

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-5 SEMESTER – OLD PAPER – S22 TO S25 – QUESTION BANK

Subject Name & Code:

Design of Structures- 3150612

Unit-1: Introduction

This unit covers the fundamental concepts, materials, and design philosophies.

Repeated Questions:

1. **Differentiate between Limit State Method and Working Stress Method.**
 - **Appeared in:** Summer 2023 (Q1a - 03 Marks), Summer 2024 (Q1a - 03 Marks), Summer 2025 (Q1a - 03 Marks), Winter 2024 (Q1a - 03 Marks).
 - **Note:** This is the most important question from this unit. Be prepared to write 3-4 key differences.
2. **Define key terms: Characteristic Load, Characteristic Strength, Partial Safety Factor, Limit State, Clear Cover, Effective Cover.**
 - **Appeared in:** Summer 2023 (Q1b - 04 Marks), Winter 2022 (Q1a - 03 Marks), Winter 2023 (Q1a - 03 Marks), Summer 2025 (Q1b - 04 Marks).
 - **Note:** Questions on definitions are very frequent. Create a master list of all key terms from the syllabus.
3. **State the advantages and disadvantages of Steel structures over RCC structures.**
 - **Appeared in:** Winter 2022 (Q4a - 03 Marks), Winter 2023 (Q1b - 04 Marks).

Other Important Questions:

1. **Explain the concept of limit state design methodology.** (Summer 2022, Q1a - 03 Marks)
2. **Discuss the various philosophies of the design in R.C.C. structures. Also discuss the merits and demerits of each.** (Winter 2023, Q2c (OR) - 07 Marks)
3. **Differentiate between (1) Pitch and Gauge distance (2) End and Edge Distance and (3) Bolt diameter and Hole Diameter of Bolted Connection** (Winter 2024, Q1b - 04 Marks)

Unit-2: Philosophy of Limit state design for RC structures

This unit is core to RCC design, covering flexure, shear, torsion, and fundamental calculations.

Repeated Questions:

1. **Define/Differentiate: Under-reinforced, Balanced, and Over-reinforced sections.**
 - **Appeared in:** Summer 2023 (Q2b - 04 Marks), Winter 2022 (Q2a - 03 Marks), Winter 2023 (Q1c - 07 Marks).
 - **Note:** Often asked to define, but also as a part of numerical problems where you must identify the type of section.
2. **Derive the limiting values of $X_{u,lim}/d$ for Fe 250 and Fe 415 grade of steel.**
 - **Appeared in:** Summer 2024 (Q1b - 04 Marks), Winter 2022 (Q1b - 04 Marks).
 - **Note:** A derivation-based question. Practice writing the derivation clearly.
3. **Calculate the Moment of Resistance (M_r) of a given beam section.**
 - **This is a critical numerical problem. Appeared in:**
 - Summer 2023 (Q1c - 07 Marks): Singly/Doubly reinforced beam.
 - Summer 2024 (Q1c - 07 Marks): Doubly reinforced beam.
 - Winter 2022 (Q1c - 07 Marks): Singly reinforced beam.
 - Summer 2022 (Q1c): Singly reinforced beam.
 - Summer 2025 (Q2c (OR) - 07 Marks): Singly reinforced beam.
 - Winter 2024 (Q1c - 07 Marks): Singly reinforced beam with section check.
 - **Note:** You must be thoroughly practiced in solving for M_r for singly reinforced, doubly reinforced, and flanged sections. This is a guaranteed question.
4. **Determine the Development Length for a given bar.**
 - **Appeared in:** Summer 2023 (Q4b), Winter 2022 (Q3b - 04 Marks), Summer 2022 (Q2a - 03 Marks), Summer 2024 (Q4b), Summer 2025 (Q4b).
 - **Note:** A standard formula-based calculation. Know the formulas for tension and compression.

Other Important Questions:

1. **Explain limit state of collapse & limit state of serviceability in flexure.** (Summer 2022, Q1b - 04 Marks)
2. **State and explain in brief types of limit states in the design of steel structures.** (Summer 2024, Q2b - 04 Marks)
3. **Discuss the assumptions made in the limit state design of reinforced concrete compression members.** (Winter 2023, Q2a - 03 Marks)
4. **An R. C. C. beam of size 350 wide and 550mm deep is reinforced by tension bars as 5nos. of 25mm dia. and compression bars as 3nos. of 20mm dia. Calculate the moment of resistance of beam...** (Winter 2023, Q2b - 04 Marks) - *A specific numerical on M_r .*
5. **The rectangular beam of width, 300 mm is having overall depth of 600 mm... The design shear force is 500 kN... Find the effective depth and check whether it is sufficient or not.** (Summer 2025, Q4c) - *A shear check problem.*
6. **The rectangular beam of width, 300 mm is having overall depth of 400 mm... Evaluate the (i) additional moment... (ii) The stress... (iii) The moment of resistance... (iv) Check the nature of the section...** (Summer 2025, Q4c (OR)) - *A complex analysis of a doubly reinforced section.*

Unit-3: Limit state design of RC structural Element

This unit involves the practical design of beams, slabs, columns, and foundations.

Repeated Questions:

1. **Differentiate between One-way and Two-way slabs.**
 - **Appeared in:** Summer 2023 (Q5a - 03 Marks), Winter 2022 (Q3a - 03 Marks), Winter 2023 (Q4a - 03 Marks), Summer 2022 (Q3a (OR) - 03 Marks).
 - **Note:** A very common theoretical question.
2. **Design a Simply Supported One-Way Slab.**
 - **This is a very common design problem. Appeared in:**
 - Summer 2023 (Q5c - 07 Marks)
 - Winter 2022 (Q3c (OR) - 07 Marks)
 - Winter 2023 (Q4c (OR) - 07 Marks)
 - **Note:** The steps are standard: determine depth, loads, moments, reinforcement, checks for deflection and development length.
3. **Design an Interior Slab Panel / Two-Way Slab.**
 - **Appeared in:** Summer 2023 (Q3c (OR) - 07 Marks), Summer 2024 (Q3c (OR) - 07 Marks), Summer 2025 (Q3c (OR) - 07 Marks), Summer 2022 (Q5c (OR) - 07 Marks).
 - **Note:** This involves using coefficients as per IS 456 to calculate bending moments for different spans.
4. **Design an Isolated Footing for a Column.**
 - **Appeared in:** Winter 2022 (Q3c - 07 Marks), Winter 2023 (Q3c - 07 Marks), Summer 2022 (Q3c - 07 Marks).
 - **Note:** A comprehensive problem covering size calculation, bending moment, reinforcement, and shear check.
5. **Design a Short R.C. Column for Axial Load.**
 - **Appeared in:** Winter 2022 (Q3c - 07 Marks), Winter 2023 (Q3b - 04 Marks).
 - **Note:** Involves determining the area of longitudinal steel and designing lateral ties.

Other Important Questions:

1. **What is the function of providing distribution steel in slab?** (Summer 2022, Q3a - 03 Marks)
2. **Give functions of following (i) Stirrups in a beam (ii) Ties in a column (iii) Distribution reinforcement in a slab** (Winter 2023, Q3a - 03 Marks)
3. **Find the maximum design moments per unit width for a two-way slab...** (Winter 2022, Q3b - 04 Marks) - *A part of the two-way slab design process.*
4. **Explain one way shear check and two way shear check for footing.** (Winter 2023, Q2c - 07 Marks)
5. **Write design steps for isolated rectangular column footing.** (Summer 2022, Q2b - 04 Marks)
6. **Design reinforcement for a rectangular R.C.C. beam...** (Summer 2022, Q2c - 07 Marks)
7. **Design for tensile and compressive reinforcement for a R.C.C. beam...** (Summer 2022, Q2c (OR) - 07 Marks)
8. **For a factored load of 15 KN/m²... on an interior panel of 4.2 m × 6.25 m... Which of the above statements [about moments] are incorrect?** (Summer 2025, Q5c (OR)) - *An analysis question on two-way slab moments.*

Unit-4: Philosophy of Limit state design for Steel

This unit covers the basics of steel design, focusing on connections (bolted and welded).

Repeated Questions:

1. **What does 4.6 or 6.8 imply for bolts?**
 - **Appeared in:** Summer 2023 (Q2a - 03 Marks), Summer 2024 (Q2a - 03 Marks), Summer 2025 (Q2a - 03 Marks), Winter 2022 (Q3a (OR) - 03 Marks).
 - **Note:** The first number indicates the Ultimate Tensile Strength (UTS) in kgf/mm². The second number is the ratio of Yield Stress to UTS. E.g., 4.6 means UTS = 400 MPa, Yield Stress = $0.6 * 400 = 240$ MPa.
2. **Differentiate between Lap Joint and Butt Joint with neat sketches.**
 - **Appeared in:** Summer 2023 (Q3a - 03 Marks), Summer 2025 (Q3a - 03 Marks), Winter 2023 (Q4a (OR) - 03 Marks).
3. **State advantages and disadvantages of Bolted / Welded connections.**
 - **Bolted:** Summer 2024 (Q4a - 03 Marks).
 - **Welded:** Summer 2023 (Q4a - 03 Marks), Winter 2022 (Q4a (OR) - 03 Marks), Winter 2024 (Q4a - 03 Marks).
 - **Compare both:** Winter 2023 (Q4a - 04 Marks).
4. **Calculate the strength of a bolt for a Lap Joint.**
 - **This is a fundamental numerical. Appeared in:**
 - Summer 2023 (Q2c - 07 Marks)
 - Summer 2024 (Q2c - 07 Marks)
 - **Note:** Involves calculating the bolt value in single/double shear and bearing, and taking the least value.
5. **Why are the end returns provided in fillet welds?**
 - **Appeared in:** Summer 2023 (Q4b (OR) - 04 Marks), Summer 2024 (Q4b (OR) - 04 Marks), Summer 2025 (Q4a (OR) - 03 Marks), Winter 2024 (Q4a (OR) - 03 Marks).
 - **Answer:** To avoid the unwrapped end (or end crater) which is a point of stress concentration and potential failure. The end return ensures the weld force is dissipated smoothly.

Other Important Questions:

1. **Explain the different types of failures observed in bolted connection with neat sketches.** (Summer 2025, Q2b - 04 Marks), (Winter 2024, Q2b - 04 Marks)
2. **Define (i) Gauge (ii) Pitch (iii) Slenderness Ratio.** (Summer 2023, Q3a (OR) - 03 Marks), (Summer 2024, Q3a (OR) - 03 Marks), (Winter 2022, Q4b - 04 Marks)
3. **Two plates of 16mm and 14mm thickness are to be joined by groove weld... Determine the safety of the joint...** (Summer 2024, Q2c (OR) - 07 Marks) - *A welded connection problem.*
4. **Design the welded connection to transmit a tensile load of 300 kN.** (Winter 2022, Q4b (OR) - 07 Marks)
5. **Design a welded connection for shop welding.** (Winter 2023, Q4c - 07 Marks)
6. **Calculate the proof load for HSFG bolts.** (Summer 2025, Q1c - 07 Marks) - *An advanced bolt question.*

Unit-5: Limit state design of Steel components

This unit involves the design of steel members like tension members, columns, beams, and their foundations.

Repeated Questions:

1. **Select/Find a suitable angle section to resist a factored tensile force.**
 - **Appeared in:** Summer 2023 (Q3c - 07 Marks), Summer 2024 (Q3c - 07 Marks), Winter 2022 (Q4c - 07 Marks).
 - **Note:** A standard design problem. Steps: Calculate required area, select a section from steel table, check for strength (yielding and rupture).
2. **Enlist the various failure modes of axially loaded tensile member along with sketch.**
 - **Appeared in:** Summer 2023 (Q5b (OR) - 04 Marks), Summer 2025 (Q5b - 04 Marks), Winter 2022 (Q5a - 03 Marks), Winter 2024 (Q5b (OR) - 04 Marks).
 - **Note:** Failure modes include: a) Yielding of gross section, b) Rupture (failure) of critical section, c) Block shear failure.
3. **Write the design steps for a single lacing system for a column.**
 - **Appeared in:** Summer 2023 (Q5b - 04 Marks), Summer 2024 (Q5b - 04 Marks), Winter 2022 (Q5b - 04 Marks).
4. **Why are four different buckling curves prescribed to evaluate column strength?**
 - **Appeared in:** Summer 2023 (Q5a (OR) - 03 Marks), Summer 2025 (Q5a - 03 Marks), Winter 2024 (Q4b (OR) - 03 Marks).
 - **Answer:** To account for the different levels of initial imperfections (like residual stresses, eccentricity of load, and lack of straightness) in different types of column cross-sections and fabrication processes (rolled, welded, etc.).
5. **Design a laterally supported steel beam.**
 - **Appeared in:** Winter 2022 (Q5c - 07 Marks), Summer 2025 (Q5c - 07 Marks), Winter 2024 (Q5c - 07 Marks).
 - **Note:** A very important design problem. Steps: Select a section based on moment capacity, check for shear, web buckling/crippling.

Other Important Questions:

1. **Draw neat sketch of gusseted base / slab base foundation.** (Summer 2023, Q3b - 04 Marks), (Summer 2024, Q3b - 04 Marks), (Winter 2022, Q5a (OR) - 03 Marks), (Winter 2023, Q3a (OR) - 03 Marks)
2. **Explain the design procedure of slab base and gusseted base foundation.** (Summer 2023, Q4c (OR) - 07 Marks)
3. **Determine the design axial load on the column section ISMB 300...** (Winter 2022, Q4c (OR) - 07 Marks)
4. **Design a double angle discontinuous strut...** (Winter 2022, Q5c - 07 Marks)
5. **Design a steel column to carry factored axial load...** (Winter 2022, Q5c (OR) - 07 Marks)
6. **Design a slab base foundation...** (Winter 2022, Q5c (OR) - 07 Marks), (Winter 2023, Q5c - 07 Marks)
7. **Explain the design procedure for laterally supported and unsupported steel beam.** (Summer 2023, Q5c (OR) - 07 Marks), (Winter 2024, Q4c - 07 Marks)
8. **Design a laced column...** (Winter 2024, Q3b - 07 Marks) - *A built-up column design problem.*
9. **Classify flanges, web and section... Also determine the plastic moment capacity...** (Summer 2024, Q5c - 07 Marks) - *Section classification and plastic analysis.*
