CE 172 STRUCTURAL STEEL DESIGN (Project-Based) (3-credit)

**Fall Semester - 2021**

**Mode of Instruction:** In-person

**Class Room:** VOTEY 209

**Time:** TR 2:50 – 4:05 PM

**Instructor:** Dr. Priyantha Wijesinghe

**Office:** VOTEY 235A

**E-mail:** pwijesin@uvm.edu

**Office Hours:** M &F 9 – 10 AM and W noon – 1 PM or by appointment. You must wear a mask for in-person office hours. If you are unable to attend in-person you may join via MS Teams.

# COURSE CATALOG DESCRIPTION:

**CE 172 Structural Steel Design.** Theory and design of steel structures including flexural members, axially loaded members and combined stress members; design of composite members; and plastic analysis and design; project-based. Prerequisite: CE 170.

# COURSE OBJECTIVES:

***Overall***

The fundamental principles behind the analysis and design of modern steel structures are studied in this course with the emphasis given to the design of steel members. The relationship between applied loads and their effect on steel structures are studied with a basic understanding of various modes of failure of steel members. Analysis and design of tension members, compression members, flexural members, combined stress members and simple connections are studied. The group design project involves designing a real-world multi-story structure and analyzing it using SAP2000. The course covers the concepts of both Load and Resistance Factor Design (LRFD) and Allowable Stress Design (ASD) methods in accordance with the 15th edition of AISC Steel Construction Manual.

***Specific Learning Outcomes and Objectives:***

Upon completion of *CE 172 Structural Steel Design*, students will be able to:

1. Identify steel as a structural material; review its material properties and identify different geometric shapes (hot-rolled and cold-formed)

2. Explain the specifications, loads and design philosophies, discuss the difference between ASD and LRFD methods

3. Analyze and design tension members for yield, fracture and block shear

4. Analyze and design compression members for buckling and yield

5. Apply plastic analysis to steel I beams

6. Apply lateral/torsional buckling to analyze and design beams

7. Integrate the considerations for shear, compact requirements, and deflection limits

8. Identify and explain different types of lateral force resisting systems in steel structures

8. Design for combined stresses under bending and axial load

9. Design and analyze simple connections

10. Design and analyze a real-world steel structure using SAP2000 and verify the analysis results using hand calculations

**RELATIONSHIP TO ABET STUDENT OUTCOMES (Criterion 3)**

|  |  |  |
| --- | --- | --- |
| ***Level of Instruction******(1-2)****M: moderate**H: High* | ***Outcome #*** | ***ABET Outcome*** |
| *H* | *1* | *an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics* |
| *M* | *2* | *an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors* |
| *M* | *5* | *an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives* |
| *M* | *7* | *an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* |

**TEXTBOOK (recommended):**

Structural Steel Design by Jack C. McCormac, 6th Edition, Prentice Hall, 2018.

**STEEL MANUAL (required):**

AISC Steel Construction Manual, 15th Edition, American Institute of Steel Construction, Inc.

***Note:***

Students enrolled for this course can purchase this manual through the instructor for the price of $135 when purchased through the AISC Student Discount Program. The coupon code and the website will be provided on the first day of class.

**REFERENCE BOOKS:**

* Steel Design by William T. Segui, 6th Edition, Cengage Learning, 2018.
* Steel Structures: Design and Behavior by Charles G. Salmon, John E. Johnson and Farris A. Malhas, 5th Edition, Prentice Hall, 2009.

**PEDAGOGY**

Students will be led through a review of reading and readiness assignments, case studies and several

example problems in each lecture period with opportunities to pause, reflect, and comment on what they’ve learned. Students will work in small groups duirng class and actively involve in their own leaning. The classroom response system, Top Hat will be used in each lecture for clicker questions, groups discussions and chats to promote active student engagemnet. Physical models and simulations will be used to demonstrate key concepts. New topics will be grounded in real world examples and case studies throughout. Students will actively participate in their group project throughout the semester.



**Classroom Environment Expectations:**

UVM expects students, faculty, and staff to remain compliant with all COVID-19 recommendations and measures in place for UVM, the State of Vermont, and the City of Burlington. This includes following all rules regarding facial coverings when attending class and generally in indoor spaces. If you do not follow these guidelines, I will ask you to leave the class. If you forget your mask, you cannot enter the class and should go back and retrieve your mask. The [Code of Student Conduct](https://www.uvm.edu/sites/default/files/UVM-Policies/policies/studentcode.pdf) outlines policies related to violations of University policies that protect health and safety on campus.

**Attendance and Illness:**

Students are expected to attend all regularly scheduled classes. With the exceptions outlined in the [Attendance Policy](http://catalogue.uvm.edu/undergraduate/academicinfo/rightsandresponsibilities/), the instructor has the final authority to excuse absences. Please note that class attendance, participation and clicker questions count 10% towards the overall course grade.

If a student will not be able to attend in-person classes for qualifying health reasons, Student Health Services (SHS) will send a notification to the [CEMS Office of Student Services](https://www.uvm.edu/cems/student-services) informing them of this along with the dates the student is unable to attend.  The SHS notification will specify whether the request for flexibility is only around in-person class attendance or includes additional flexibility for assignments and tests because the student is too ill to participate. Students are responsible for working with their faculty to make up class content and work they miss due to a documented illness

**Recording Class Sessions:**

If need arises, our class sessions may be audio-visually recorded for students in the class to refer back to, and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the chat feature, which allows students to type questions and comments live.

**GRADING:**

Class attendance, participation and clicker questions 10% (via *Top Hat*)

Homework and Case Study Quizzes 20% (will be assigned periodically)

Midterm Exams 20% (two, hour exams, each counts 10%)

Group Project 30%

Final Exam (comprehensive) 20% (due during finals week)

----------------------------------

Total 100%

The minimum passing grade is 60%. Other grades will be assigned as shown below.

|  |  |
| --- | --- |
| Letter Grade | Numerical Grade |
| A+ | 97-100 |
| A | 94-97 |
| A- | 90-93 |
| B+ | 87-89 |
| B | 83-86 |
| B- | 80-82 |
| C+ | 77-79 |
| C | 73-76 |
| C- | 70-72 |
| D+ | 67-69 |
| D | 63-66 |
| D- | 60-62 |
| F | <60 |

A statistical scale may be used at instructor’s judgment in addition to the above scale.

**EXAM AND HOMEWORK POLICIES:**

All exams will be timed, delivered in class and will be proctored. Make-up exams will be given at the discretion of the instructor, and appropriate documentation of absence will be required for consideration of a make-up exam. It is strongly encouraged to obtain prier permission from the instructor.

Additional instructions will be posted on Bb a week prior to the exam date.

Homework assignments will be assigned weekly and will be posted in the class website. All assignments will be collected at the beginning of class. You are required to follow the guidelines and the HW format posted on Bb to prepare your solutions. No late assignments will be accepted and there will be no make-up quizzes and no make-up “in-class’ questions and activities.

**COURSE OUTLINE**

1. **Introduction to Structural Steel Design (*text chapter 1*)**
	1. Steel as a Structural Material *(text sections 1.1-1.3)*
	2. Steel Sections (Hot-rolled and Cold-formed) *(text sections 1.4 &1.6)*
	3. Properties of Structural Steel (Stress-Strain Relationship etc.) *(text sections 1.7, 1.10 &1.12)*
	4. Types of Structural Steel *(text sections 1.8 & 1.9)*
	5. Design of Steel Members *(text sections 1.13 - 1.17)*
2. **Specifications, Loads and Design Philosophies *(text chapter 2)***
	1. Specifications and Building Codes *(text section 2.1)*
	2. Loads (Dead Load, Live Load and Environmental Loads) *(text sections 2.2 - 2.5)*
	3. Design Philosophies *(text sections 2.6-2.11)*
	4. Allowable Strength Design (ASD) *(text sections 2.6-2.11)*
	5. Load and Resistance Factor Design (LRFD) *(text sections 2.6-2.11)*
	6. Safety Factor and Resistance Factor *(text sections 2.12-2.13)*
3. **Analysis and Design of Tension Members *(text chapters 3 & 4)***
	1. Introduction *(text sections 3.1 - 3.2)*
	2. Net Area and Gross Area *(text section 3.3)*
	3. Tensile Strengths *(text section 3.2)*
	4. Effective Area *(text section 3.5)*
	5. Staggered Holes *(text section 3.4)*
	6. Block Shear *(text section 3.7)*
	7. Design of Tension Members *(text section 4.1)*
	8. Rods and Bars *(text section 4.3)*
	9. Tension Members in Roof Trusses *(text section 4.3)*
4. **Analysis and Design of Axially Loaded Compression Members *(text chapters 5 - 7)***
	1. Introduction *(text sections 5.1 & 5.3)*
	2. The Euler Formula *(text section 5.5)*
	3. Effective Lengths of Columns *(text section 5.6)*
	4. Local Stability *(text section 5.7)*
	5. Long, Short and Intermediate Columns *(text section 5.8)*
	6. AISC Column Formulas *(text section 5.9)*
	7. Design of Compression Members *(text section 6.1& 6.2)*
	8. Further Discussion of Effective Lengths *(text section 7.1 & 7.2)*
	9. Flexural-Torsional Buckling *(text section 6.10)*

**5.0 Analysis and Design of Flexural Members *(text chapters 8 - 10)***

5.1 Introduction and Types of Beams *(text sections 8.1 - 8.3)*

5.2 Plastic Analysis *(text sections 8.4 - 8.8)*

5.3 Bending Strength of Compact Shapes *(text sections 9.2 - 9.8)*

5.4 Bending Strength of Noncompact Shapes *(text section 9.9)*

5.5 Shear Strength *(text section 10.2)*

5.6 Deflection *(text section 10.3)*

5.7 Design

5.8 Floor and Roof Framing Systems

**6.0 Design of Beam-Columns *(text chapter 11)***

Introduction and Design Examples

**7.0 Design of Simple Connections *(text chapters 12 - 15)***

Introduction and Design Examples

**REQUIRED SOFTWARE AND PLATFORMS:**

Please read this technology check list to make sure you are ready for classes. <https://www.uvm.edu/it/kb/student-technology-resources/>
Students should contact the Helpline (802-656-2604) for support with technical issues.

This course uses resources in different formats. Please make sure that you can open a PDF document and watch a YouTube video. Adobe Acrobat Reader is needed to view PDF documents. If you do not have adobe reader on your computer you can download it for free from the Adobe website at <http://www.adobe.com>.

**Blackboard (Bb):**

Make sure you are using a supported browser to access Blackboard (Bb). To check your browser and for more help on using Bb, [please follow this link.](https://www.uvm.edu/it/kb/article-categories/bb-for-students/) Additionally, bookmark UVM Tech Team [Knowledge Base](https://www.uvm.edu/it/kb/article-categories/bb-for-students/) to get UVM-specific information, and to get one-on-one help, if needed.

Bb will be used to (a) organize all course materials, (b) deliver, collect and grade homework assignments and exams, (2) post grades, and (3) post weekly announcements.

**Top Hat**

We will be using Top Hat Pro ([www.tophat.com](https://t.tophat.com/t/9954/c/c45434e3-63a6-4582-83d6-de4844b667a7/NB2HI4B2F4XXO53XFZ2G64DIMF2C4Y3PNU7XGYTSMM6TCUCEJ5YEE2SMMF4VC5S2OJZHG52OKJ3FM3THEUZUIJJTIQSTENDCMVIGORRRGRLHKZKCJBVXU6DOIRCDKV3SM4STGRBFGNCA%3D%3D%3D%3D/www-tophat-com)) for class participation and attendance. Class participation includes, clicker questions, short quizzes, discussions and chats.

**Top Hat Pro requires a paid subscription**, and a full breakdown of all subscription options available can be found here: [www.tophat.com/pricing](https://t.tophat.com/t/9954/c/c45434e3-63a6-4582-83d6-de4844b667a7/NB2HI4B2F4XXO53XFZ2G64DIMF2C4Y3PNUXXA4TJMNUW4ZZ7ONRHEYZ5GFIEIT3QIJVEYYLZKF3FU4TSON3U4UTWKZXGOJJTIQSTGRBFGI2GEZKQM5DDCNCWOVSUESDLPJ4G4RCEGVLXEZZFGNCCKM2E/www-tophat-com-pricing).

You will be able to submit answers to in-class questions using Apple or Android smartphones and tablets, laptops, or through text message. You can visit the Top Hat Overview ([https://success.tophat.com/s/article/Student-Getting-Started-with-Top-Hat](https://t.tophat.com/t/9954/c/c45434e3-63a6-4582-83d6-de4844b667a7/NB2HI4DTHIXS643VMNRWK43TFZ2G64DIMF2C4Y3PNUXXGL3BOJ2GSY3MMUXVG5DVMRSW45BNI5SXI5DJNZTS2U3UMFZHIZLEFV3WS5DIFVKG64BNJBQXI%3D%3D%3D/success-tophat-com-s-article-student-getting-started-with-top-hat)) within the Top Hat Success Center which outlines how you will register for a Top Hat account, as well as providing a brief overview to get you up and running on the system.

An email invitation will be sent to you by email, but if you do not receive this email, you can register by simply visiting our course website:

<https://app.tophat.com/e/731319>

Note: our Course Join Code is **731319**

Should you require assistance with Top Hat Pro at any time please contact their Support Team directly by way of email (support@tophat.com), the in-app support button, or by calling 1-888-663-5491. Specific user information may be required by their technical support team when troubleshooting issues.

**MS Teams**

MS Teams will be used for office hours for those who cannot meet in-person. Please [follow this link](https://www.uvm.edu/it/kb/article/teams/) for instructions to download MS Teams. When you login, you should be able to see *Fall 2021 Office Hours for CE 172 and CE 271 (Prof Wijesinghe)* MS Team.

**SAP2000**

SAP2000 is a structural analysis software that you will use for the group design project. You can access SAP2000 via Virtual Votey. Please follow these [instructions](https://www.uvm.edu/cems/virtual-lab) to connect.

**Inclusive Learning Environment**

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

**Academic Integrity**

Offences against the **Code of Academic Integrity** are deemed serious and insult the integrity of the entire academic community. This policy addresses plagiarism, fabrication, collusion, and cheating. [https://www.uvm.edu/sites/default/files/UVM-Policies/policies/acadintegrity.pdf (PDF link)](https://www.uvm.edu/sites/default/files/UVM-Policies/policies/acadintegrity.pdf).

Any suspected violations of the code are taken very seriously and will be forwarded to the [Center for Student Conduct](https://www.uvm.edu/sconduct) for further intervention.

**Code of Student Conduct:**

[https://www.uvm.edu/policies/student/studentcode.pdf (PDF link)](https://www.uvm.edu/policies/student/studentcode.pdf)

**General statement regarding potential changes during the semester:**
<http://catalogue.uvm.edu/>
The University of Vermont reserves the right to make changes in the course offerings, mode of delivery, degree requirements, charges, regulations, and procedures contained herein as educational, financial, and health, safety, and welfare considerations require, or as necessary to be compliant with governmental, accreditation, or public health directives.

## Intellectual Property Statement/Prohibition on Sharing Academic Materials:

Students are prohibited from publicly sharing or selling academic materials that they did not author (for example: class syllabus, outlines or class presentations authored by the professor, practice questions, text from the textbook or other copyrighted class materials, etc.); and students are prohibited from sharing assessments (for example homework or a take-home examination). Violations will be handled under UVM’s Intellectual Property policy and Code of Academic Integrity.

**Student Learning Accommodations:**

In keeping with University policy, any student with a documented disability interested in utilizing ADA accommodations should contact Student Accessibility Services (SAS), the office of Disability Services on campus for students. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly recommended to discuss with their faculty the accommodations they plan to use in each course. Faculty who receive Letters of Accommodation with [Disability Related Flexible accommodations](https://www.uvm.edu/academicsuccess/forms/disability-related-flexibility-agreement) will need to fill out the Disability Related Flexibility Agreement. Any questions from faculty or students on the agreement should be directed to the SAS specialist who is indicated on the letter.

**Contact Student Accessibility Services (SAS):**

A170 Living/Learning Center
802-656-7753 (phone link)
access@uvm.edu (email link)
<https://www.uvm.edu/academicsuccess/student_accessibility_services>

**Health and Wellbeing**

The Center for Health & Wellbeing (CHWB) offers a wide range of services to support your mind, body, and soul while you're at UVM. The Student Health Services staff of board certified physicians, physician assistants, nurse practitioners, nurses, and dietitians work with patients and collaborate with other CHWB providers to ensure personalized and timely care to UVM students. Counseling & Psychiatry Services (CAPS) offers short-term individual counseling, urgent needs counseling, group counseling, outreach and education, psychiatry, referrals, and consultation services.

Please visit their website at: <http://www.uvm.edu/~chwb/> to find out more.

At Living Well they believe that mental and physical health go hand in hand. They have a variety of programs that offer you the space to create a wellness practice that will support your goals and positive intentions. I highly recommend you to visit their LivingWell website at <http://www.uvm.edu/~chwb/livingwell/> and checkout the meditation and yoga videos.

Extensive research has shown the benefits of meditation towards the learning process.

<http://www.huffingtonpost.com/2013/04/08/mindfulness-meditation-benefits-health_n_3016045.html>

**Counseling & Psychiatry Services (CAPS)**

Phone: (802) 656-3340

**C.A.R.E.** If you are concerned about a UVM community member or are concerned about a specific event, we encourage you to contact the Dean of Students Office (802-656-3380). If you would like to remain anonymous, you can report your concerns online by visiting the Dean of Students website at <https://www.uvm.edu/studentaffairs>

Tips for Success**:**

***Course-specific study/preparation tips***Checklist for success in <https://learn.uvm.edu/about/support-for-students/checklist-online-credit-courses/>

* Academic support for online courses: <https://www.uvm.edu/academicsuccess/online-learning-student-resources-remote-instruction>
* 30-minute webinar on online learning success (Mar 2020): <https://www.youtube.com/watch?v=Xp_MYsqQyvE>

Helpful resources other than the professor (e.g. [Undergraduate/Graduate Writing Center](https://www.uvm.edu/uwi/writingcenter), [Supplemental Instruction, Learning Co-op tutors](https://www.uvm.edu/academicsuccess/tutoring_center), supplemental course materials)

**Religious Holiday Policy Statement**

Students have the right to practice the religion of their choice. If you need to miss class to observe a religious holiday, please submit the dates of your absence to me in writing by the end of the first week of classes. You will be permitted to make up work within a mutually agreed-upon time.

**Grading:**

Your grades will be posted on Bb. Please check your grades frequently and notify me if you find any mistakes.

For information on grading and GPA calculation, go to the Registrar’s page on grading. <https://www.uvm.edu/registrar/grades> .

**Grade Appeals:**

If you would like to contest a grade, please follow the procedures outlined in this policy: [https://www.uvm.edu/policies/student/gradeappeals.pdf (PDF link)](https://www.uvm.edu/policies/student/gradeappeals.pdf)

**FERPA Rights Disclosure:**

The purpose of this policy is to communicate the rights of students regarding access to, and privacy of their student educational records as provided for in the Family Educational Rights and Privacy Act (FERPA) of 1974.
<http://catalogue.uvm.edu/undergraduate/academicinfo/ferparightsdisclosure/>

**Final exam policy:**

The University final exam policy outlines expectations during final exams and explains timing and process of examination period. <https://www.uvm.edu/registrar/final-exams>

**Statement on Alcohol and Cannabis in the Academic Environment**

As a faculty member, I want you to get the most you can out of this course. You play a crucial role in your education and in your readiness to learn and fully engage with the course material. It is important to note that alcohol and cannabis have no place in an academic environment. They can seriously impair your ability to learn and retain information not only in the moment you may be using, but up to 48 hours or more afterwards. In addition, alcohol and cannabis can:

* Cause issues with attention, memory and concentration
* Negatively impact the quality of how information is processed and ultimately stored
* Affect sleep patterns, which interferes with long-term memory formation

It is my expectation that you will do everything you can to optimize your learning and to fully participate in this course.