CE 321: Structural Design – I (Steel)

Semester I, 2012-2013

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Course Objective

This course is to serve as an introduction to the concepts of structural steel design through the use of the Indian Standard IS 800 design code. It deals the concepts of structures through the design of individual members and connections, such as, the design of tension members, compression members, beams, and beam columns; plate girders and bolted, and welded connections. The primary course objective is to equip the students with the tools necessary for designing steel structures and to familiarize them with the relevant national design codes.

Course Outline

1. Introduction: *Steel structures, material properties, Limit states and design philosophies; analysis and design methods, Loads, actions, partial safety factors and load combinations, Codes and standards*
2. Section Classification: *Role of plate buckling on section behaviour, Plastic, compact, semi-compact, and slender sections*
3. Tension members : *Design based on net section including shear lag effects and block shear, lug angles*
4. Compression members: *Design for flexural and flexural-torsional buckling, Effective length factor: Sway and Non-sway frames, Local buckling, Built-up columns - Battens and lacings*
5. Laterally Supported Beams: *Design strength using shear-moment interaction; Built-up beams, Shear buckling strength, Plate girders and design of stiffeners*
6. Laterally Unsupported Beams: *Lateral torsional buckling, Effect of restraints and effective length*
7. Beam-Columns: *Effect of axial load on flexure behaviour, P-M interaction and moment amplification, Flexural torsional buckling and Bi-axial bending.*
8. Connections: *Structural fasteners - Rivets, bolts and welds, strength under combined stresses, Bolted and Welded Connections - Simple and Eccentric, Frame connection and Column bases.*

Pre-requisite

ESO 204. *Mechanics of Solids*

Main Reference

BIS (2007). *IS 800:2007 General Construction in Steel-Code of Practice,* Bureau of Indian Standards, New Delhi.
This publication is urgently required; it is a necessity for every civil engineer and especially for students of this course. It is imperative that you possess your own copy and that you bring it to each lecture. A PDF copy can be downloaded from Kelkar Library's CD Services.

IS:808-1989 and *SP:6 (1)-1964: Handbook for structural steel sections*. Bureau of Indian Standards, New Delhi.
These publications provide geometric properties of IS rolled steel sections, connection details, etc.

References

Subramanian, N. (2008). *Design of Steel Structures,* Oxford University Press.

Duggal, S.K. (2010). *Limit State Design of Steel Structures*, Tata McGraw Hill.

Bhavikatti, S. S. (2010). *Design of Steel Structures (by Limit State Method as Per IS: 800 – 2007)*, IK International.

Shiyekar, M. R. (2010). *Limit State Design of Steel Structures*, PHI Learning.

Sai Ram, K. S. (2010). *Design of Steel Structures*, Pearson Education
Above books are written following the Limit State Design approach of the current IS 800:2007. It is advised that you should have a ready access to these books.

Negi, L.S. (1997). *Design of Steel Structures*, Tata McGraw Hill.

Dayarathnam, P. (1996). *Design of Steel Structures.* Wheeler.
These books refer Allowable Stress Design approach of the older IS 800:1984 and therefore not very useful for the course, however, can be used for general principles of steel design.

Segui, W.T. (2007). *Design of Steel Structures*, Cengage Learning.
A very good US textbook for the fundamentals of structural steel design and discusses all basic materials to be covered in this course. Albeit, design solutions refer to LRFD and ASD code provisions of American Institute of Steel Construction (AISC).

McCormack, J. C. and Nelson, J. K. (2003). *Structural Steel Design: LRFD Method*, Prentice Hall.

Engelkirk, R. (1995). *Steel Structures*, Prentice Hall.

Galambos, T.V. (1996). *Basic Steel Design with LRFD*, Prentice Hall.

Salmon, C.G. and Johnson, J.E. (1996). *Steel Structures: Design and Behaviour*, Prentice Hall.
An advanced book on steel structures for serious students.

Homework

Homework problems will be assigned regularly to help you deepen the understanding of the course material covered. You are strongly advised to attempt them. They will be graded and solution will be posted on the course website. Please remember the reason you are asked to do homework, which is so that you can learn to reason and solve these types of problems yourself! You can work in groups; however, you have to submit the solution in your own handwriting. They are due in the class on the assigned day. Late submissions will attract a penalty of 50% upto

one week and after that they will not be graded.

Homework grading policy

Motivation

Emphasis of homework assignment is on developing your skills to solve problems completely and correctly and to present it in a neat and legible manner so that it can be understood easily by others verifying it. Remember that engineering calculations are not for you; they are for someone else to read and decipher, so an organized, neatly done presentation is essential. Homework submissions, therefore, will be graded for the accuracy of solution as well as its presentation separately and overall grade will be based on the composite score as per the following description:

Grades for the** accuracy **of results

A: All answers are correct, **B**: A few mathematical errors, **C**: More than a few mathematical errors, and **D**: Conceptual or serious mathematical errors.

***Grades for the** presentation*

N: Neat (*All* calculations *shown, codal references mentioned, diagrams labeled, units mentioned, etc.*), **F**: Fair, **P**: Poor (*Hastily done, looks copied, missing details or problems*)

Overall grade

100% : A+N, **90%**: A+F, B+N, **80%**: A+P, B+F; **70%**: C+N/F, B+P; **60%**: D+N/F/P, C+P

Tutorial Sessions

Tutorials sessions will be used to illustrate lecture materials through design examples and discuss design projects and homework problems.

Design Projects

In addition to the homework, there will be three design projects assigned during the course. You may work in a group of *four*. It is expected that you develop design solutions through discussions and collaboration as usually happens in design offices. They are due in the class on the assigned day. No grades will be awarded for late submissions; they can be delayed or rescheduled for a *very good* reason by *prior* permission.

Submission Rules

All submitted work, homework solutions, design projects and exams, must be presented in a manner which shows a clear and logical approach to your solution. Make sure that you mark and delineate each step along the way and explain your work. IS 800 formulas should be written in symbolic form with the IS 800 reference number before any numerical computations performed. Also, pertinent code references should be included where possible. The final design must be clearly labeled with appropriate units or designation and underlined or boxed. When necessary, provide final design drawings which must be clearly lettered (such as when designing connections). Although no computer output is required, your penmanship must be neat. All work should be self explanatory as if it were a final copy of design calculations for archival. These will not only make your submissions a better reference for the future for you but will also help me to give partial credits for incorrect answers. You are encouraged to use software like *MathCad* to reduce time and effort in design iterations.

Attendance

You are expected to attend every class session. However, to qualify for a pass grade, you must have a minimum of 80% attendance. Please take note of the fact that excessive absenteeism will surely reflect on your performance and affect your course grade negatively. Further, it may help favourably in deciding borderline cases while assigning final course grade!

Grading

The course grade will be based on: Homework —15%, Design Project —25%, Quizzes—10%, Mid-sem exam —20%, Final exam—30%, and Bonus for 80% and above attendance —10%.

Passing grades (D or better) will be given only to those students whose overall score exceeds 55%. A grade of "A" is guaranteed for overall score of 90% or higher. Corresponding guarantees for "B" and "C" grades are 80% and 70%, respectively. Actual cutoffs may be different, but those are not guaranteed.

Academic Dishonesty Policy

Students who violate Institute rules on academic dishonesty (by violating the Honor Code in exams and quizzes, indulging in proxy attendances, etc), will subject to disciplinary action as described in UG Manual (http://www.iitk.ac.in/doaa/ugweb.htm#Art120). Penalties include the possibility of failure in the course and/or dismissal from the Institute. Since such dishonesty harms the individual, all students, and the integrity of the Institute, policies on academic dishonesty will be strictly enforced.

Honor code policy has not been perfect for IIT Kanpur too! Experience tells us that resolving cheating situations can be very painful and time consuming. Prevention appears to be the next best solution; however, it assumes that cheating is inevitable, if not stopped. Despite ensuing displeasure and agony, please be ready for randomized seating plan just before exam, multiple variations of question papers and intrusive proctoring!