

Heaven's Light is Our Guide  
**DEPARTMENT OF CIVIL ENGINEERING**  
**RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY**  
 B.Sc. Engineering Third Year Odd Semester Examination, 2016  
**CE- 3115**  
**Reinforced Concrete - I**

Total marks: 72

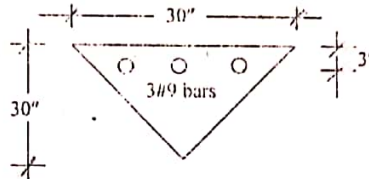
Time: 3 Hours

*Rakibul Islam*  
CE-140022

- N.B:-**
- (i) Answer any **SIX** questions, taking **THREE** from each section.
  - (ii) Figures in the margin indicate full marks.
  - (iii) Use separate answer script for each section.
  - (iv) Assume reasonable value for any data missing.

**SECTION-A**

- Q.1(a) What is reinforced concrete? Explain with necessary diagrams the behavior of a reinforced concrete beam loaded to failure. 4.00
- (b) A reinforced concrete beam section is shown in figure below. Compute (i) reinforced ratio (ii) mode of failure (iii) ultimate moment (iv) amount of live load that can be applied on the beam on a span of 10 ft. Assume  $f'_c = 4000$  psi and  $f_y = 60000$  psi. 8.00

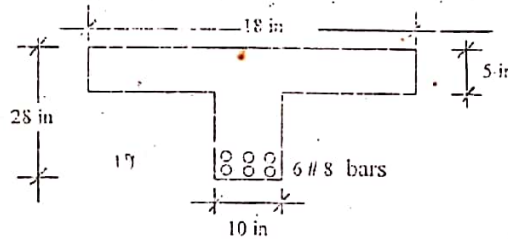


- Q.2(a) Define diagonal tension. Derive the equation to compute shearing unit stress in beam? 4.00
- (b) A simply supported rectangular beam 10" wide and 20" effective depth carries total factored load of 5 kip/ft over an effective span of 20'. Determine the length over which vertical stirrup is to be provided. Obtain also spacing of stirrup at a distance of 2' from support. Assume  $f'_c = 4000$  psi and  $f_y = 50000$  psi. 8.00

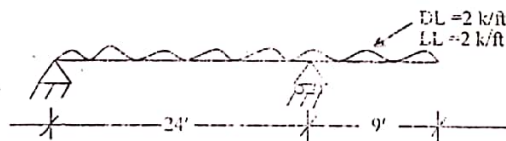
*shear*

- Q.3 (a) Explain how T-beam is formed? "Tension controlled failure is expected in case of a T-section"- do you agree with this comment. Justify your answer. 4.00
- (b) Compute the positive design moment capacity of the beam shown in figure below. The concrete and steel strengths are 3000 psi and 60000 psi, respectively. The beam also contains stirrups not shown in figure. 8.00

*T-b*



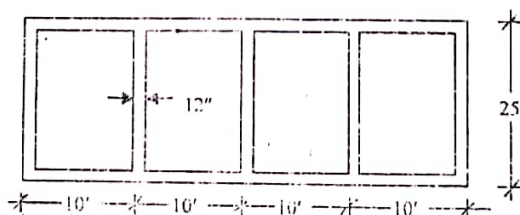
- Q.4 (a) Explain necessity of providing safety provisions in the design of RC member. 3.00
- (b) An overhanging beam is shown in figure below. The beam section may be assumed as simply reinforced section. Design the beam using the following information (i) dead load including self weight = 2 k/ft (ii) live load = 2 k/ft (iii)  $f'_c = 5000$  psi (iv)  $f_y = 60000$  psi (v) method of design = USD 9.00



**SECTION-B**

- Q.5(a) Explain the necessity of providing shrinkage reinforcement in one-way slabs. Draw typical cross section and show shrinkage reinforced for (i) simply supported slab (ii) Cantilever slab. 4.00
- (b) Design the roof slab shown in figure below with  $f'_c = 3$  ksi and  $f_y = 50$  ksi. Width of beam below the slab is 12" and take the live load 100 psf. 8.00

*slab*



Q.6(a) Why is it necessary to provide reinforcements in the compression zone of a rectangular beam? List some practical examples of such beam. 4.00

Beam

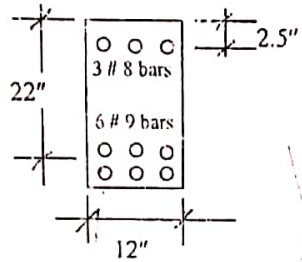
(b) Find the cross-section of concrete and area of steel required for a simply supported rectangular beam of a span length 20ft and the height of the beam restricted to 16 inch and the width to 12 inch for architectural considerations with the following loads and material properties are given:  $w_d = 0.9$  kips/ft,  $w_l = 1.70$  kips/ft,  $f'_c = 5000$  psi and  $f_y = 60000$  psi. 8.00

Q.7(a) Define bond. List the factors affecting bond. 2.00

(b) Derive an equation to calculate average bond stress. 4.00

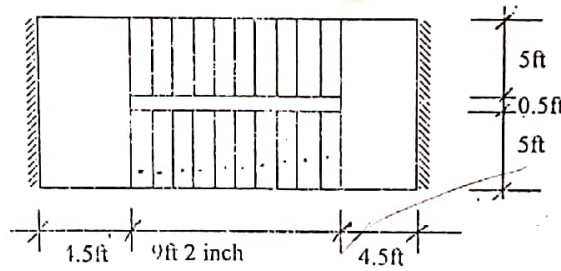
(c) Compute the working moment capacity of the beam shown in figure below. Assume  $f'_c = 3000$  psi and  $f_s = 20000$  psi. 6.00

Double



Q.8 Design the stair shown in figure below for a live load 100 psf. Use  $f'_c = 3000$  psi and  $f_y = 50000$  psi and riser of 12.00 stair 6" and tread 11".

stair



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**CE 315**  
**Reinforced Concrete - I**

**Full Marks: 70**

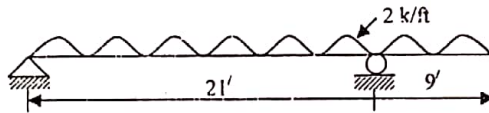
**Time: 3 Hours**

- N.B.:-**
- (i) Answer SIX questions, taking THREE from each section.
  - (ii) Figure in the margin indicates full marks.
  - (iii) Use separate answer script for each section.
  - (iv) Assume reasonable value for any data not given.

*RAKIBUL ISLAM*  
*CE'140022*

**SECTION-A**

- Q.1(a) Explain why mild steel is used as reinforcement in reinforced concrete structures. 2.67  
 (b) The overhanging beam shown in the figure is subjected to a uniform live load of 2k/ft. Design the beam by WSD method for flexure if  $f_c' = 3000$  psi and  $f_s = 24,000$  psi. 9.00



- Q.2(a) What do you mean by diagonal tension? 2.00

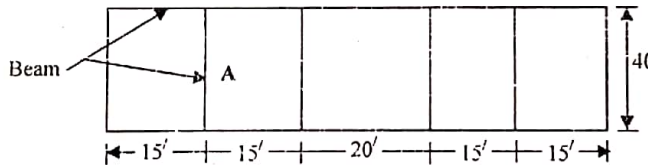
*shear* A reinforced concrete beam carries a total factored load of 7 kip/ft on a simple clear span of 20ft. Find the dimension of the beam such that the shear carried by stirrup  $V_s = 1.5V_c$ . Find also spacing of stirrup at a distance 4ft from support. Assume  $f_c' = 4000$  psi and  $f_y = 50,000$  psi 9.67

- Q.3(a) Define T-beam. 2.00

*T-b* (b) A concrete floor system is supported by T-beams spaced at 9 ft on centers. The beam has the dimension  $b_w = 11$  inch,  $h_f = 4.5$  inch,  $d = 22$  inch. If the beam is to support a live load of 200 psf on a simple span of 22 ft, what tensile steel area is required? Assume  $f_c' = 3000$  psi and  $f_y = 60,000$  psi. 9.67

- Q.4(a) Why is shrinkage reinforcement provided? Draw typical cross section of simply supported and cantilever one-way slab and indicate shrinkage reinforcement. 3.00

*slab* (b) For the floor system shown in figure below, design slab panel A and draw reinforcement detail. Assume (i)  $f_c' = 4000$  psi (ii)  $f_y = 50,000$  psi (iii) live load = 50 psf (iv) beam width = 12 in. Follow USD method. 8.67



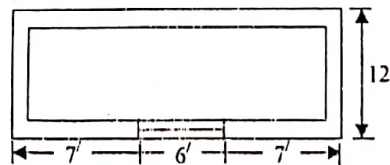
**SECTION-B**

- Q.5 A beam is to carry its own dead load plus a uniform live load of 1.75 kips/ft and a super-imposed service dead load of 1.0 kip/ft on a 33ft simple span. Assume  $f_c' = 3500$  psi and  $f_y = 60,000$  psi. Compute (i) Width and overall depth of the beam (ii) Reinforcement required. Also check whether the beam section is large enough to bear the shear stresses. Finally, draw the cross section of the beam at mid-span. 11.67

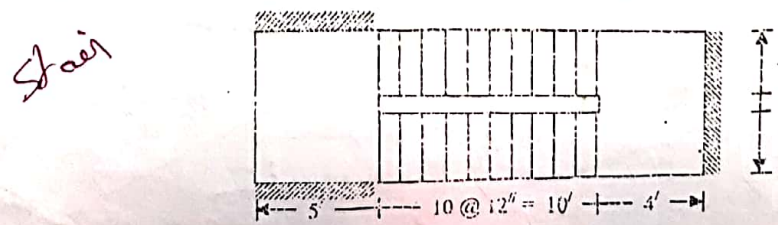
- Q.6(a) Explain the necessity of using reinforcement in the compression zone of a rectangular beam. Give some example where such beams are provided. 3.00

*Double* (b) A rectangular beam is 12 in wide and has an effective depth of 22in. The beam is reinforced with six No. 9 bars on the tension side and 2 No. 9 bars on the compression side. The compression bars are placed 2.5 in below the compression face. Calculate the ultimate moment capacity of the beam using  $f_c' = 4$  ksi and  $f_y = 60$  ksi. 8.67

- Q.7 Design a lintel over a window opening of 6 ft as shown in figure below. Assume (i) Width of wall = 10in (ii) height of wall above opening = 4 ft (iii) thickness of slab = 5 in (iv) live load on slab = 50 psf (v)  $f_c' = 2500$  psi (vi)  $f_y = 40,000$  psi. 11.67



- Q.8 Design the stair shown in figure below. Assume  $f_c' = 5000$  psi,  $f_y = 60,000$  psi and rise of step = 6 in. 11.67



**CE 315**  
**Reinforced Concrete - I**

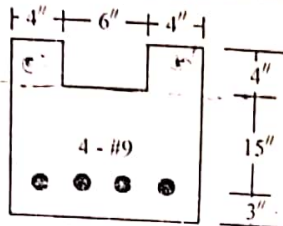
Full marks: 70

Time: 3 Hours

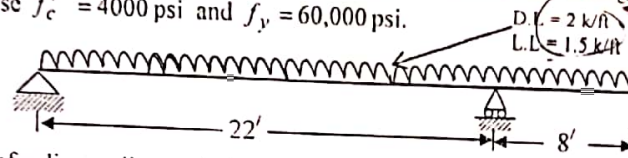
- B:- (i) Answer any SIX questions, taking THREE from each section  
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**SECTION - A**

- 1(a) Discuss, with the help of stress-strain diagram, the behavior of a simply supported reinforced concrete beam loaded to failure. 3.00  
 (b) Determine the ultimate moment capacity of the beam section shown in the figure below using  $f'_c = 4000$  psi and  $f_y = 60,000$  psi. 8.67



- 2.2(a) Explain why strength reduction factor  $\phi$  for shear is less than  $\phi$  for bending moment. 2.00  
 (b) The beam shown in the figure overhanging on one side carries a uniform dead load of  $2 \text{ k/ft}$  including its own weight and a uniform live load of  $1.5 \text{ k/ft}$ . Design the beam considering singly reinforced rectangular section. Use  $f'_c = 4000$  psi and  $f_y = 60,000$  psi. 9.67



- 3.2(a) Explain the behavior of a diagonally cracked beam. 2.00  
 (b) A rectangular beam 14 inch wide with an effective depth of 22 inch carries a dead load of  $1.5 \text{ k/ft}$  including self weight and a live load of  $4 \text{ k/ft}$  on a single span of 20 ft. Design web-reinforcement using  $f'_c = 3000$  psi and  $f_y = 60,000$  psi. 9.67

- Q.4(a) What is a T-beam? What are the recommendations of ACI code for effective width of T-beam? 2.00  
 (b) A floor system consists of 3.5 inch slab supported by 19 ft simple span beams spaced at 9 ft on centers. The beams have web width  $b_w = 11$  inch and effective depth  $d = 17.5$  inch. Calculate necessary reinforcement for a typical interior beam if the ultimate applied moment is 6000 k-in. Use  $f'_c = 3000$  psi and  $f_y = 60,000$  psi. 9.67

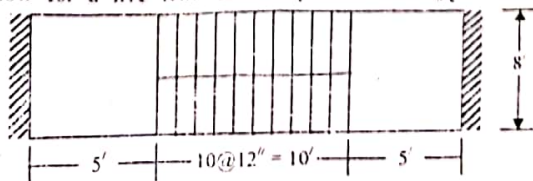
**SECTION - B**

- Q.5(a) What is shrinkage reinforcement? Why and where are these reinforcements provided? 3.00  
 (b) A reinforced concrete slab is to be built integrally with its support and consists of two spans, one is 15 ft and the other is 12 ft. Design the slab to carry a service live load of 120 psf. Assume  $f'_c = 4000$  psi and  $f_y = 60,000$  psi. Support width is 12 inch. 8.67

- Q.6(a) Explain the necessity of using reinforcement in the compression zone of a rectangular beam. 2.67  
 (b) A rectangular beam is 12 in. wide and has an effective depth of 21 in. The beam is reinforced with six No. 9 bars on the tension side and 2 No. 8 bars on the compression side. The compression bars are located 2 in. below the compression face. Calculate the ultimate moment capacity of the beam using  $f'_c = 4$  ksi and  $f_y = 50$  ksi. 9.00

- Q.7 Design a lintel over a window opening of 6 ft. The window is to be located in 10 in. thick brick wall and the length of brick wall on each side of window is 2.5 ft. The height of brick wall above the lintel is 7 ft. A 2 ft wide sunshade is to be built integrally with the lintel. Design the sunshade as well. Assume  $f'_c = 2500$  psi and  $f_s = 20,000$  psi. 11.67

- Q.8 Design the stair shown in figure below for a live load of 120 psf. Assume  $f'_c = 3000$  psi,  $f_s = 20,000$  psf and rise of step = 7 in. 11.67



The End

**CE 315**  
**Reinforced Concrete-I**

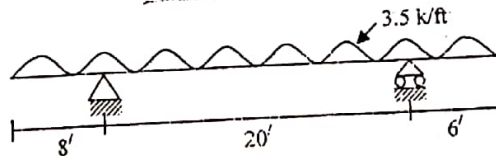
Full marks: 70

Time: 3 Hours

- N.B:- (i) Answer any **SIX** questions, taking **THREE** from each section.  
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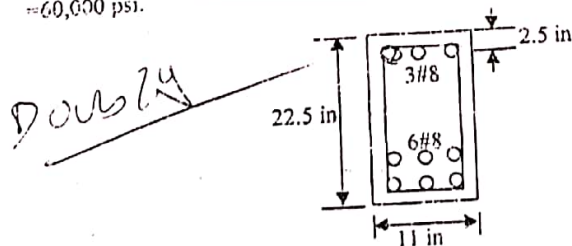
**SECTION-A**

- Q.1(a) Explain the followings: 4.67  
 (i) A lower load factor is used for dead load than live load.  
 (ii) The strength reduction factor for compression controlled member is smaller than that for tension controlled member.  
 (iii) An under-reinforced section is more desirable than over reinforced section. 7.00  
 (b) A beam is 10 in. wide and with effective depth of 20 in. is reinforced with 6#8 bars. Check (i) whether tension steel yields at failure (ii) whether the section is tension controlled. Also compute the nominal moment capacity. Assume  $f_c' = 3$  ksi and  $f_y = 60$  ksi. 2.00
- Q.2 (a) Explain why mild steel is used as good reinforcement. 9.67  
 (b) A floor system consists of a slab 4" thick supported by beams spaced at 8 ft on centres having simple span of 19 ft. The floor supports a live load of 230 psf, web width  $b_w = 12"$ , total depth  $h = 22"$ . Using  $f_c' = 3000$  psi and  $f_y = 60,000$  psi, calculate the steel area. Select bar size and number of bars. Follow USD method. 2.67
- Q.3 (a) Explain what is bond. Derive expression for flexural bond stress. 5.00  
 (b) A reinforced concrete rectangular beam having effective depth,  $d = 18"$  and carrying uniform load over a 21 ft simple span requires 7-#6 bars. Where the first pair of bars be cut off. 6.00  
 (c) A rectangular beam has width  $b = 10"$  and effective depth  $d = 18"$ . The beam carries a dead load of 1.5 kip/ft including self weight and a live load of 3.0 kip/ft on a simple span of 18 ft. If  $f_c' = 3000$  psi, through what part of the beam is web reinforcement required? 2.67
- Q.4 (a) Explain why limitations are imposed on the maximum and minimum tension steel in reinforcement concrete beams. 9.00  
 (b) The overhanging beam shown in figure below is 12 in. wide and 20 in. effective depth. Compute the reinforcement required at the critical sections considering  $f_c' = 3000$  psi and  $f_y = 20,000$  psi. Follow WSD method.



**SECTION-B**

- Q.5(a) Explain the necessity of doubly reinforced beam in civil engineering construction. Enumerate some practical example where such beams are usually recommended. 3.00  
 (b) Compute the design moment capacity of the beam section shown in figure below. Assume  $f_c' = 3000$  psi and  $f_y = 60,000$  psi. 3.00



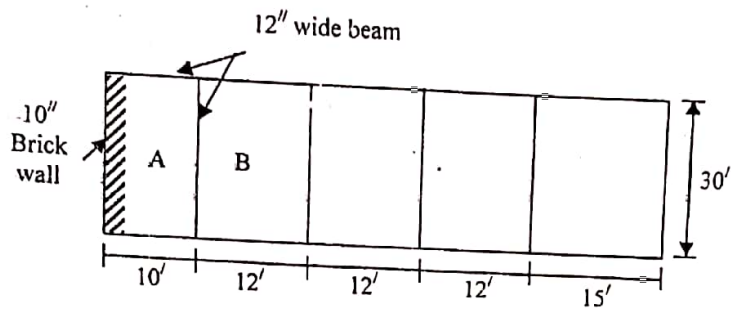
- Q.6(a) Show bar cutoff requirements of the ACI code for continuous beam.  
 (b) Design a lintel with sunshade over window opening of 6 ft. The height of 5 in. brick wall above the opening is 3 ft. Room size is 13' x 15'. Assume  $f_c' = 3500$  psi and  $f_y = 50,000$  psi.

Lintel

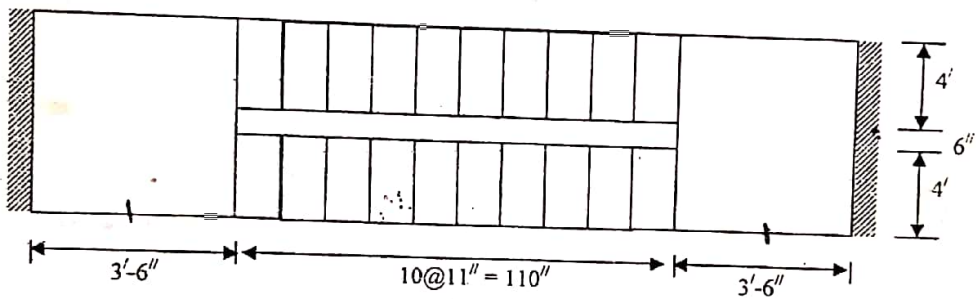
Full Marks: 70  
A.B.S.

- Q.7(a) Reinforcements are provided at right angles and on the top of the main reinforcement in addition to the calculated reinforcement in case of a simply supported one-way slab-Explain.
- (b) A floor system is shown in figure below. As an engineer you are asked to design the slab panels A and B. Briefly explain your design considerations and then compute
- (i) thickness of the slab
  - (ii) reinforcement required at different critical sections
  - (iii) distribution reinforcements if required. Also draw typical reinforcement detail and shown your calculated figures on the diagram.

9/10/20



- Q.8 (a) Design the stair shown in the figure below by WSD method for a live load of 112 psf using  $f'_c = 3000$  psi and  $f_s = 20,000$  psi 11.67



R =

\*\*\*\*

- (i) Answer SIX questions taking THREE from each section.
- (ii) Frame in the margin as a guide to marks.
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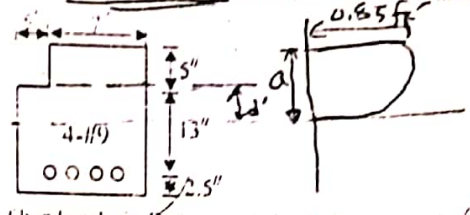
SECTION-A

Q.1 Explain the terms (i) Tension failure (ii) Compression failure (iii) Balanced failure. Derive the relation  $\rho_{cr} = 0.85\beta_1 f_c' / f_y$ .

3.00  
2.00

Neglecting lack of symmetry, determine the ultimate moment capacity of the section shown in the figure below using  $f_c' = 4000$  psi and  $f_y = 60000$  psi.

6.67



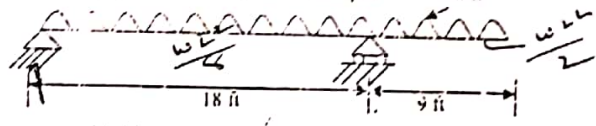
$0.85 f_c' A_c = A_s f_y$   
 $\Rightarrow A_c = \frac{A_s f_y}{0.85 f_c'}$   
 $= \frac{4 \times 60}{0.85 \times 4}$   
 $= 70.59$   
 $A_c > (7 \times 5)$

Q.2 Define bond. Explain the necessity of bond analysis. Derive expression for flexural bond stress. A rectangular beam is to carry a service dead load of 1.6 kip/ft including self weight and a service live load of 3.5 kip/ft on a clear span of 21 ft. Find the width and effective depth for a beam in which web reinforcement provides shear strength  $V_s = 3.5 f_y b_w d$ . Use  $f_c' = 4000$  psi. Using No 3 U stirrup with  $f_y = 60000$  psi, find spacing of stirrup at a distance of 2.5 ft from the support.

3.00  
3.67

Q.3 How are safety provisions ensured in WSD and LSD methods of design? The overhanging beam shown in the figure below is 12 in wide and 22 in effective depth. Design by WSD method the reinforcement for different points using  $f_c' = 3000$  psi and  $f_y = 60000$  psi.

3.00  
3.67



$\therefore A_c = 7 \times 5$   
 $= 2 \times 12$   
 $\Rightarrow d' = \frac{70.59 - 3}{12}$   
 $= 2.96$

Q.4 "In practice, reinforcements are provided in both tension and compression zones of a beam". Explain. Do you think all of these beams are doubly reinforced. Justify your answer.

3.00

Q.5 A rectangular beam carries a service dead load of 1.25 kip/ft including self weight and a service live load of 2.60 kip/ft on a simple span of 19 ft. The beam is limited in cross section to 11 in width and 21 in total depth. If  $f_c' = 3000$  psi and  $f_y = 60000$  psi, find the steel areas.

3.67

$a = 5 + 2.96$   
 $= 7.96$

SECTION-B

Q.6 Write the functions of distribution reinforcement in one-way slab. Why is it placed on the top of the main reinforcement in case of a simple span?

3.00

Q.6.1 Design a continuous one-way slab for a clear span of 13 ft to support a live load of 90 psf. Use  $f_c' = 3000$  psi and  $f_y = 40000$  psi. Beam width is 12 in.

3.67

Q.6.2 "A tension failure in generally occurs in a T-beam". Explain.

2.67

Q.6.3 A T-beam with  $b = 32$  in,  $b_w = 8$  in,  $d = 12$  in,  $A_s = 3.00$  in<sup>2</sup>,  $f_c' = 3000$  psi and  $f_y = 60000$  psi and  $h_f = 2$  in (i) Determine the stresses in concrete and steel if the applied moment is  $1.5 \times 10^6$  lb-in. (ii) The ultimate strength of the beam.

9.00

Q.7 Design the stair shown in the figure below for a live load of 100 psf. Assume rise = 6 in,  $f_c' = 3000$  psi and  $f_y = 18000$  psi.

11.67

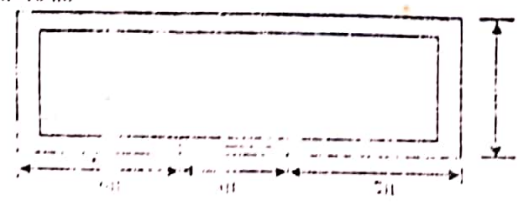


$R = 6''$   
 $T = 12''$

Q.8 A lintel is to be designed over a window opening as shown in figure below. Design the lintel using the following data (i) a Sunshade of 2 ft width to be cast monolithic with the lintel (ii) live load on sunshade = 40 psf (iii) height of wall above lintel = 4 ft (iv) the building is one storey and design load on the roof slab is 100 psf. (v)  $f_c' = 2500$  psi (vi)  $f_y = 18000$  psi. (vii) width of brick wall = 10 in.

11.67

Lintel



**CE 315**  
**Reinforced Concrete - I**

all marks: 70

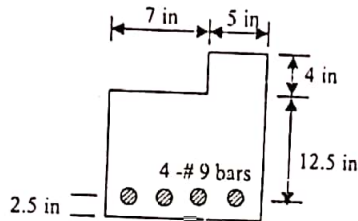
Time: 3 Hours

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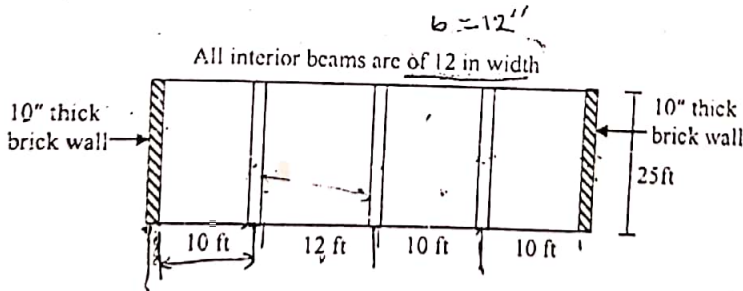
**SECTION-A**

- Q.1 (a) Discuss in brief different types of flexural failure of RC member. Which one is adopted in the design and why? 3.00
- (b) Estimate the ultimate moment capacity of the section shown in the figure using  $f'_c = 4000$  psi and  $f_y = 60,000$  psi. Neglect the lack of symmetry. 8.67



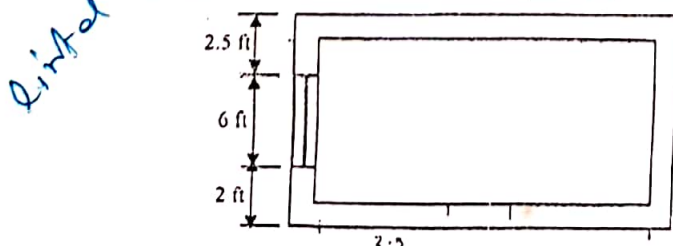
*Handwritten notes:*  
 4 #9 bars  
 4x12  
 4x12

- Q.2 (a) Define bond. What are the different types of bond? Derive expression for flexural bond stress. 3.00
- (b) Derive an expression for spacing of vertical stirrup. 2.00
- (c) A reinforced concrete cantilever beam carries a load P at the free end. The beam has width  $b_w = 10$  in and effective depth  $d = 20$  in. No. 3 vertical U-stirrups spaced at 5 in c/c are used and stressed to  $f_y$  under the effect of shear due to P. Neglect self weight of the beam. Calculate the magnitude of load P if  $f'_c = 4000$  psi and  $f_y = 60,000$  psi. 6.67
- Q.3 (a) Explain the reasons for providing shrinkage reinforcements in slab. 2.67
- (b) Design the slab shown in figure below. Assume L.L. = 100 psf,  $f'_c = 4000$  psi and  $f_y = 60,000$  psi. 9.00



*Handwritten notes:*  
 Development  
 length =  $\frac{f_s d}{4u}$

- Q.4 Design the lintel shown in figure below. Assume (i) A sunshade of 2 ft width to be cast monolithic with the lintel (ii) live load on sunshade = 40 psf (iii) height of wall above lintel = 6 ft (iv)  $f'_c = 3000$  psi (v)  $f_s = 20,000$  psi (vi) width of brick wall = 10 in. 11.67



*Handwritten note:* Lintel

END

SECTION - B

What are doubly reinforced beams? When are they used?

A rectangular beam section 12 in. wide and 26 in total depth is reinforced with six No. 7 bars on the tension side in two-rows and two No. 7 bars on the compression side. Effective depth  $d = 22.5$  in and  $d' = 2.5$  in. What uniform live load can the beam sustain if the simple span of the beam is 20 ft. Assume  $f_c' = 4000$  psi and  $f_s = 24,000$  psi.

4.00  
9.67

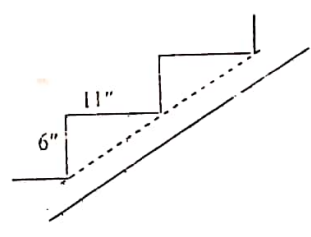
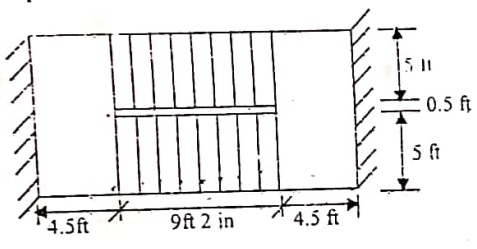
Q.6(a) What is T-beam? What are the advantages of T-beam over rectangular beams? 3.00

(b) A floor system is supported by RC beams spaced at 10 ft on centers on a simply supported span of 15 ft. The beam is reinforced with three No. 9 bars. If  $h_t = 4$  in,  $b_w = 10$  in and  $d = 17.5$  in., determine the moment capacity of a typical interior beam by USD method. Use  $f_c' = 4000$  psi and  $f_s = 40,000$  psi. 8.67

Q.7(a) Why is it necessary to provide anchorage length for reinforcement? Provide some examples where it is necessary to consider anchorage length. 3.00

(b) A T beam floor consists of 5 in thick RC slab cast monolithic with 12 in. wide beam spaced 12 ft on centers. The super-imposed live load on the slab is 250 psf. The effective span of the beam is 20 ft simply supported. The overall depth of the beam is 25 in. Design the beam for flexure. Assume  $f_c' = 4000$  psi and  $f_s = 60,000$  psi. 8.67

Q.8 Design the stair shown in the figure for a live load of 90 psf. Use  $f_c' = 3000$  psi and  $f_s = 50,000$  psi. 11.67



$$M = \frac{w_d l^2}{8}$$

$$w_d = w_l + w_d$$