Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–V (NEW) EXAMINATION – WINTER 2020

Subject Code:3150612 Date:01/02/2021

Subject Name:Design of Structures

Time:10:30 AM TO 12:30 PM Total Marks: 56

Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of IS:456(2000), IS:800 (2007) and Steel table is permitted**
5. **Assume M20 grade concrete and Fe415 steel for RCC element, if not provided.**

			MARKS
Q.1	**(a)**	Differentiate between working stress method and limit state method of reinforced concrete.	**03**
	(b)	Write down the value of partial safety factors applied to Dead Load (DL), Imposed Load (IL) and Wind Load (WL) for the DL + IL + WL load combination considered for limit state of collapse, as per IS:456(2000). What will be the partial safety factors value for DL + WL load combination for limit states of serviceability, as per IS:456(2000)?	**04**
	(c)	AnRCC beam of a rectangular section 300 mm × 450 mm is reinforced with tensile reinforcement of 3 nos. 16mm Fe415 bars. The clear cover is 25 mm and the grade of concrete used is M25. State whether the section is under reinforced. Also, calculate moment of resistance of the section.	**07**
Q.2	**(a)**	Calculate the area of tension reinforcement needed with regard to the limit state method for a rectangular reinforced concrete beam of width, 250 mm and effective depth of 315 mm. The concrete grade is M20 and the grade of reinforcing steel is Fe415. Consider the section to be a balanced section.	**03**
	(b)	State and explain in brief types of limit states in the design of reinforced concrete structures.	**04**
	(c)	A rectangular reinforced concrete beam of width 300 mm and effective depth 565 mm is subjected to the design shear force of 250 kN. The beam is reinforced with tensile reinforcement of 0.90 %. Design for 2-legged shear reinforcement of 8 mm diameter having grade Fe415. Use concrete grade M20.	**07**
Q.3	**(a)**	Discuss the assumptions made in the limit state design of reinforced concrete compression members.	**03**
	(b)	Design lateral and longitudinal reinforcement for the short axially loaded square column, 500 mm × 500 mm subjected to the design axial load of 3000 kN. Use M20 grade concrete and Fe415 steel. Take minimum eccentricity of 20 mm.	**04**
	(c)	A simply supported reinforced concrete slab of effective dimension 4.5m × 6.0m is carrying a characteristic load of 15 KN/m^2, inclusive of the dead load, live load and floor finish load. Assuming M25 grade of concrete and Fe415 grade of steel, overall thickness of the slab being 180 mm and 20 mm cover, what is the required area of steel in the shorter span, if 12 mm diameter bars are used?	**07**
Q.4	**(a)**	Plot neat sketch of stress-strain curve of concrete and stress block parameters adopted by IS:456(2000).	**03**
	(b)	A square isolated footing of dimension 1.5m × 1.5m is subjected to a	**04**

characteristic load, P=660kN (including the self weight of the footing) to the ground, through a column of 350mm × 350mm. The load factor is taken as 1.5. The overall depth of footing is 350mm. The clear cover is 40mm. The diameter of reinforcement provided is 12mm. Calculate the one-way shear force, per meter width, due to soil reaction at the critical section for design.Consider SBC value 150 KN/M^2

(c) Design an interior slab panel of effective dimensions 4.2m × 6.25m subjected to a factored load of 15 kN/m^2 inclusive of self-weight and floor finish load. The slab is provided with main reinforcement bar diameter as 10 mm, and has overall thickness of 150mm. Clear cover is 20 mm, grade of concrete is M20, grade of steel Fe415. **07**

Q.5 **(a)** State advantages and disadvantages of welded connections. **03**

(b) Two plates having thickness 6 mm and 8 mm made up of Fe 410 grade steel are joined together by 16 mm diameter bolts of grade 4.6. Calculate nominal bearing strength of bolt. (Take k_b = 1). **04**

(c) In a truss a compression strut 3 m long consists of two angles ISA 100×100×6 mm. Find the strength of the member if the angels are connected on both sides of 12 mm gusset plate usingSingle bolt. Take yield and ultimate stress as 250 MPa and 410 MPa, respectively and Modulus of Elasticity as 200000 MPa. **07**

Q.6 **(a)** State advantages and disadvantages of Steel structures over reinforced structures. **03**

(b) How the design bending strength of a beam section is calculated as per IS:800 (2007), if shear force on the beam exceeds 60% of design shear strength of the section? **04**

(c) A tie member of a roof truss consists of single ISA 100×75×8 of Fe410 grade, is welded to a 10 mm thick gusset plate. Design the welded connection to transmit a tensile load of 300kN. Assume connection are made in the workshop **07**

Q.7 **(a)** Draw neat sketch of different lacing systems. **03**

(b) Draw neat sketch of gusseted based foundation. **04**

(c) Determine the design axial load on the column section ISMB 400, if the height of the column is 3.5 m and the column is pin-ended at both ends. Take: f_y= 250 N/mm^2, f_u=410 N/mm^2; E = 2×10^5 N/mm^2. **07**

Q.8 **(a)** Draw neat sketch of battening system. **03**

(b) Draw neat sketch of slab based foundation. **04**

(c) Design a laterally supported beam of effective span 5 m for the following data. **07**

Grade of steel: Fe 410
Factored maximum B.M. = 180 kN-m
Factored maximum S. F. = 200 kN
Check for deflection is not required.

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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2021

Subject Code:3150612 Date:27/12/2021

Subject Name:Design of Structures

Time:02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of IS:456 (2000), IS:800 (2007) and Steel table is permitted.**
6. **Assume M20 grade concrete and Fe415 steel for RCC element, if not provided.**

			MARKS
Q.1	**(a)**	Differentiate the limit state method and working stress method of design for RCC structures.	**03**
	(b)	Define (1) Characteristic load (2) Characteristic strength (3) Clear cover (4) Effective cover	**04**
	(c)	Calculate the moment of resistance for a singly reinforced beam of 150 X 350 mm overall size and effective cover of 40 mm. The beam is reinforced with 3-16 mm diameter bars. Use M: 20 grade of concrete and Fe: 415 grade of steel.	**07**
Q.2	**(a)**	Enlist advantages and disadvantages of structural steel.	**03**
	(b)	Explain the lap and butt joint with neat sketches.	**04**
	(c)	Calculate the area of reinforcement in tension and compression zone of rectangular R.C. beam of limited size 250 mm wide and 400 mm deep effective. The effective cover for compression and tension reinforcement is 40 mm. The beam has to resist factored bending moment 180 kN.m. Use M: 20 grade of concrete and Fe: 415 grade of steel.	**07**
		OR	
	(c)	A singly reinforced slab 120 mm thick is supported by T-beams spaced 3.2 m centre to centre. The effective depth and width of web are 560 mm and 450 mm respectively. 8 nos. of Tor steel of 20 mm diameter are provided in 2 layers. The effective cover to the bars in lower layer is 50 mm. The effective span of simply supported beam is 3.60 m. Determine the depth of neutral axis and moment of resistance of T-beam. Use M: 20 grade of concrete and Fe: 415 grade of steel.	**07**
Q.3	**(a)**	Explain the single lacing system and double lacing system with neat sketch.	**03**
	(b)	Determine the development for 16 mm diameter bar, Fe: 415 grade steel in compression and M: 25 grade of concrete.	**04**
	(c)	Design a short R.C. square column for an axial compressive factored load of 1500 kN. Consider minimum percentage of steel as longitudinal reinforcement. Also, design lateral ties. Use M: 20 grade of concrete and Fe: 415 grade of steel.	**07**
		OR	
Q.3	**(a)**	Differentiate between one-way slab and two-way slab.	**03**
	(b)	A cantilever beam of 2 m span is projected from a column of 400 mm width. The cantilever beam is provided with 4 bars of 20 mm diameter of Fe: 415 grade steel. Effective cover is 50 mm. Determine the anchorage length and sketch the anchorage details. Use M: 20 grade of concrete.	**04**

	(c)	A R.C. Beam 250 X 500 mm effective is reinforced with 4-20mm diameter bar with Fe: 415. The beam carries factored shear force of 200 kN. Calculate the spacing of 8 mm dia-2 legged-Fe: 250 stirrups. Use M: 20 grade of concrete.	**07**
Q.4	**(a)**	Define (1) Pitch distance (2) Edge distance (3) End distance	**03**
	(b)	Two plates of 12 mm and 20 mm thickness have width of 100 mm. These plates are connected by lap joint to resist design tensile load of 70 kN. Find bolt value if 16 mm bolts of grade 4.6 is used for connection.	**04**
	(c)	Design a simply supported one way slab for an effective span of 3.0 m to carry total factored load of 9 kN/m^2. Use M: 20 grade of concrete and Fe: 250 grade of steel.	**07**
		OR	
Q.4	**(a)**	Explain slenderness ratio, lug angle and shear leg effect.	**03**
	(b)	Enumerate the design steps for isolated rectangular column footing.	**04**
	(c)	Design a tension member to carry a factored load of 230 kN. Use single unequal angle with 4 mm fillet weld for the connection to gusset plate. Length of member is 3.0 m. Take f_y = 250MPa and fu = 410 MPa.	**07**
Q.5	**(a)**	Draw a neat sketch with all details of gusseted base footing.	**03**
	(b)	Explain term (1) Lateral – torsional buckling and (2) Web crippling	**04**
	(c)	Design a double angle discontinuous strut to carry a factored load of 200 kN. The length of the strut is 3.0 m between intersections. The two angles are connected back to back on the opposite sides of gusset plate and tack bolted.	**07**
		OR	
Q.5	**(a)**	Draw a neat sketch with all details of slab base footing.	**03**
	(b)	Enumerate the design steps for single lacing system for column.	**04**
	(c)	Determine the design axial load on the column section ISMB 350 having height 3.0 m, hinged at both ends. Take f_y = 250 MPa.	**07**

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GUJARAT TECHNOLOGICAL UNIVERSITY

BE –SEMESTER V (NEW) EXAMINATION- SUMMER 2021

Subject Code: 3150612 Date:06/10/2021

Subject Name: Design of Structures

Time:10.30 AM TO 01.00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of IS:456 (2000), IS:800 (2007) and Steel table is permitted.**

			MARKS
Q.1	**(a)**	Discuss advantages of Limit states method over the ultimate load method of design of RC structures.	**03**
	(b)	What is the permissible slenderness limits specified by IS:456 (2000) to ensure lateral stability?	**04**
	(c)	RCC beam of a rectangular section 300 mm × 600 mm is reinforced with 5-20mm diameter tensile reinforcement with clear cover 25mm. The concrete and steel grades are M20 and Fe-415, respectively. Give section classification and calculate moment of resistance of the section.	**07**
Q.2	**(a)**	Write the assumptions made in the limit state of collapse of Reinforced Concrete compression members.	**03**
	(b)	Answer the following questions for the design of reinforced concrete beam as per IS:456 (2000). i) What is the maximum allowable percentage of tension and compression reinforcement? ii) What is the minimum percentage of tension and shear reinforcement?	**04**
	(c)	RCC beam of a rectangular section 300 mm × 600 mm is reinforced with 5-20mm diameter tensile reinforcement with clear cover 25mm. The concrete and steel grades are M20 and Fe-415, respectively. Calculate the nominal shear strength of the beam. Design 2-legged shear stirrups using 12mm diameter bar to carry the design shear force of 350kN.	**07**
		OR	
	(c)	Find the percentage of tensile and compression reinforcement required for a rectangular beam of size 300 mm × 500 mm effective for the factored moment of 250 kNm. Take the effective cover for the tensile and compression reinforcement as 50 mm. The M20 grade concrete and HYSD reinforcement of grade Fe-415 is used in the design.	**07**
Q.3	**(a)**	For Reinforced Concrete columns restrained laterally by struts, how the unsupported shall be calculated as per IS:456 (2000)?	**03**
	(b)	A square footing for a square RC column of size 300 mm × 300 mm is carrying 650kN load inclusive of its self weight. Calculate the dimensions of footing, if the soil bearing capacity is 150 kN/m^2.	**04**
	(c)	Design an RCC short axially loaded column to carry working load of 1000 kN. The un-supported length of a column is 3 m and both ends of the column are pin supported. Use M20 grade of concrete and Fe-415 steel.	**07**
		OR	
Q.3	**(a)**	A square footing of 1.5 m × 1.5 m for a square RC column of size 300 mm × 300 mm is carrying the characteristic load of 650kN load inclusive of its self weight. The overall depth of footing is 350 mm and is reinforced with 12mm diameter bar with clear cover of 50mm. Calculate the bending	**03**

moment at critical section for design.

(b) A concrete column 450mm × 450mm having unsupported length of 4 m is subjected to an axial load of 1200 kN. Find out the maximum eccentricity of the applied load along both axes, as per the IS:456 (2000), from the center of the cross-section so that the section will be under compression only and no moment effects need to be considered. **04**

(c) Design a simply supported RC slab to cover the room of inside dimensions 7.5 m × 3.5 m supported on bearing of 0.2m. The slab carries total load of 5 kN/m^2 inclusive of imposed load and floor finish load. Use M20 grade of concrete and Fe-415 steel. Use 10mm bars as tension reinforcement with clear cover of 20mm. **07**

Q.4 **(a)** What is the maximum permissible distance between the centers of any two consecutive bolts in a line adjacent and parallel to an edge of an outside plate? **03**

(b) Design a lap joint between two plates of size 120mm × 12mm thick and 100mm × 16mm thick to transmit a factored load of 80kN using a single raw of M16 bolts of grade 4.6. Take plate of steel Fe-410. **04**

(c) A tension member in bracing system consists of 2 angle sections placed back to back on each side of 10 mm thick gusset plate and is subjected to factored tensile load of 200 kN. Design the member. Use M16 bolts of grade 4.5. Take the grade of steel Fe-410. **07**

OR

Q.4 **(a)** Give advantages of steel structures over Reinforced Concrete structures. **03**

(b) Design suitable longitudinal fillet weld to connect a plate (200 mm × 12 mm thick) with another plate (300 mm × 16 mm thick) to transmit a pull equal to the full strength of thiner plate. Take the grade of steel Fe-410. **04**

(c) A tension member in bracing system consists of 2 angle sections placed back to back on each side of 10 mm thick gusset plate and is subjected to factored tensile load of 200 kN. Design the member. Use 6mm size of fillet weld. Take the grade of steel Fe-410. **07**

Q.5 **(a)** Plot neat sketch of slab based foundation (plan view and front view) with labeling of components. **03**

(b) Determine the design axial compressive load a section ISMB200 can carry. Take length of column as 3 m and both ends are restrained against rotation & translation. Take yield and ultimate stress as 250 MPa and 410 MPa, respectively and Modulus of Elasticity as 200000 MPa. **04**

(c) Design a simply supported beam of 5 m span carrying Dead Load of 30kN/m and Live Load of 10 kN/m. Assume that compression flange is fully restrained throughout. Take yield and ultimate stress as 250 MPa and 410 MPa, respectively and Modulus of Elasticity as 200000 MPa. **07**

OR

Q.5 **(a)** Plot neat sketch of gusseted base foundation (plan view and front view) with labeling of components. **03**

(b) Plot neat sketch showing different lacing systems with labeling of components. **04**

(c) A column 4 m long is fixed at base and hinged at top is subjected to beam reaction of 300 kN at an eccentricity of 30 mm from the major axis of bending. Design the column. Take yield and ultimate stress as 250 MPa and 410 MPa, respectively and Modulus of Elasticity as 200000 MPa **07**

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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V(NEW) EXAMINATION – SUMMER 2022

Subject Code:3150612 Date:09/06/2022

Subject Name:Design of Structures

Time:02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of IS: 456, IS: 800 and steel table is permitted.**
6. **Assume M20 grade concrete and Fe415 steel for RCC element and fy of 250 MPa and fu of 410 MPa for the structural steel if not given.**

Q.1	**(a)**	Explain the concept of limit state design methodology.	**03**
	(b)	Explain limit state of collapse & limit state of serviceability in flexure.	**04**
	(c)	Find the Moment of Resistance of a singly reinforced concrete beam of 200mm width and 450mm effective depth, reinforced with 4 bars of 12mm dia of Fe415 and M20 concrete.	**07**
Q.2	**(a)**	Determine development length for 20 mm diameter, Fe 415 grade steel bar in compression. Take M-20 grade of concrete.	**03**
	(b)	Write design steps for isolated rectangular column footing.	**04**
	(c)	Design reinforcement for a rectangular R.C.C. beam, 200 mm wide, simply supported over an effective span of 4 m loaded with service load of 40 KN/m including self-weight. Draw sketches of cross section of beam.	**07**
		OR	
	(c)	Design for tensile and compressive reinforcement for a R.C.C. beam 250 mm wide and 550 mm deep with concrete grade M20 & steel Fe 415 at effective cover of 40 mm on both sides to resist factored moment of 310 KN.m.	**07**
Q.3	**(a)**	What is the function of providing distribution steel in slab?	**03**
	(b)	Deign lap joint to connect two plates 100x16 mm and 100x12mm to transfer 100 kN axial factored load. Use single row of 4.6 grade bolts. Plates are of steel grade 410.	**04**
	(c)	Design isolated footing for an axially loaded column 350 X 350 mm in cross Section and carrying 1600 KN working load. Take SBC of soil as 250 kN/m2.check for one ways shear.	**07**
		OR	
Q.3	**(a)**	Explain the difference between one way and two way slab?	**03**
	(b)	Two plates 150 X 10 mm of grade 410 are connected by 20 mm diameter bolts using butt joint. Design the bolted connections to transmit the pull equal to the strength of the plate. Grade of bolt is 4.6.	**04**
	(c)	Design simply supported roof slab for a room 9 m x 4 m clear in size. The slab is carrying an imposed load of 2.5KN/m2. Use M-20 concrete & Fe 415 steel. Check the slab for control of deflection & cracking. Show reinforcement details.	**07**

Q.4	**(a)**	What are the reasons for providing combined footing?	**03**
	(b)	Write design steps of lacing column.	**04**
	(c)	Design a tension member to carry a factored load of 240 KN. Use single unequal angle with 4mm fillet weld for the connection to gusset plate. Length of the member is 3.0m. Take f_y = 250 MPa & f_u = 410 MPa.	**07**

OR

Q.4	**(a)**	Explain the possible failure modes of an axially loaded Column.	**03**
	(b)	A Double angle strut made of 2 ISA 80 X 80 X6 mm placed back to back on either side of gusset plate. The length of the member is 3 m. Determine compression capacity of the member. Assume Fe410 steel with fy = 250 MPa.	**04**
	(c)	Design a steel column to carry factored axial load of 1400 KN, the length of the column is 3.5 m and hinged at both ends. Assume fy = 250 MPa.	**07**

Q.5	**(a)**	Write short notes on block shear failure in plates and angles.	**03**
	(b)	Explain "battening" with neat sketch.	**04**
	(c)	Design a slab base foundation for a suitable column section to carry a factored load of 1200 KN. Assume Fe 410 steel and M 25 concrete. Take safe bearing capacity of soil 200 KN/m^2.	**07**

OR

Q.5	**(a)**	Explain shear lag effect and lug angle?	**03**
	(b)	Draw a neat sketch of gusseted steel footing.	**04**
	(c)	Design a simply Supported two way slab of 4 m X 5m clear span supported on 230 mm thick wall on all four sides. Live load 4 KN/m^2 and floor finish 1 KN/m^2.Use M-20 concrete and Fe-250 steel. Corners are not held Down. Check for cracking and deflection of slab.	**07**

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