DESIGN OF STEEL STRUCTURES

Subject code: **CE601PC**

Regulations: R16-JNTUH

Class: III Year B. Tech CE II Sem

DEPARTMENT OF CIVIL ENGINEERING

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

Ibrahimpatnam - 501 510, Hyderabad

DESIGN OF STEEL STRUCTURES (CE601PC)

COURSE PLANNER

I. COURSE OVERVIEW:

This course is recommended for undergraduate students of Civil engineering program who are interested in learning the design of steel structures. The objectives of this are to learn the behavior and design of structural steel. The course is structured to introduce inelastic analysis of steel structures, issues of strength and stability and its application to design for cases of extreme loading, and related code provisions. The objective of the course is to make the student conversant with the design principles of steel structural elements as per IS Codal provisions

II. PREREQUISITE(S):

Level	Credits	Periods	Prerequisite
UG	4	5	Structural Analysis I& II

III. COURSE OBJECTIVES:

The objectives of the course are to enable the student;

1. To the student conversant with the design principles of steel structural elements as per IS Codal provisions
2. To know the design of different steel structural elements
3. To understand the behavior and response of steel
4. To analyze the forces acting on the steel structures
5. To give economical steel section designs

IV. COURSE OUTCOMES:

At the end of this course, a student will be able to:

COURSE OUTCOMES	Description	Blooms Taxonomy Levels	PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES
C01	Understand the characteristic properties and behavior of steel material.	Understand	PO1,PO2,PO3, PSO 1
C02	Understand the different design procedures	Understand	PO1,PO2,PO3, PO5, PSO 1
C03	Design tension and compression members	Design	PO1,PO2,PO3, PO5, PSO 2
C04	Design beams and beam columns	Design	PO1,PO2,PO3, PO5, PSO 1, PSO 2

C05	Design bolt and weld connections, Design built up members and Column base, Design of plate girders and Roof Trusses	Design	PO1,PO2,PO3, PO5, PSO 1, PSO 2

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		**Level**	**Proficiency assessed by**
PO1	**Engineering knowledge**: To Apply the knowledge of mathematics, science, engineeringfundamentals/principals, and civil engineering to the solution of complex engineering problems encountered in modern engineering practice.	0.4	Assignments
PO2	**Problem analysis**: Ability to Identify, formulate, review research literature, and analyze complexengineering problems related to Civil Engineering andreaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1.2	Exercise, Exams
PO3	**Design/development of solutions**: Design solutions for complex engineering problems related to Civil Engineering anddesign system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	0.4	Exercise
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	-	Discussion, Seminars
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modernengineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1.2	Discussion, Seminars
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Civil Engineering professional engineering practice.	-	Discussions
PO7	**Environment and sustainability**: Understand the impact of the Civil Engineeringprofessional engineering solutionsin societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	-	------
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.	-	------

PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader indiverse teams, and in multidisciplinary settings.	-	------
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	-	------
PO11	**Project management and finance**: Demonstrate knowledge and understanding of theengineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	-	-----
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage inindependent and life-long learning in the broadest context of technological change.	-	Prototype, Discussions

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program outcomes		**Level**	**Proficiency assessed by**
PSO 1	**ENGINEERING KNOWLEDGE:**Graduates will be able to apply technical knowledge in drawing, analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good basics in mathematics, basic sciences and technical communication.	1.2	Lectures and Assignments
PSO 2	**BROADNESS AND DIVERSITY:**Graduates will be able to summarize and can demonstrate about societal, economical, environmental, health and safety factors involved in infrastructural development, and shall work within multidisciplinary teams with competence in modern tool usage.	-	Tutorials
PSO 3	**SELF-LEARNING AND SERVICE:**Graduates will be able to pursue lifelong learning and professional development to face the challenging and emerging needs of our society, ethically and responsibly.	-	Seminars and Projects

1 - None **2 - Supportive** **3 – Highly Related**

VII. SYLLABUS:

UNIT – I:

Materials - types of structural steel-Mechanical Properties of Steel - Concept of Plasticity, Yield Strength. Loads and Combinations local buckling behavior of Steel.

Concept of Limit State Design –Limit States – Design Strengths - Deflection Limits – Serviceability – serviceability – stability check – Bolted connections-Riveted connections-IS-

800-2007- specifications- Design strength- efficiency of a joint- Prying Action -, Types of Welded connections - Types of Welded joints- Specifications - Design requirements.

UNIT – II:

Design of tension Members – Design strength – Design procedure splice – lug angle.Design of compress in members- Buckling class- slenderness ratio/ strength design- laced- battened columns- splice- column base- slab base.

UNIT – III:

Plastic theory , Plastic hinge, theorems of plastic analysis classification of beams as oer IS 800-2007.

Design of beams- Plastic Moment - Bending and Shear Strength / buckling – Built up sections- laterally/ supported beams- Design of eccentric connections- Framed- Stiffened/ seat connections.

UNIT-IV:

Design of plate girders- elements-economical depth-design of main section- connections between web and flange- design of stiffness bearing- intermediate stiffeners- Design of websplica & Flange splica.

UNIT-V:

Design of roof trusses- Types of roof trusses, loads on trusses- purlin design- truss design, Design of joints and end bearings.

SUGGESTED BOOKS:

TEXT BOOKS:

1. Steel Structures by Subramanyam.N, Oxford Higher Education, New Delhi.
2. Limit State Design of steel structures by S.K. Duggal, Tata McGraw-Hill, New Delhi.

REFERENCE BOOKS:

1. Design of steel structures by k.s.Sai ram ,person education
2. Design of Steel Structures by Edwin Gaylord,Charles Gaylord,James Stallmeyer, Tata Mc.Graw-Hill, New Delhi.
3. Design of steel structures vol.1&2-ram Chandra,standard publications
4. Design of steel structure,structures,.s.s bhavikatti,ik int publications house,new delhi,2010

MOOC'S- SWAYAM/ NPTEL:

https://nptel.ac.in/courses/105106112/

https://nptel.ac.in/courses/105106112/

GATE SYLLABUS:

Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Plastic analysis of beams and frames.

IES SYLLABUS:

Principles of Working Stress methods, Design of tension and compression members, Design of beams and beam column

connections, built-up sections, Girders, Industrial roofs, Principles of Ultimate load design.

VIII. COURSE PLAN:

Lecture No.	Week	Unit	Topics to be covered	Learning Objective	Teaching Methodlogy	References
1.	1	1	**UNIT-I** Introduction to DSS	**To understand:** Introduction to Materials	Chalk & talk	R3, T1,T2
2.	1	1	Materials - types of structural steel	**To learn:** Concepts of limit state design	Chalk & talk	R3, T1,T2
3.	1	1	Concept of Plasticity, Yield Strength	**To understand:** Code for Steel Structures	Chalk & talk	R3, T1,T2
4.	2	1	Concept of Limit State Design	**To understand:** Design of Connections	Chalk & talk	R3, T1,T2
5.	2	1	Limit States – Design Strengths	Riveted connections	Chalk & talk	R3, T1,T2
6.	2	1	Deflection Limits	**To understand:** Design strength	Chalk & talk	R3, T1,T2
7.	2	1	Serviceability – serviceability – stability check	**To learn:** Design strength	Chalk & talk	R3, T1,T2
8.	3	1	Bolted connections-Riveted connections	**To understand:** efficiency of joint	Chalk & talk	R3, T1,T2
9.	3	1	Bolted connections-Riveted connections	**To understand:** efficiency of joint	Chalk & talk	R3, T1,T2
10.	3	1	IS-800-2007-specifications	**To learn:** Welded connections	Chalk & talk	R3, T1,T2
11.	3	1	Design strength-efficiency of a joint	**To understand:** Design of Welds	Chalk & talk	R3, T1,T2
12.	4	1	Design strength-Prying Action	**To learn:** Tension Members	Chalk & talk	R3, T1,T2
13.	4	1	Types of Welded connections	**To understand:** Design strength,	Chalk & talk	R3, T1,T2

				Design		
14.	4	1	Types of Welded joints- Specifications	**To learn:** procedure, splice lug- angle.	Chalk & talk	R3, T1,T2
15.	5	1	Design requirements	**To understand:** Problem related to tension members	Chalk & talk	R3, T1,T2
16.	5	2	**UNIT-II** Design of tension Members	Introduction to tension and compression members	Chalk & talk	R3, T1,T2
17.	5	2	Design strength	**To understand:** Design strength of tension members	Chalk & talk	R3, T1,T2
18.	6	2	Design procedure splice – lug angle	**To learn:** Splice and lug angle	Chalk & talk	R3, T1,T2
19.	6	2	Design of compress in members	**To understand:** Introduction to compression members	Chalk & talk	R3, T1,T2
20.	6	2	Buckling class	**To learn:** Buckling class	Chalk &talk	R3, T1,T2
21.	7	2	slenderness ratio/ strength design	**To learn:** Problems on slenderness ratio	Chalk & talk	R3, T1,T2
22.	7	2	laced- battened columns	**To understand:** To know Laced and battened columns	Chalk & talk	R3, T1,T2
23.	7	2	splice- column base- slab base.	**To learn:** To know Splice column base slab base	Chalk & talk	R3, T1,T2
24.	8	3	**UNIT-III :** Introduction to Plastic Theory, Plastic hinge,	**To understand:** To know Plastic Theory and plastic hinge	Chalk & talk	R3, T1,T2
25.	8	3	Theorems of plastic Analysis	**To learn:** To know plastic Analysis	Chalk & talk	R3, T1,T2
26.	8	3	Classifications of beams as perI.S 800-2007	**To understand:** Classifications of beams as per I.S 800-2007	Chalk & talk	R3, T1,T2
27.	8	3	Design of beams- Pwlastic Moment	**To understand:** Concept of plastic moment	Chalk & talk	R3, T1,T2
28.	9	3	Bending and Shear Strength / buckling	**To learn:** To know Bending and Shear	Chalk & talk	R3, T1,T2

				Strength / buckling		
29.	9	3	Built up sections- laterally/ supported beams	**To understand:** Bending and shear strength of beams	Chalk & talk	R3, T1,T2
30.	10	3	Design of eccentric connections – Framed – stiffened/ seat connection.	**To learn:** Design of eccentric connections	Chalk & talk	R3, T1,T2
31.	10	4	**UNIT-IV** Design of plate girders	**To understand:** Introduction to plate girders,	Chalk & talk	R3, T1,T2
32.	10	4	Design of plate girders	Introduction to plate girders,	Chalk & talk	R3, T1,T2
33.	10	4	elements- economical depth-	**To understand:** economical depth,	Chalk & talk	R3, T1,T2
34.	11	4	design of main section-	**To learn:** design of main section.	Chalk & talk	R3, T1,T2
35.	11	4	connections between web and flange	**To understand:** Connections between web flange,	Chalk & talk	R3, T1,T2
36.	11	4	design of stiffness bearing	design of stiffness bearing, intermediate stiffeners,	Chalk & talk	R3, T1,T2
37.	12	4	design of intermediate stiffeners	**To understand:** design of web splice and flange	Chalk & talk	R3, T1,T2
38.	12	4	Design of websplica	**To understand:** Design of Plate girder using IS 800:2007 Problems related.	Chalk & talk	R3, T1,T2
39.	12	4	Design of websplica problems	**To learn:** Design of Plate girder using IS 800:2007 Problems related.	Chalk & talk	R3, T1,T2
40.	12	4	Design of Flange splica.	**To learn:** Design of Flange splica.	Chalk & talk	R3, T1,T2
41.	13	5	**UNIT-V** Design of roof trusses	**To understand:** Introduction to roof trusses , Bracings ,Types of Roof Trusses	Chalk & talk	R3, T1,T2

42.	13	5	loads on trusses	**To understand:** Design considerations Nomenclature of member of trusses	Chalk & talk	R3, T1,T2
43.	14	5	Types of roof trusses	**To learn:** Types of loads, load Combinations Simple Problems related to load Combinations	Chalk & talk	R3, T1,T2
44.	14	5	Types of roof trusses	**To understand:** Types of loads, load Combinations Simple Problems related to load Combinations	Chalk & talk	R3, T1,T2
45.	14	5	Design of purlin	**To learn:** Analysis of trusses, design of members,	Chalk & talk	R3, T1,T2
46.	15	5	Design of truss	**To understand:** Design of joints, End bearings	Chalk & talk	R3, T1,T2
47.	15	5	Design of joints and end bearings	**To understand:** Design of joints, End bearings	Chalk & talk	R3, T1,T2
48.	16		1st unit revision			
49.	16		2nd unit revision			
50.	16		3rd unit revision			
Beyond Syllabus						
51.	16		*Analysis and Design of Industrial Buildings			
52.	16		*Dynamic Analysis of Structures			

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	2	3	-		-	-	-	-	-	-	-	-	3	-	-
II	-	-	-			-		-	-	-	-	-	-	-	-
III	-	3	-	--	3	-	-	-	-	-	-	-	3	-	-
IV	-	-	-			-	-	-	-	-	-	-	-	-	-

V	-	-	2		3	-	-	-	-		-	-	-	-	-
average	0.4	1.2	0.4	-	1.2	-	-	-	-	-	-	-	1.2	-	-

1=None **2=Supportive** **3=Highly related**

X. QUESTION BANK: DESCRIPTIVE QUESTIONS: (WITH BLOOMS PHRASES)

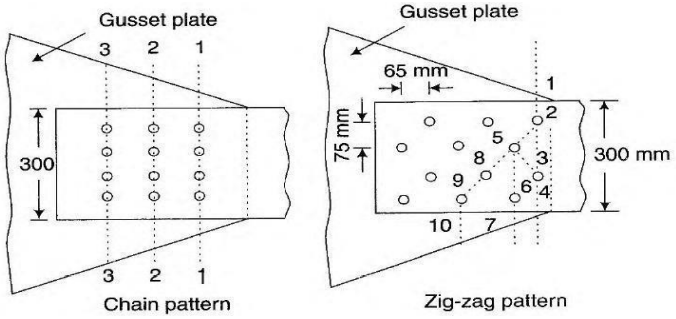
UNIT-I

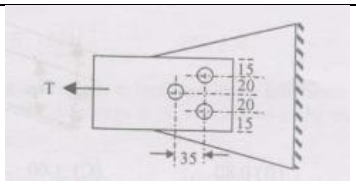
SHORT ANSWER QUESTIONS-

S.NO	Question	Blooms Taxonomy Level	Programme Out come
1.	What are the advantages and disadvantages of steel as a structural material?	Understand	1
2.	State the physical and mechanical properties of steel as a structural material.	Remember	1
3.	How the standards and specifications are different from codes?	Understand	1
4.	Why is it necessary to follow codes of practice for designing structures?	Understand	1
5.	Find the shape factors for a Square of side ‘a’ with its diagonal parallel to the zz- axis.	Understand	1
6.	Sketch the typical stress-strain curve of steel, indicating the important regions.	Remember	2
7.	What is meant by ductility? Why and where is it important?	Understand	2
8.	How the toughness of steel is measured?	Remember	2
9.	How are residual stress induced in steel sections? Sketch the typical residual stress distribution in a rolled I beam and a welded I beam.	Understand	2
10.	How do residual stresses affect design of intermediate columns and beams?	Understand	2

LONG ANSWER QUESTIONS-

S.No	Question	Blooms Taxonomy Level	Programme Out come
1.	How the local buckling of steel structural shapes does affect the member strength? How is it avoided?	Understand	1
2.	What are the defects that may originate while rolling steel section?	Remember	1
3.	Strength and ductility of steel are equally important for steel structures. How are these improved? If the strength is to be increased while retaining the desired ductility of steel. What is done?	Understand	2

4.	Draw idealised stress-strain curve for mild-steel. Discuss the effect of residual stresses.	Remember	2
5.	A specimen was tested in laboratory and the yield strength was found to be 250 N/mm^2. Taking a factor of safety of 2. Find the working stress.	Understand	1
6.	A 100 mm long steel bar and having a square cross section of 20 mm is pulled in tension with a load of 90 kN. It experiences an elongation of 0.10 mm. Assuring that the deformation is entirely elastic, determine the modulus of elasticity of the steel.	Understand	1
7.	Hot-rolled steel sections are used to fabricate steel sections. Under no load Condition whether the section will have stresses? Comment!	Understand	2
8.	An ISA 65 x 65 x 10 carries a tensile load of 200 KN, applied along its centroidal axis. This angle is to be welded to a gusset plate. Find out the Lengths of side fillet welds required at the heel and toe of the angle	Understand	3
9.	A 300 ISF 14 mm of grade Fe410 is used as a tension member in a lattice girder. It is connected to a 18 mm thick gusset plate by 18 mm diameter bolts of grade 4.6 Calculate the effective net area of the member, if (a) chain bolting is done as shown inFigure1. (b) zig-zag bolting is done as shown inFigure1. 	Understand	3
10.	A steel flat of rectangular section of size 70 × 6 mm is connected to a gusset plate by three bolts each having a shear capacity of 15 kN in holes having diameter 11.5 mm. If the allowable tensile stress in the flat is 150 MPa, Find the maximum tension that can be applied to theflatis	Understand	3

UNIT-2

SHORT ANSWER QUESTIONS-

S.N	Question	Blooms Taxonomy Level	Programme Out come
1.	What is buckling?	Remember	4
2.	Two steel columns P (length L and yield strength f_y=250 MP_a) and Q (length 2L and yield strength f_y=500 MP_a) have the same cross-sectionsand end-conditions. Find the ratio of buckling load of column P to thatof column Q.	Understand	4
3.	What is radius of gyration?	Remember	4
4.	What is slenderness ratio? State the relation between elastic critical stress and slenderness ratio.	Remember	4
5.	Compression members are more critical than tension members. Comment!	Understand	4
6.	Why are plastic or compact sections preferred for compression members?	Understand	4
7.	What is the difference in behaviour of long and intermediate columns?	Understand	4
8.	Which of the two, buckling or stiffness of compression members is more critical?	Remember	4
9.	Why are four different buckling curves prescribed to Understand column strength?	Understand	4
10.	How does strain hardening affect the strength of short columns?	Understand	4

LONG ANSWER QUESTIONS-

S.No	Question	Blooms Taxonomy Level	Programme Out come
1.	Why a separate provision (formula) for the design of a single angle strut has been proposed by IS: 800 code?	Understand	5
2.	Cite the instances when a column may be regarded as an axially loaded column?	Remember	4
3.	What is the basic difference in behaviour between tension and compression members, while resisting	Understand	4

	the loads?		
4.	How does the behavior of a compression member differ based on its length?	Understand	4
5.	Why is it better to choose plastic or compact sections for columns?	Understand	2
6.	Derive the Euler's formula.	Understand	4
7.	Calculate the design strength of W14 x 74 with length of 20 ft. and pinned ends. A36 steel is used.	Understand	4
8.	A strut of 3.4 m length in a truss is connected at each of its ends with welding to the gusset plate. The strut is of a section ISA 100 x 100 x 10 mm. Determine its equivalent slenderness ratio.	Understand	4
9.	Design a column of I-section to support a factored load of 1050 kN. The column has an effective length of 7.0 m with respect to z-axis and 5.0 m with respect to y-axis. Use steel of grade Fe 410.	Understand	4
10.	(a) Design a built up column composed of two channel sections placed back to back, carrying an axial load of 1500 kN. The effective length of column is 7 m (b) Also design a single lacingsystem.	Understand	4

UNIT-3

SHORT ANSWER QUESTIONS-

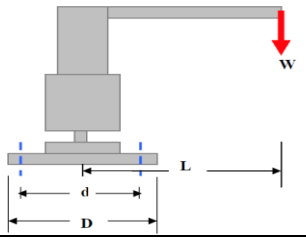
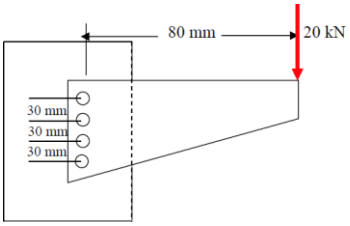
S.No	Question	Blooms Taxonomy Level	Programme Out come
1.	What are rolled I-sections widely used as beam members?	Remember	4
2.	Differentiate between the bending and buckling of a beam.	Understand	4
3.	How does buckling of column and beam differ?	Remember	4
4.	Why should plastic or compact section be preferred for flexural members in limit state design method?	Understand	4
5.	What are checks to be performed for beam member design?	Understand	4
6.	What is the difference between bending and buckling of a beam member?	Remember	4
7.	What is meant by lateral torsional buckling of beam member?	Understand	4
8.	Under what conditions can lateral buckling occur?	Understand	4
9.	Under what conditions can a beam member be assumed as laterally restrained?	Remember	4
10.	What is local buckling of a beam member	Remember	4

LONG ANSWER QUESTIONS-

S.No	Question	Blooms Taxonomy Level	Programme Out come
1.	Application of loads on a beam may be at its top flange or bottom flange or centroid. How does level of application of load affect the beamdesign?	Understand	4
2.	How are the column buckling and the lateral buckling of beam similar?	Understand	4
3.	How will torsion will be there in beams? What is the difference in St Venant torsion and warping torsion?	Understand	4
4.	Mention common situations where shear might become critical?	Remember	4
5.	What is meant by web crippling?	Remember	4
6.	Design by limit state method as per IS: 800 draft code, a hand operated crane, which is provided in a shed, whose details are: Capacity of crane = 50 kN Longitudinal spacing of column = 6m Center to center distance of gantry girder = 12m Wheel spacing = 3m Edge distance = 1m Weight of crane girder = 40 kN Weight of trolley car = 10 kN.	Understand	4
7.	Design a beam of 5 m effective span, carrying a uniform load of 20 kN/m if the compression flange is laterally supported (Assume f_y = 250 N/m^2)	Understand	4
8.	Design a beam of effective span 6.0 m and subjected to a bending moment of 105.3 x 106 Nmm for the following conditions (i) The compression flange is laterally unsupported throughout, (ii)The beam is encased in concrete Checks for deflection and shear are not required. Assume f_y = 250 MPa.	Understand	4
9.	Design a simply supported beam of effective span 1.5 m carrying a factored concentrated load of 360 kN at mid span.	Understand	4
10.	Design a simply supported beam of 10 m effective span carrying a total factored load of 60 kN/m. The depth of beam should not exceed 500 mm. The compression flange of the beam is laterally supported by floor construction. Assume stiff end bearing is 75 mm.	Understand	4

UNIT-4

SHORT ANSWER QUESTIONS-

S.No	Question	Blooms Taxonomy Level	Programme Out come
1.	What is the meaning of eccentricity in loading	Remember	5
2.	What is the meant by Eccentric connection in steel structures.	Understand	5
3.	How are the building connections classified based on their moment-rotation characteristics?	Remember	5
4.	What is stiffened seat connection?	Remember	5
5.	When the seated beam connections are preferred and name the types?	Remember	5
6.	Mention some of the requirements of good connections (joints).	Remember	5
7.	What are the possible ways to impose eccentric loading on a welded joint.	Understand	5
8.	The base of a pillar crane is fastened to the foundation by n bolts equally placed on a bolt circle of diameter ***d***. The diameter of the pillar is ***D***. Determine the maximum load carried by any bolt when the crane carries a load ***W*** at a distance ***L*** from the center of the base. Observe the figure below to solvetheproblem. 	Understand	5
9.	A bracket is supported by means of 4 rivets of same size as shown in figure below. Determine the diameter of the rivet if the maximum shear stress is 140MPa. 	Understand	5
10.	What are the assumptions that are used when analyzing a simple truss?	Remember	5

LONG ANSWER QUESTIONS-

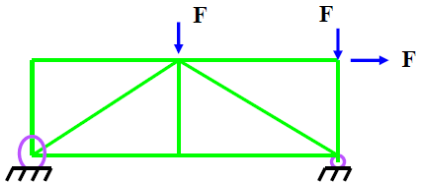
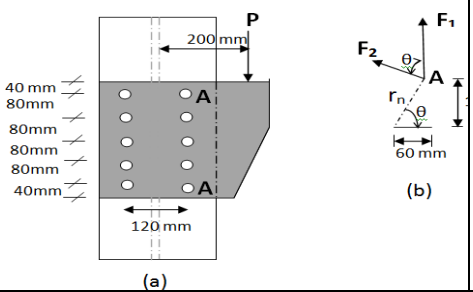
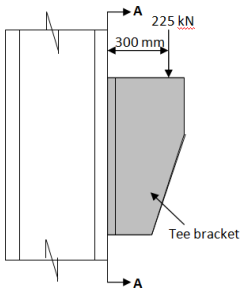
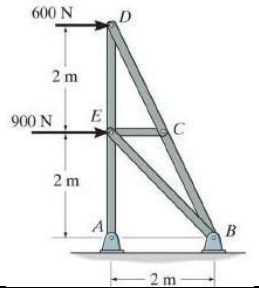
S.No	Question	Blooms Taxonomy Level	Programme Out come
1.	How are the building connections classified based on their moment- rotation characteristics?	Understand	5
2.	Describe connection of purlin to rafter with neat sketch.	Understand	5
3.	Explain Anchorages of trusses with concrete column neat sketch.	Understand	5
4.	Given: Loads as shown on the truss. Find the forces in each member of the truss.	Understand	5
5.	For this truss, determine the number of zero-force members. 	Understand	5
6.	An ISLB 300 carrying UDL of 50 kN/m has effective span of 8 m. This is to be connected to the web of girder ISMB 450. Design the framed connection using 20 mm black bolts.	Understand	5
7.	An ISMB 450 is connected to the flange of a column ISHB 300 @618 N/m. The end reaction transmitted the beam is 120 kN. Design an unstiffened seated connection. Use M20 black bolts.	Understand	5
8.	Determine the safe load P that can be carried by the joint shown inFigure below. The bolts used are 20 mm diameter of grade 4.6. The thickness of the Flange of I-section is 9.1 mm and that of bracket plate 10mm. 	Understand	5
9.	Design a bracket connection to transfer an end reaction of 225 kN due to factored loads as in	Understand	5

	Figure below. The end reaction from the girder acts at an eccentricity of 300 mm from the face of the column flange. Design bolted joint connecting the Tee-flange with the column flange. Steel is of grade Fe 410 and bolts of grade4.6. 		
10.	Given: Loads as shown on the truss. Determine the force in all the truss members (do not forget to mention whether they are in Tension or Compression). 	Understand	5

UNIT-5

SHORT ANSWER QUESTIONS-

S.No	Question	Blooms Taxonomy Level	Programme Out come
1.	Give the expression for the optimum depth of plate girder.	Remember	5
2.	Differentiate between a beam and a plate girder.	Remember	5
3.	Where are the plate girders used?	Remember	5
4.	What are the main characteristics of a plate girder?	Remember	5
5.	State some advantages and disadvantages of plate girders over trusses.	Remember	5
6.	List the different elements of a welded plate girder	Understand	5
7.	What are the various types of stiffners?	Remember	5
8.	State the minimum web thickness provisions of a IS 800:2007	Understand	5
9.	What is the range of the minimum thickness of	Understand	5

	the web that is usually adopted in practice?		
10.	Why / where are bearing stiffeners provided?	Understand	5

LONG ANSWER QUESTIONS-

S.No	Question	Blooms Taxonomy Level	Programme Out come
1.	In what sense the design of plate girders by elastic method and limit state method is different?	Understand	5
2.	What is tension field action in plate girders?	Understand	5
3.	How does a plate girder derive post- buckling strength?	Understand	5
4.	Briefly explain the steps involved in the design of plate girders.	Understand	5
5.	Why have bolted and riveted plate girders become obsolete?	Understand	5
6.	Design a welded plate girder 24 m in span and laterally restrained throughout. It has to support a uniform load of 100 kN/m throughout the span exclusive of self-weight. Design the girder without intermediate transverse stiffners. The steel for the flange and web plates is of grade Fe	Understand	5
7.	410. Yield stress of steel may be assumed to be 250 MPa irrespective of the thickness of plates used. Design the cross section, the end load bearing stiffner and connections.	Understand	5
8.	Design a welded plate girder 24 m in effective span and simply supported at ends. It carries an uniformly distributed load of 100 kN/m. draw section at support and front elevation of plate girder.	Understand	5
9.	What are stiffeners and why are they used? How many types of stiffeners are being used in the design of plate girder? Give the conditions (as per IS 800) when stiffeners are required.	Understand	5
10.	A plate girder is subjected to a maximum factored moment of 4000 kN-m and factored shear force of 600 kN. Design girder without any stiffeners.	Understand	5

XI. OBJECTIVE QUESTIONS:

UNIT-I

1.The Indian codes which deals with the steel structure is

(a)IS: 800 (b) IS: 875 (c) IS: 475 (d) IS: 400

2.The main advantage of steel structures is

(a) Its high strength (b) its long service life

(c) its gas & water tightness (d) All the above

3.With a percentage increase in carbon in steel, it decreases

(a) Ductility (b) strength (c) hardness (d) brittleness

4.Poisson's ratio for steel within the elastic limit varies from

(a) 0.15 to 0.20 (b) 0.25 to 0.24 (c) 0.25 to 0.33 (d) 0.33 to 0.35

5.The tensile strength of mild steel for bolts & nuts should not be less than

(a) 32 kg/mm^2 (b) 36 kg/mm^2 (c) 40 kg/mm^2 (d) 44 kg/mm^2

6. The heaviest I-section for same depth is

a) ISMB b) ISLB c) ISHB d) ISWB

7. Bending compressive and tensile stresses respectively are calculated based on

a) net area and gross area b) gross area and net area

c) net area in both cases d) gross area in both cases

8. If the thickness of thinnest outside plate is 10 mm, then the maximum pitch of rivets in tension will be taken as

a) 120 mm b) 160 mm c) 200 mm d) 300 mm

9. In a gusseted base, when the end of the column is machined for complete bearing on the base plate, then the axial load is assumed to be transferred to base plate

a) fully by direct bearing

b) fully through fastenings

c) 50% by direct bearing and 50% through fastenings

d) 75% by direct bearing and 25% through fastenings

10. When the axis of load lies in the plane of rivet group, then the rivets are subjected to

a) only shear stresses b) only tensile stresses

c) both (a) and (b) d) none of the above

UNIT-II

1. The ratio of unsupported length to least radius of gyration is known as

(a) Gyration ratio (b) Slenderness ratio (c) Both a and b (d) none of above

2. The effective length of a compression member of length *L* held in position and restrained in direction at one end and effectively restrained in direction but not held in position at the other end, is

(a) L (b) 0.67L (c)0.85 L (d) 2L

3. A structural member subjected to compressive stress in a direction parallel to its longitudinal axis, is generally known as

(a) Column (b) stanchion (c) post (d) strut

4. Slenderness ratio of a compression member is

(a) $\frac{\text{Moments of Interia}}{\text{Radius of gyration}}$ (b) $\frac{\text{Effective length}}{\text{Area of cross-section}}$

(c) $\frac{\text{Radius of gyration}}{\text{Effective length}}$ (d) $\frac{\text{Radius of gyration}}{\text{Area of cross-section}}$

5. The distance between e.g. of compression and e.g. of tension flanges of a plate girder, is known as

a. Over all depth b.Clear depth c.Effective depth d.None of these

6. If the depth of two column sections are equal, then the column splice is provided

a. with filler plates b.with bearing plates c.with filler and hearing plates d.none of these

7. Web crippling generally occurs at the point where
   a. bending moment is maximum b.shearing force is minimum
   c. concentrated loads act d.deflection is maximum

8. According to IS Specifications, the effective length of a column effectively held in position at both ends and restrained in direction at one end is taken as
   a) 0.67 L b) 0.8 L c) L d) 1.5 L
9. The effective length of a battened strut effectively held in position at both ends but not restrained in direction is taken as
   a) 1.8 L b) L c) 1.1 L d) 1.5 L
10. The maximum slenderness ratio of a compression member carrying both dead and superimposed load is
    a) 180 b) 200 c) 250 d) 350

UNIT-III

1. A beam is defined as a structural member subjected to

(a) Axial loading (b) Transverse loading

(c) Axial and transverse loading (d) None of these.

The area A_p of cover plates in one flange of a built up beam, is given by

(a) $A_p = \frac{Z_{reqd} + Z_{beam}}{h}$ (b) $A_p = \frac{Z_{reqd} + Z_{beam}}{A}$

(c) $A_p = \frac{Z_{reqd} \times Z_{beam}}{h}$ (d) $A_p = \frac{Z_{reqd} - Z_{beam}}{h}$

The average shear stress for rolled steel beam section, is

(a) 845 kg/cm^2 (b) 945 kg/cm^2 (c) 1025 kg/cm^2 (d) 1500 kg/cm^2

The rolled steel I-sections are mostly used as beams because these provide

(a) Large moment of inertia with less cross-sectional area

(b) Large moment of resistance as compared to other section

(c) Greater lateral stability (d) All the above

5. The permissible stress in bending for rolled steel I-beams and channels, is
   (a) 1500 kg/cm^2 (b) 1575 kg/cm^2 (c) 945 kg/cm^2 (d) 1650 kg/cm^2
6. Rolled steel beams are designated by Indian Standard series and its
   (a) Weight per metre and depth of its section (b) Depth of section and weight per metre
   (c) Width of flange and weight per metre (d) Weight per metre and flange width.
7. A major beam in a building structure, is known as
   (a) a girder (b) a floor beam (c) a main beam (d) all the above
8. Lacing bars in a steel column should be designed to resist
   a) bending moment due to 2.5% of the column load
   b) shear force due to 2.5% of the column load
   c) 2.5% of the column load d) both (a) and (b)
9. Angle of inclination of the lacing bar with the longitudinal axis of the column should preferably be between
   a) 10° to 30° b) 30° to 40° c) 40° to 70° d) 90°
10. Battening is preferable when the
    i) column carries axial load only

ii) space between the two main components is not very large
iii) column is eccentrically loaded The correct answer is
a) only (i) b) only (iii) c) (i) and (ii) d) (ii) and (iii)

UNIT-IV

1. Lug angle is
   a) used with single angle member b)not used with double angle member
   c)used with channel member d)used with channel member
2. Bulb angles are used in
   a) column building b)bridge building c)ship building d)water tank building
3. Rolled steel angle sections are classified as
   a) equal angles b)unequal angles c)bulb angle d)all the above
4. The stiff portion of a bearing stiffeners is taken equal to
   a)Depth of the beam b)3/4 th depth of the beam c)depth of the beam d)2/3 depth of beam
5. According to IS:800 lacing bars resist transverse shear equal to
   a)1.0% of the axial load b)2.0% of the axial load
   c)2.5% of the axial load d)3.0% of the axial load
6. The overlap of batten plates with the main members in welded connections should be more than a) 3t b) 4t c) 6t d) 8t where t = thickness of the batten plate
7. The slenderness ratio of lacing bars should not exceed
   a) 100 b) 120 c) 145 d) 180
8. Minimum pitch provided in riveted steel tanks is
   a) 1.5 d b) 2.0 d c) 2.5 d d) 3.0 d
   where d is diameter of rivets
9. Shear buckling of web in a plate girder is prevented by using
   a) vertical intermediate stiffener b) horizontal stiffener at neutral axis
   c) bearing stiffener d) none of the above
10. Horizontal stiffener in a plate girder is provided to safeguard against
    a) shear buckling of web plate b) compression buckling of web plate
    c) yielding d) all of the above

UNIT V

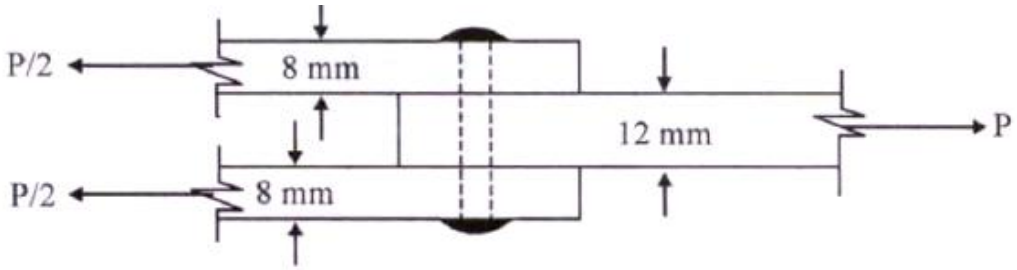
1. In a steel plate girder, the web plate is connected to the flange plates by fillet welding. The size of fillet welds is designed to safely resist.
   (a) the bending stresses in the flan (b) the vertical shear force at the section
   (c) the horizontal shear forces between the flanges and the web plate
   (d) the forces causing buckling in the web
2. Gantry girders are designed to resist:
   1) Lateral loads 2) Longitudinal load 3) Vertical loads
   (a) 1 and 2 only (b) 1 and 3 only (c) 2 and 3 only (d) 1, 2 and 3
3. The distance between the outer faces of flanges of a plate girder, is known as
   (a)overall depth (b) clear depth (c)effective depth (d) None of these
4. Bearing stiffener in a plate girder is used to
   a) transfer the load from the top flange to the bottom one
   b) prevent buckling of web
   c) decrease the effective depth of web d) prevent excessive deflection
5. The forces acting on the web splice of a plate girder are
   a) axial forces b) shear and axial forces

c) shear and bending forces d) axial and bending forces

6. Bearing stiffeners are provided at
   i) the supports ii) the mid span
   iii) the point of application of concentrated loads The correct answer is
   a) only (i) b) both (i) and (ii) c) both (i) and (iii) d) (i), (ii) and (iii)
7. Rivets connecting flange angles to cover plates in a plate girder are subjected to
   a) horizontal shear only b) vertical load only c) both (a) and (b) d) none of the above
8. Bearing stiffener in a plate girder is used to
   a) transfer the load from the top flange to the bottom one b) prevent buckling of web
   c) decrease the effective depth of web d) prevent excessive deflection
9. Economical depth of a plate girder corresponds to
   a) minimum weight b) minimum depth
   c) maximum weight d) minimum thickness of web
10. Shear buckling of web in a plate girder is prevented by using
    a) vertical intermediate stiffener b) horizontal stiffener at neutral axis
    c) bearing stiffener d) none of the above

GATE

1. Two steel columns P (length L and yield strength fy = 250MPa) and Q (length 2L and yield Strength fy=500MPa) have the same cross-sections and end-conditions. The ratio of buckling load of column P to that of column Q is:
   a)0.5 9 b)1.0 c)2.0 d) 4.0
2. A symmetric I-section (with width of each flange = 50 mm, thickness of each flange = 10mm, depth of web = 100 mm, and thickness of web = 10mm) of steel subjected to a shear force of 100 mm. Find the magnitude of the shear in N/mm2) in the web at its junction with the top flange. _____
3. In a steel plate with bolted connections, the rupture of the net section is a mode of failure under
   (A) Tension (B) compression (C) flexure (D) shear
4. The ratio of the theoretical critical buckling load for a column with fixed ends to that of another column with the same dimensions and material, but with pinned ends, is equal to
   (A) 0.5 (B) 1.0 (C) 2.0 (D) 4.0
5. A 12 mm thick plate is connected to two 8 rnm thick plates, on either side through a 16 rnm diameter power driven field rivet as shown in the figure below. Assuming permissible shear stress as 90 MPa and permissible bearing stress as 270 MPa in the rivet, the rivet value of the joint is

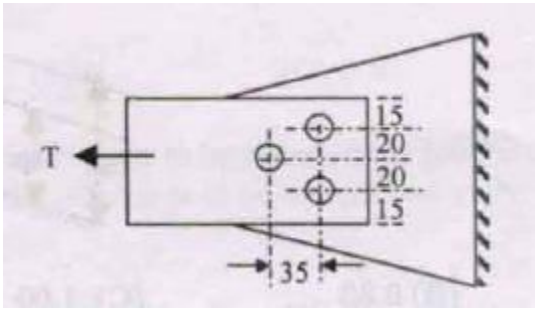


A)56.70 kN (B) 43.29 kN (C) 36.19 kN (D) 21.65 Kn

6. Battening is preferable when the
   i) column carries axial load only
   ii) space between the two main components is not very large

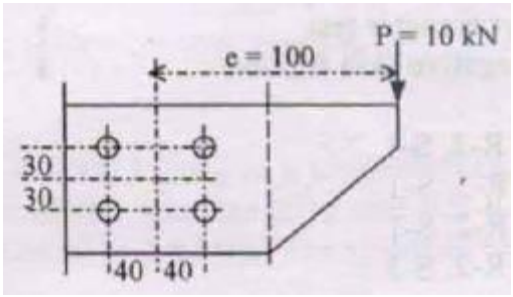
iii) column is eccentrically loaded The correct answer is
a) only (i) b) only (iii) c) (i) and (ii) d) (ii) and (iii)

7. A steel flat of rectangular section of size 70 x 6 mm is connected to a gusset plate by three bolts each having a shear capacity of 15 kN in holes having diameter 11.5 mm. If the allowable tensile stress in the flat is 150 MPa, the maximum tension that can be applied to the flat is



(A) 42.3 kN (B) 52.65 kN (C) 59.5 kN (D) 63.0 kN

8. A bracket connection is made with four bolts of 10 mm diameter and supports a load of 10 kN at an eccentricity of 100 mm. The maximum force to be resisted by any bolt will be



A) 5 kN (8) 6.5 kN (C) 6.8 kN (D) 7.16 kN

9.Bearing stiffeners in plate girders are provided to

(a) decrease the effective depth of web

(b) transfer the load from the top flange to the bottom flange

(c) prevent buckling of web

(d) increase the bearing capacity of the flange

10.Strength and serviceability of a structure cannot be predicted on account of several unforeseen factors.

(a)1, 2 and 3 (b) 3 only (c) 2 only (d) 1 only

IES:

1.Two angles of ISA 100 x 100 x 6 have been used as a tie member. The angles are welded on either side of a gusset and tag welded over its length. The maximum length of the member is: (For ISA 100x100x6, Area = 2334 mm^2 and YXX = 30 mm)

(a)5.4 m (b) 6.0 m (c) 12.0 m (d) 24.0 m

2.Gantry girders are designed to resist:

1)Lateral loads 2)Longitudinal load 3)Vertical loads

(a)1 and 2 only (b) 1 and 3 only (c) 2 and 3 only (d) 1, 2 and 3

3.The effective width of outstand in compound steel columns for design purposes is equal to

(a) half the flange width (b) distance of the free edge from the rivet line

(c) distance of the free edge from the stiffeners

(d) distance of the free edge to the nearest row of rivets

4.For a steel built up column subjected to an axial force of 1200 kN, the lacing system is to be designed for resisting transverse shear of

(a)15 kN (b) 20 kN (c) 25 kN (d) 30 Kn

5.At certain location of a plate girder of web size 1000x10, a pair of bearing stiffeners 100 mm x 5 mm is welded. The effective area of bearing stiffeners is

(a)1000 mm^2 (b) 2000 mm^2 (c) 3000 mm^2 (d) 5000 mm^2

6.ISMB 250 ($Ze = 410x10^3$) mm^3 has been chosen as a beam cross-section to resist a bending moment. Two plates 100 mm x 10 mm are welded to each flange to enhance the moment capacity. The enhanced moment capacity is

(a)71.5 kNm (b) 79.5 kNm (c) 99.0 kNm (d) 148.0 kNm

7.Bearing stiffeners in plate girders are provided to

(a) decrease the effective depth of web

(b) transfer the load from the top flange to the bottom flange

(c) prevent buckling of web (d) increase the bearing capacity of the flange

8.Which of the following statements is/are correct?

1)A steel structure designer can guarantee the safety of the structure.

2)Working stress method of design of steel structures offers a safer and economical structure.

3)Strength and serviceability of a structure cannot be predicted on account of several unforeseen factors.

(a)1, 2 and 3 (b) 3 only (c) 2 only (d) 1 only

9.When the effect of wind or earthquake load is taken into account in the design of a riveted connection, the permissible stresses in rivets may be exceeded by

(a) 16.66% (b) 33.33% (c) 25% (d) 50%

10.A mild steel flat subjected to a tensile force of 840 kN is connected to a gusset plate using rivets. If the permissible forces required per pitch length (i) to shear a single rivert, (ii) to crush the rivet and (iii) to tear the plate are 50 kN, 80 kN and 60 kN respectively, then the number of rivets required is

(a)12 (b) 14 (c) 16 (d) 17

11.The effective throat thickness of a fillet weld depends upon

(a) angle between fusion faces (b) length of weld

(c) permissible shear stress (d) type of weld

12.When the load line coincides with the centroid of the rivet group, the rivets are subjected to

(a)shear only (b) tension only (c) bending only (d) shear as well as tension

A column member of length l which cannot sway has a rigid foundation at its bottom. Its top is held with heavy beams. The effective length of the column is

(a)1.5 l (b) 1.0 l (c) 0.8 l (d) 0.65 l

13.An ISMB 500 is used as a beam in a multistory construction. From the viewpoint of structural design, it can be considered to be 'laterally restrained' when

(a) the tension flange is laterally restrained

(b) the compression flange is laterally restrained

(c) the web is adequately stiffened

(d) the conditions in both (a) and (c) are met.

14.A steel column pinned at both ends has a buckling load of 200kN, If the column is restrained against lateral movement at its mid-height, its buckling load will be

(a)200 kN (b) 283 kN (c) 400 kN (d) 800 kN

15.Consider the following provisions to possibly improve the shear capacity of a steel girder: 1.Horizontal stiffeners 2.Verticalstiffeners 3.Columnsplice 4.Bearing stiffeners Which of these are correct?

(a) 1,2,3 and 4 (b) 3 and 4 only (c) 1 and 2 only (d) 2 and 3 only

16.In a steel plate girder, the web plate is connected to the flange plates by fillet welding. The size of fillet welds is designed to safely resist.

(a) the bending stresses in the flanges (b) the vertical shear force at the section

(c) the horizontal shear forces between the flanges and the web plate

(d) the forces causing buckling in the web

17.In laced columns, end tie-plates are provided to

(a) check the buckling of column

(b) keep the column components in position

(c) check the distortion of column sections at ends because of unbalanced

18.horizontal force from lacings

(d) prevent rotation of elements.

19.Which of the following elements of a pitched roof industrial steel building primarily resists lateral load parallel to the ridge?

(a) Bracing (b) Purlin (c) Truss (d) Column

XIII. WEBSITES:

1. http://www.asce.org
2. http://www.icivilengineer.com
3. http://www.construction-guide.in
4. http://nptel.ac.in/courses/112105171/1

XIV.EXPERT DETAILS:

1. Vinayak Eswaran, Professor & Head of the Department, IIT Hyderabad
2. Dr.Raja Banerjee, Associate Professor, IIT Hyderabad

3. Dr.YVD Rao. Faculty In charge, Engineering Services Division, BITS Pilani, Hyderabad Campus
4. Dr. Jeevan Jaidi, Associate Professor, Dept. of Mechanical Engineering, BITS-Pilani, Hyderabad Campus
5. Dr P. Laxminarayana, Head, Dept. of Mechanical Engineering, Osmania University College of Engineering, Hyderabad
6. Dr. T.I. Eldho. Department of Civil Engineering, IIT Bombay

XV. JOURNALS:

1 Thesis Digest on civil Engineering
2 International Engineering and Technology Journal of Civil and Structure
3 International journal of civil engineering
4 Journal of information knowledge and research in civil engineering
5 International journal of civil engineering and technology
6 International Journal of Civil Engineering and Applications
7 Recent Trends in Civil Engineering and Technology
8 World Research Journal of Civil Engineering
9 International Journal of Structural and Civil Engineering
10 International Journal of Civil Engineering (IJCE)
11 International Journal of Structural and Civil Engineering Research
12 International Journal of Advanced Research in Civil, Structural, Environmental and Infrastructure Engineering and Developing

XVI. LIST OF TOPICS FOR STUDENT SEMINARS:

1. Mechanical Properties of Steel
2. Riveted, Welded, and Bolted Connections
3. Design of Tension Members
4. Design of Compression Members
5. Design of Steel Beams
6. Design of Plate Girders
7. Design of Roof Truss

XVII. CASE STUDIES / SMALL PROJECTS:

1. Study of various types of connections
2. Study of Plated Girders
3. Study of Columns and Column Base
4. Study of Roof Truss