI assistance is strictly banned during exams and quizzes.
- **Disclosure:** All computational structural modeling deliverables must incorporate an AI disclosure block outlining any generative AI prompts employed, the code generated, and the validation checks performed against commercial structural software (such as RISA-2D).

Grading Components and Weights

- **Weekly Problem Sets:** 15% (Due Wednesdays at 11:59 p.m. in Canvas (weeks 2–14; lowest dropped))
- **Biweekly Structural Mechanics Quizzes:** 10% (Administered in class on alternate Thursdays (weeks 3, 5, 9, 13; lowest dropped))
- **Midterm Exam 1 (Loads, Influence Lines & Virtual Work):** 20% (In class, Thursday, October 1)
- **Midterm Exam 2 (Force Method & Slope-Deflection):** 20% (In class, Thursday, November 5)
- **Building Frame Matrix Analysis & RISA-2D Project:** 10% (Due Friday, November 20 at 11:59 p.m.)
- **Comprehensive Final Examination:** 25% (Tuesday, December 15, 2026, 8:00–10:00 a.m.)

Grading Scale (Alkimi University Standard)

- **A:** 93–100% | **A-:** 90–92%
- **B+:** 87–89% | **B:** 83–86% | **B-:** 80–82%
- **C+:** 77–79% | **C:** 73–76% | **C-:** 70–72%
- **D+:** 67–69% | **D:** 60–66% | **F:** Below 60%
- **Extra credit:** No individual extra credit assignments are offered in CE 301.

Course Schedule (Fall 2026)

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 1	Aug 27	**Structural Systems, Loads, and ASCE 7 Standards:** Classification of structures (trusses, cables, arches, frames,	*First day of classes: Wed Aug 26.*

Week	Dates	Topics & Readings	Assignments & Deadlines
		surface structures), dead and live loads, environmental loads (wind, snow), and ASCE 7 load combinations. *Reading: Hibbeler Ch. 1*	
Week 2	Sep 1, 3	**Analysis of Statically Determinate Trusses:** Determinacy and stability criteria, planar trusses, method of joints, method of sections, space trusses, and structural efficiency of truss configurations. *Reading: Hibbeler Ch. 3*	*Wed Sep 2: Add/section change deadline.*
Week 3	Sep 8, 10	**Internal Loads in Beams and Portal Frames:** Internal axial force, shear force, and bending moment diagrams for determinate non-prismatic beams and rigid portal frames; differential relationships. *Reading: Hibbeler Ch. 4*	*Mon Sep 7: Labor Day (no classes). Wed Sep 9: Census date (last day to drop without a W).*
Week 4	Sep 15, 17	**Influence Lines for Determinate Beams:** Concept of moving loads, qualitative influence lines via Müller-Breslau principle, analytical influence lines for beam reactions, shear, and bending moment. *Reading: Hibbeler Ch. 6.1–6.4*	—
Week 5	Sep 22, 24	**Influence Lines for Girders, Trusses, and Moving Trucks:** Floor-girder systems, panel points, influence lines for truss member forces, and absolute maximum shear and moment envelopes for AASHTO HL-93 truck loading. *Reading: Hibbeler Ch. 6.5–6.9*	—
Week 6	Sep 29, Oct 1	**Deflections: Geometric and Moment-Area Methods:** Elastic beam theory, double integration, moment-area theorems, conjugate-beam method, and administration of Midterm Exam 1 during Thursday class. *Reading: Hibbeler Ch. 8.1–8.5*	**Midterm Exam 1 (Loads, Influence Lines & Virtual Work) (in class).**
Week 7	Oct 6, 8	**Energy Methods: Virtual Work and Castigliano's Theorem:** Principle of virtual work (unit load method) for trusses, beams, and frames; temperature changes and fabrication errors; Castigliano's second theorem. *Reading: Hibbeler Ch. 9.1–9.9*	—
Week 8	Oct 15	**Indeterminate Structures and Approximate Analysis:** Degree of kinematic and static indeterminacy; approximate analysis of building frames subjected to vertical and lateral wind loads (portal and cantilever methods). *Reading: Hibbeler Ch. 2.4–2.5, 7.1–7.4*	*Oct 12–Oct 13: Fall break (no classes).*
Week 9	Oct 20, 22	**Force Method of Analysis (Consistent Deformations):** Compatibility equations, flexibility coefficients, redundant choice, force method applied to single- and multiple-degree indeterminate beams and trusses. *Reading: Hibbeler Ch. 10.1–10.4*	—
Week 10	Oct 27, 29	**Force Method Applied to Frames and Support Settlements:** Force method applied to indeterminate portal frames, support settlement effects, temperature changes, and internal moment diagrams for continuous frames. *Reading: Hibbeler Ch. 10.5–10.7*	—
Week 11	Nov 3, 5	**Displacement Method: Slope-Deflection Equations:** Kinematic degrees of freedom, slope-deflection equations for continuous beams, fixed-end moments, and administration of Midterm Exam 2 in Thursday class. *Reading: Hibbeler Ch. 11.1–11.3*	*Fri Nov 6: Last day to withdraw (W) or elect Pass/No Pass.* **Midterm Exam 2 (Force Method & Slope-Deflection) (in class).**
Week 12	Nov 10, 12	**Slope-Deflection for Frames With and Without Sidesway:** Slope-deflection analysis of non-sway frames, side-sway shear equations for multistory portal frames, and joint equilibrium formulation. *Reading: Hibbeler Ch. 11.4–11.6*	—
Week 13	Nov 17, 19	**Moment Distribution Method (Hardy Cross):** Stiffness factors, distribution factors, carry-over factors, iterative convergence for continuous beams and non-sway frames; Matrix Project due Friday. *Reading: Hibbeler Ch. 12.1–12.4*	**Building Frame Matrix Analysis & RISA-2D Project due Fri Nov 20 at 11:59 p.m.**

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 14	Nov 24	**Moment Distribution for Frames with Sidesway:** Sidesway correction in rigid frames, superposition of non-sway and pure-sway solutions, and comparison of classical methods. *Reading: Hibbeler Ch. 12.5–12.7*	*Nov 25–Nov 27: Thanksgiving break (no classes).*
Week 15	Dec 1, 3	**Introduction to Matrix Structural Analysis:** Direct stiffness method, local vs. global coordinate systems, member transformation matrices, assembly of structure stiffness matrix, and boundary restraints. *Reading: Hibbeler Ch. 14, 15*	—
Week 16	Dec 8	**Computational Structural Synthesis and FE Review:** Validation of matrix computer solutions against commercial software (RISA-2D), synthesis of indeterminate behavior, and comprehensive final examination review. *Reading: Review Hibbeler Ch. 4, 6, 9–12, 14*	*Wed Dec 9: Last day of classes. Thu Dec 10: Reading Day.*
Finals	Dec 15	**Comprehensive Final Examination:** Tuesday, December 15, 2026, 8:00–10:00 a.m., Rowan Engineering Center 110.	Comprehensive.

Course Policies

Attendance Policy

Class attendance at every lecture is expected. Structural analysis methods involve intricate iterative procedures (slope-deflection, moment distribution, virtual work) that require guided problem-solving and immediate instructor feedback. If an unavoidable illness or university-approved absence arises, notify Dr. Rashid prior to class. Students who miss the first two class meetings without notifying the instructor may be dropped. Students may miss class for religious observance without penalty if they notify the instructor in writing within the first two weeks of the semester (by Wednesday, September 9, 2026). Absences for university-sponsored activities (athletics, performances, conferences) are excused with a letter from the sponsoring office at least one week in advance.

Late Work Policy

Homework problem sets submitted after the deadline will be assessed a penalty of 15% per day up to 48 hours late, after which solutions will be made available and zero credit awarded. The lowest homework score and lowest quiz score are automatically dropped to accommodate emergencies.

Final Exam Policy

The final examination (Tuesday, December 15, 2026, 8:00–10:00 a.m.) is scheduled by the University Registrar and can't be moved without the Dean's written approval (Faculty Handbook §5.5). A student with three or more final exams on the same calendar day may reschedule one of them. Requests go to the instructor of the middle exam by the last day of classes. For this term, send the request by Wednesday, December 9, 2026 (Student Handbook §6.4).

Academic Integrity

Alkimi University is an academic community devoted to rigorous scholarship, open intellectual inquiry, and uncompromising ethical conduct. All students are subject to the regulations of the Alkimi University Academic Integrity Policy. Academic dishonesty—including plagiarism, cheating on examinations, unauthorized collaboration, fabrication of empirical data, and unauthorized submission of academic work generated by artificial intelligence—undermines the integrity of the university and carries severe disciplinary sanctions. Sanctions range from a failing grade on an assignment or exam to an administrative course failure recorded as an 'XF' on the official transcript, academic suspension, or expulsion. Suspected violations are formally investigated and resolved through the Office of Academic Integrity in accordance with Faculty Handbook §6. For detailed information, consult the Office of Academic Integrity, Lovell Hall 315, (555) 555-0163, integrity@university.alkimi.ai.

Accessibility Services

Alkimi University is committed to providing equitable educational access and reasonable accommodations for all students with documented disabilities, including physical, sensory, psychological, learning, and chronic health conditions. Students requesting academic accommodations must formally register with the Office of Accessibility Services, Harlan Hall 204, (555) 555-0155, access@university.alkimi.ai. Once approved, students will receive an official Faculty Accommodation Letter detailing approved accommodations. Students should present this letter to the instructor as early in the semester as possible, and at least one week prior to any exam or assignment requiring accommodation. Accommodations cannot be applied retroactively.

Student Wellness and Mental Health

Your physical health, psychological well-being, and mental health are essential to your academic success. If you experience heightened stress, anxiety, depressive symptoms, personal trauma, or academic burnout, free, confidential counseling and medical care are available through the Hollis Health & Counseling Center, located in the Hollis Center. Routine appointments are available Monday–Friday 8:00 a.m.–6:00 p.m. and Saturday 10:00 a.m.–2:00 p.m. during the semester by calling (555) 555-0190 or emailing health@university.alkimi.ai. Urgent, 24/7 crisis psychological counseling is accessible immediately at (555) 555-0199.

Campus Student Support Services

- **Academic Advising Center:** Lovell Hall 101 | (555) 555-0158 | advising@university.alkimi.ai
- **Writing Center:** Whitcombe Library 3rd Floor | Free consultations on papers, reports, and research projects at any stage.
- **Whitcombe Library:** Whitcombe Library, Main Floor | (555) 555-0170 | askalibrarian@university.alkimi.ai
- **Hollis Health & Counseling Center:** Hollis Center | (555) 555-0190 | 24/7 Counseling Line: (555) 555-0199 | health@university.alkimi.ai
- **Structural Analysis Help Desk:** Rowan Engineering Center 140 | Drop-in tutoring for structural calculations and software modeling available Monday and Wednesday 4:00–7:00 p.m.