GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Civil Engineering

Subject Code: DI04006031

Subject Name: Design of Steel Structures

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	PCC

Prerequisite:	Mechanics of Structures-I
Rationale:	After gaining foundational knowledge through Mechanics of Rigid Bodies in the second semester and Mechanics of Deformable Bodies in the third semester, students are introduced to Design of Steel Structures in the fourth semester. This subject plays a crucial role in shaping a Civil Engineering students' understanding of structural design, making it one of the core components of the curriculum. Steel, being a widely used construction material due to its high strength-to-weight ratio, ductility, and ease of fabrication, requires careful design considerations to ensure structural safety and serviceability. The course bridges the gap between theoretical mechanics and real-world structural design, focusing on both analysis and application. The subject introduces students to the fundamental principles and practices involved in designing steel structures in accordance with Indian Standards (IS 800:2007).

Course Outcome:

After completion of the course, the student will be able to:

No	Course Outcomes	RBT Level
01	Interpret steel behavior, relevant codes, and load calculations with combinations in steel structure design.	R,U
02	Design safe, economical bolted and welded connections as per IS 800:2007.	R,U,A
03	Analyze and design tension and compression members as per IS 800:2007 for safe, efficient steel structures.	R,U,A,N
04	Calculate dead, live, and wind loads on steel roof trusses using IS code provisions.	R,U,A
05	Analyze and design laterally restrained beams and purlins for strength and safety using IS 800:2007.	R,U,A

Revised Bloom's Taxonomy (RBT)

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	**T**	**PR**	**C**	**ESE (E)**	**PA (M)**	**PA (I)**	**ESE (V)**	
2	0	2	3	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Fundamental of Steel Design** 1.1 Steel versus RCC as a building material. Advantages and disadvantages of steel. Types of steel sections normally in use. 1.2 Characteristic strength and design strength, Stress-strain curve for mild steel. Partial safety factors for load and materials as per IS provision 1.3 Limit state of strength and serviceability.	02	5
2.	**Bolted and Welded connections** 2.1 Types of connections in steel structures Bolted connection: Types of bolts, Black Bolts, Turned Bolts, HSFG Bolts, Grade of Bolts Lap and Butt Joint, Minimum and Maximum Pitch, Tack Bolting, Edge Distance, Gauge Distance, Bolt Hole. 2.2 Shear Capacity of Bolt – Vdsb, Bearing Capacity of Bolt – Vdpb as per IS-800-2007, Bolt Value, Efficiency of Joint. 2.3 Analysis and design of bolted connection of plate and Angle sections (Only Shear connections). Numericals based on this. 2.4 Welded connection: Types of weld, Fillet Weld and its symbol, tack welding, minimum and maximum size of weld, effective throat thickness, end returns. 2.5 Analysis and design of Fillet weld in plate and angle section as per IS-800-2007. Numericals based on this.	06	20
3.	**Load Calculation for Roof Truss** 3.1 Types of Truss for various spans, Pitch of Truss, Rise, Spacing of Truss, Members of Truss: Purlin, Principal Rafter, Main Tie, Sag Tie. Joints: eave joint, ridge joint, intermediate joint and middle	06	20

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	bottom joint. Roofing material- GI and AC Sheets. 3.2 Types of load and load combinations for roof truss as per IS 875 codal provisions. 3.3 Dead Load of Truss per panel point: self weight ,weight of Purlin , Wind Bracing , and weight of Roofing Material . 3.4 Live Load per panel point on purlin and Truss. 3.5 Wind Load per panel point on roof truss 3.6 Numericals on dead load, live and wind load for roof truss.		
4.	**Tension Member** 4.1 Types of sections used as Tension Members in Steel Structures. 4.2 Design strength of Tension Member governed by Yielding, rupture of critical section and Block shear in Angle section according to provision of IS: 800-2007 4.3 Analysis and Design of Axially loaded tension members - Single and Double angle section with Bolted and welded connections. 4.4 Numerical of Analysis and design of tension members for single and double angle sections with bolted and welded connections.	06	20
5.	**Compression Member (Strut)** 5.1 Type of sections to be used as compression members in steel structures. Calculation of effective length, radius of gyration, slenderness ratio and its permissible value as per IS:800-2007. 5.2 Cross section classification, Buckling class, Imperfection factors as per IS:800-2007 5.3 Design compressive strength of (i) Axially loaded compression members (ii) Single angle struts (iii) Double angle struts as per IS:800-2007 5.4 Numerical of Analysis and design of compression members (Struts) for single angle section, double angle section, with bolted and welded connections (No Column Design).	06	20
6.	**Laterally Restrained Beam and Purlin** 6.1 Main Beam , Secondary Beam , Standard I Sections , Laterally restrained (only) symmetrically loaded with UDL and/or point load. 6.2 Plastic Section Modulus – Annexure –H , IS-800-2007 , Section classification as per Table 2 – IS-800-2007 , Shear buckling , Shear Strength and Bending Strength of Section as per Cl. 8.4.1 and Cl. 8.2.1.2 of IS-800-2007 , Deflection as per Table-6 of IS-800-2007 ,	04	15

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	Shear Leg Effect , Web Crippling		
	Total	**30**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**20**	**55**	**10**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyse and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

   (a) Books:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Design of Steel Structures by Limit State Method as per IS:800-2007	S.S. Bhavikatti	Dreamtech press New Delhi ISBN:9389307058
2	Limit State design of Steel structures	S.K. Duggal	Mc Graw Hill ISBN: 9353164877
3	Limit State design of Steel structures as per IS:800-2007	S. Kanthimathinathan	Dreamtech press, New Delhi ISBN:9389447577
4	IS:800-2007-Indian Standard Code of practice for use of structural steel in general building construction.	BIS, New Delhi	BIS, New Delhi
5	SP:6-Handbook for Structural Engineers (Structural Steel Sections)	BIS, New Delhi	BIS, New Delhi
6	IS 875 (Part 1) (1987): Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures – Dead Loads	BIS, New Delhi	BIS, New Delhi
7	S 875 (Part 2) (1987): Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures – Imposed Loads	BIS, New Delhi	BIS, New Delhi

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Sr. No.	Title of Book	Author	Publication with place, year and ISBN
8	IS 875 (Part 3) (2015): Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures – Wind Loads	BIS, New Delhi	BIS, New Delhi

NOTE:- *Use of IS:800-2007, SP:6 and IS: 875(Part 1 to 3) are permitted during Examination.*

(b) Open source software and website:

List of **open-source (or free-to-use)** software tools that can be used for teaching or learning **Design of Steel Structures:**

1. Ftool
   - **Type:** 2D frame analysis software (Free)
   - **Developed by:** COPPE/UFRJ (Brazil)
   - **Use:** Analysis of trusses and beams
   - **User-Friendly:** Great for teaching support reactions, moment diagrams
   - **Platform:** Windows
   - **Website:** https://www.ftool.com.br/Ftool/
2. SkyCiv (Free Version for Students)
   - **Type:** Cloud-based structural analysis software
   - **Use:** Beam, truss, and frame analysis
   - **Note:** Free basic version available; educational licensing
   - **Website:** https://www.skyciv.com
3. NPTEL Videos
   - IIT courses on steel design (Free)
   - URL: https://nptel.ac.in/courses/105105162
4. BIMserver
   - Open-source BIM platform- helpful for steel detailing workflow
   - URL: https://www.adriabim.com/strubim-steel-software-for-steel-structures-design/
5. LibreCAD
   - Lightweight 2D CAD software (Free alternative to AutoCAD).

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Suggested Course Practical List:

Sr. No.	Practicals	Unit No.	Approx. Hrs. required
1	Interpret IS Code provisions for Limit state Steel Design from IS:800-2007 and SP-6.	1	2
2	Draw sketches (not to scale) showing details for standard rolled steel sections, built up sections, Beam to Beam and Beam to Column connections (Bolted and Welded). (Sheet1) (A2 Sheet Size)	2	2
3	Design a bolted connection for the given data of steel section as per IS: 800-2007.	2	4
4	Design a welded connection for the given data of steel section as per IS: 800-2007.	2	4
4	Draw sketches for types of roof trusses, components of roof truss and important four joints like ridge joint, eave joint, bottom middle joint and intermediate joint. (Sheet5) (A2 Sheet Size)	3	2
6	Interpret IS provision for dead load, live load and wind load for steel roof truss from IS 875 (Part- I to III)	3	2
7	Calculate dead load, live load and wind load for the given data of steel roof truss with graphical method. Sheet2: Space & Stress Diagram of D.L./L.L. (A2 Sheet Size) Sheet3: Space & Stress Diagram of W.L. (A2 Sheet Size) Sheet4: Force Table (A2 Sheet Size)	3	4
8	Analyse and Design Axially Loaded Tension Member made up of Angle Section (Equal or Unequal), ISA or 2ISA (1-Problem Each).	4	4
9	Analyse and Design Strut made up of Angle Section (1-Problem Each).	5	4
10	Design laterally restrained steel beam and purlin. (1-Problem Each)	6	2
	Total hours		**30 Hrs.**

List of Laboratory/Learning Resources Required:

Sr. No	Learning Resources	Practical No.
1	IS Codes and Standards: • **IS:800-2007** – General Construction in Steel – Code of Practice • **IS:875 (Part 1 to 3)** – Code of Practice for Design Loads ○ **URL**: https://standardsbis.bsbedge.com/	1 to 10

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Sr. No	Learning Resources	Practical No.
2	Handbooks and Design Manuals: • **SP:6(1)** – Handbook for Structural Engineers: Steel ○ **URL**: https://standardsbis.bsbedge.com/	1 to 10
3	Software Tools: (If available) ○ **STAAD.Pro / ETABS / SAP2000** – Structural Analysis & Design **URL**: https://www.bentley.com/software/staad/ ○ **URL:** https://www.csiamerica.com/products/etabs ○ **URL:** https://www.csiamerica.com/products/sap2000 • **AutoCAD** – For Drafting and Detailing • **Tekla Structures** – For Steel Connection Detailing (if available) ○ **URL**: https://www.tekla.com/in/products/tekla-structures	2, 5,6,7,9,10
4	Drawing and Detailing Equipment • Drawing sheets (A2 size) • Pencils, set squares, compass, scale • CAD lab access with printer/plotter (if available)	2,9,10
5	Models / Demonstration Aids • Physical models of standard steel sections (I, L, T, C) • Scaled models of trusses and frames • Sample bolted and welded connections	2,3,4,9,10

Suggested Project List:

a) Prepare a drawing in AutoCAD for Dead load, Live load and Wind Load for the given roof truss and compare the answers with the manual drawing.

b) Carry out a market survey for steel sections that are available in the market but not included in the steel table or SP:6.

c) Compare the design and analysis done manually with computer software or Excel worksheets for at least one of the lists below.
- Steel Design and analysis for axially loaded Tension members, axially loaded compression members, laterally restrained beams, and Purlins.

d) Prepare a spreadsheet computer program to design at least one of the following.
- Steel Design and analysis for axially loaded Tension members, axially loaded compression members, laterally restrained beams, and Purlins.

e) Analyse and design a steel roof truss or a residential block building with structural engineering software.

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Suggested Activities for Students: If any

a) Collect different photographs of steel structural members (by visiting railway stations, warehouses or industrial sheds) where connections can be shown actually implemented at the site.

b) Collect the photographs of five different types of rolled steel sections.

c) Collect the information with photographs of world-famous steel structures from journals or websites.

d) Identify different situations with photographs of steel structural members where tensile force is predominant in the field. (Bridge, Railway station).

e) Identify different situations with photographs of steel structural members' connections (Bolted & welded connections).

f) Identify different situations with photographs of steel structural members where compressive force is predominant in the field. (Suspension bridge, Railway bridge).

g) List out various software available for steel design and submit a review report.

h) Use of a computer program (software or Excel worksheets) to compare the results of design and analysis problems solved manually.

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