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Bangladesh Army University of Science and Technology

Department of Civil Engineering

Final Examination, Summer 2022

Course Code: CE 3111 **Level-3 Term-I**

Time: 03 (Three) hours **Full Marks: 240**

Course Title: Structural Analysis and Design I

N.B.
- The questions are of equal value.
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course learning outcomes (CLOs) are given in the right most column.

PART- A (Marks: 120)

(Answer any three questions including Q. No. 1)

			Marks	CLOs
1.	a)	Explain the following terms: i) Stability of structures ii) Determinacy of structures.	(10)	1
	b)	Solve the frame given in Fig. 1 below and draw the shear force diagram and bending moment diagram of it.	(30)	2

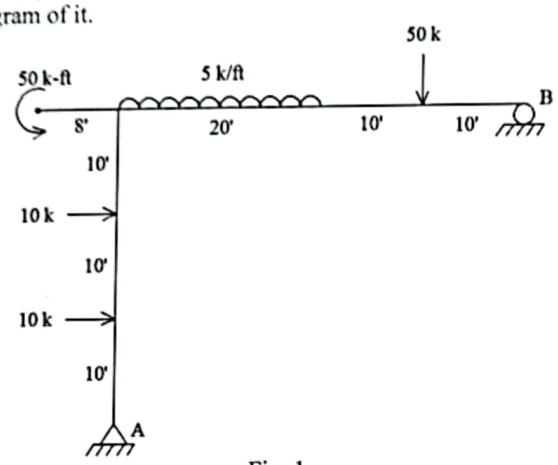

Fig. 1

2.		A set of axle load is given in Fig. 2 below. For a simply supported girder of 60 ft. span analyze the effect of the given moving load to determine the position and value of absolute maximum bending moment on it.	(40)	3

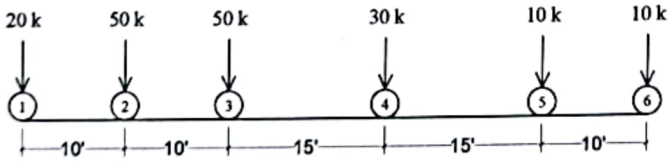

Fig. 2

3.	a)	For a three hinged parabolic arch, analyze the equation of central rise and show that $y = 4y_c\, x\,(L\text{-}x)/L^2$	(10)	2
	b)	For the arch given in Fig. 3, calculate the maximum positive and negative moments.	(30)	2

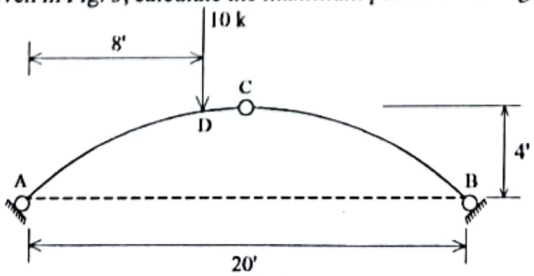

Fig. 3

a) For the shear force and bending moment diagram, explain the following terms: (10) 2

i) Point of inflection
ii) Point of contra-flexure.

b) For the wheel load arrangement shown in Fig. 4, evaluate the value of any of the followings: (30) 2

i) Maximum Shear at a point 15 ft. from the left support of a 60 ft. simply supported girder.
or,
ii) Maximum moment at a point 15 ft. from the left support of a 60 ft. simply supported girder.

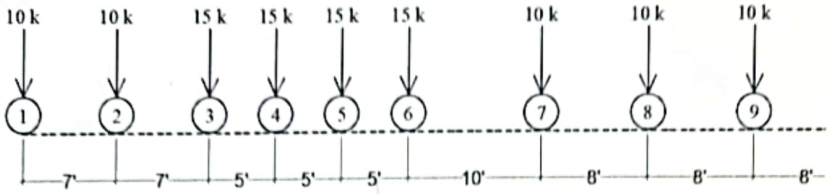

Fig. 4

PART- B (Marks: 120)

(Answer any three questions including Q. No. 5)

			Marks	CLOs
5.	a)	Define influence line. Explain its necessity to draw?	(10)	3
	b)	Determine the tension in each segment of the cable and dimension *h* shown in Fig. 5.	(30)	4

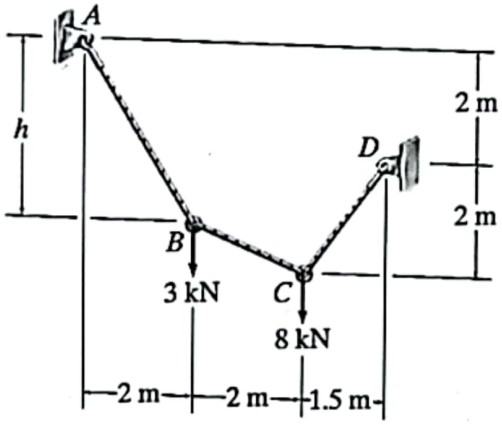

Fig. 5

6.	a)	State and prove general cable theorem.	(16)	4
	b)	Draw the Influence diagram of F_{BC}, F_{BH}, and F_{CH} for the following structure shown in Fig. 6.	(24)	3

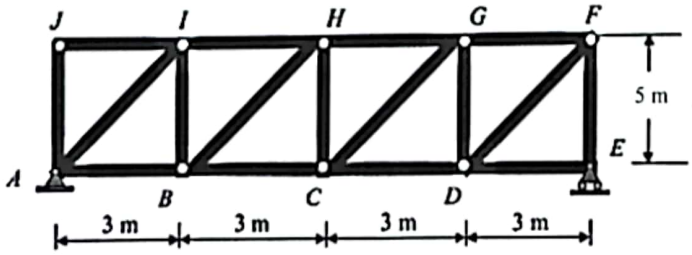

Fig. 6

7. a) Explain Muller-Breslau principle for Influence Line. (10) 3

b) Draw the influence lines with ordinate for the following structure shown in Fig. 7: (30) 3

(1) Vertical reactions at A and C. (ii) Shear and moment at B and E. (iii) Shear at just left of support C and support G.

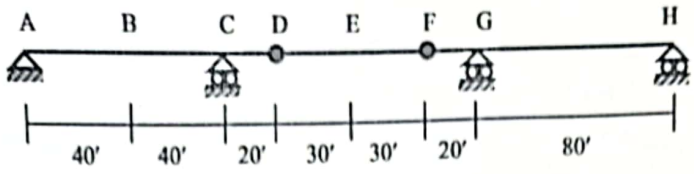

Fig. 7

8. a) Explain H-20 and HS-20 moving load. (10) 3

b) Determine the maximum value of R_A, R_D, R_C, V_{DL}, and M_B for the following structure shown in Fig. 8 due to a 7 kN moving load. (30) 2

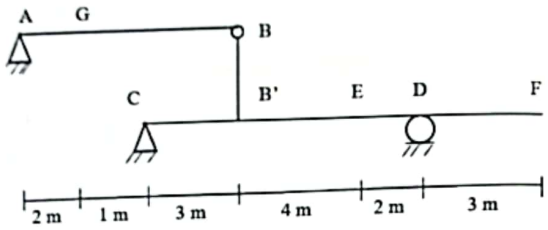

Fig. 8

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Department of Civil Engineering

Final Examination, Summer 2022

Course Code: CE 3131 **Level-3 Term-I**

Time: 03 (Three) hours **Full Marks: 180**

Course Title: Geotechnical Engineering I

N.B.
- The questions are of equal value.
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course learning outcomes (CLOs) are given in the right most column.

PART- A (Marks: 90)

(Answer any three questions including Q. No. 1)

			Marks	CLOs
1.	a)	Explain the rock cycle with necessary illustrations.	(8)	1
	b)	Classify soils based on their mode of transportation.	(7)	1
	c)	Calculate the shear strength of soil of Fig. 1 at a depth of 14 ft. below ground level.	(15)	2

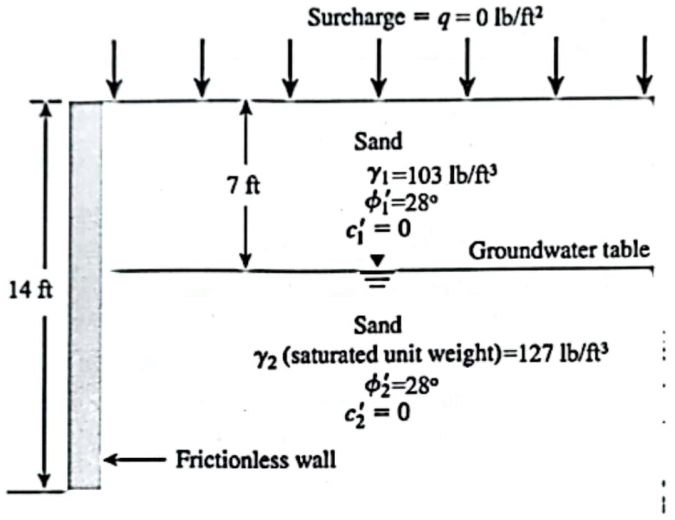


Fig. 1

2.	a)	Explain briefly soil structures with necessary illustrations.	(15)	1
	b)	The moist weight of 0.2 ft³ of a soil is 23 lb. The moisture content and the specific gravity of soil solids are determined in the laboratory to be 11% and 2.7 respectively. Calculate -	(15)	1

i) Moist unit weight (lb/ft³)
ii) Dry unit weight (lb/ft³)
iii) Void ratio
iv) Porosity
v) Degree of saturation (%).

3.	a)	Explain (any four) with necessary illustrations -	(10)	1

i) Liquid limit
ii) Plasticity index
iii) Porosity
iv) Void ratio
v) Flow curve.

	b)	Explain Unified Soil Classification System (USCS). Also explain the meaning of G, S, C, M, O, Pt, W, P, L, H in this classification system.	(10)	1

Classify the soil using Unified Soil Classification System (USCS) and find the group symbol for this soil. Following parameters are determined for this soil - (10) 1

Percentage passing through No. 4 sieve = 70
Percentage passing through No. 200 sieve = 30
Liquid limit = 33
Plastic limit = 12

4. a) Explain (any two) with necessary illustrations - (10) 2

i) Direct shear test
ii) Unconfined compression test
iii) Thixotropy of clay
iv) Active earth pressure.

b) For the retaining wall shown in Fig. 2, determine the force per unit length of the wall for Rankine's active state. Also find the location of the resultant. (20) 2

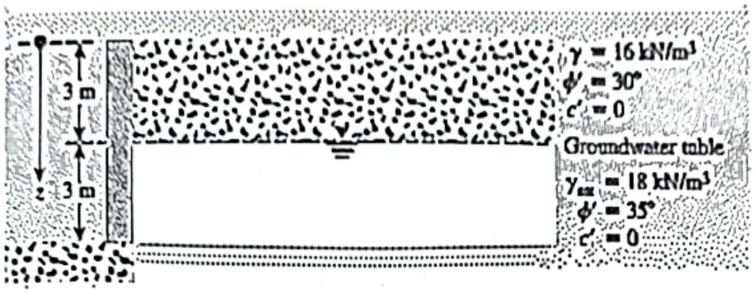


Fig. 2

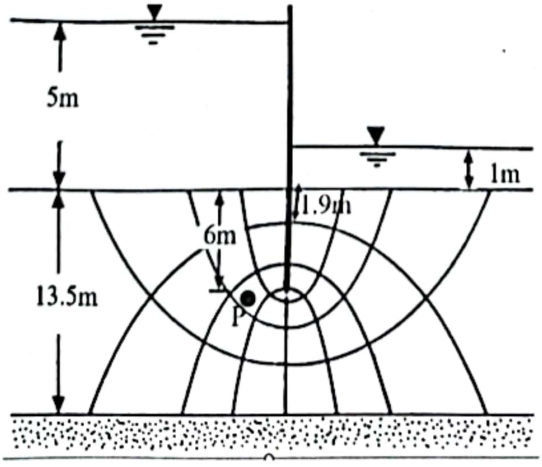
PART- B (Marks: 90)

(Answer any three questions including Q. No. 5)

			Marks	CLOs
5.	a)	Briefly describe soil compaction and factors affecting compaction.	(10)	4
	b)	A sheet pile penetrates 6 m into a permeable soil stratum with coefficient of permeability of 1 x 10^{-8} m/s. The permeable stratum extends up to 13.5 m from the ground level and is underlain by an impermeable stratum as shown in Fig. 3.	(20)	3

Find -

i. The quantity of seepage
ii. The seepage pressure at point P located 6 m below the surface of the soil stratum and 3 m away from the sheet pile wall on its upstream side
iii. The hydrostatic pressure at P
iv. The maximum exit gradient.



5.

Fig. 3

		Derive formula for calculating coefficient of permeability using falling head method.	(20)	3
	b)	If during a permeability test on a soil sample with a falling head permeameter, equal time intervals are noted for drops of head from h_1 to h_2 and again h_2 to h_3, find the relationship between h_1, h_2 and h_3.	(10)	3
7.	a)	Explain –	(10)	3
		i. Critical hydraulic gradient ii. Flow net		
	b)	The in situ moisture content of a soil is 18% and the moist unit weight is 105 lb/ft^3. The specific gravity of soil solids is 2.75. This soil is to be excavated and transported to a construction site for use in a compacted fill. If the specification calls for the soil to be compacted to minimum of dry unit weight of 103.5 lb/ft^3 at the same moisture content of 18%, then determine the cubic yards of soil from the excavation site are needed to produce 10,000 yd^3 of compacted fill. Also determine the number of 20-ton truckloads needed to transport the excavated soil.	(20)	4
8.	a)	Differentiate between normally consolidated clay and over-consolidated clay.	(10)	4
	b)	From Fig. 4, determine the primary consolidation settlement in the clay layer when (i) the soil is normally consolidated, (ii) the pre-consolidation pressure σ'_c = 2200 lb/ft^2. Given: $\Delta\sigma$ = 550 lb/ft^2, H_1 = 6 ft, H_2 = 12 ft, and H_3 = 18 ft. Soil characteristics are as follows Sand: γ_d = 114 lb/ft^3, γ_{sat} = 118 lb/ft^3 Clay: γ_{sat} = 117 lb/ft^3, LL = 38, e = 0.73, $C_s = \frac{1}{5} C_c$	(20)	4

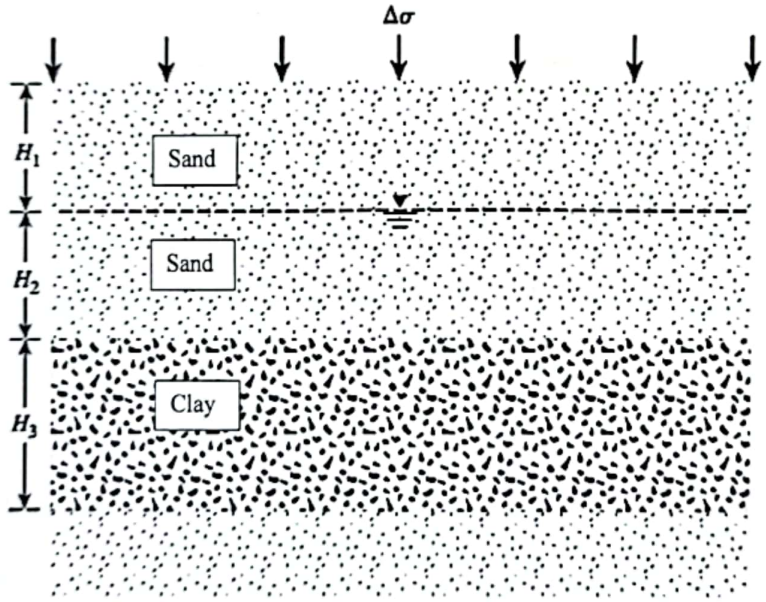


Fig. 4

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Bangladesh Army University of Science and Technology

Department of Civil Engineering

Final Examination, Summer 2022

Course Code: CE 3107 **Level-3 Term-I**

Time: 03 (Three) hours **Full Marks: 120**

Course Title: Numerical Methods for Engineers

N.B.
- The questions are of equal value.
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use a separate answer script for each PART.
- The corresponding course learning outcomes (CLOs) are given in the right most column.
- Assume any reasonable value for missing data.

PART- A (Marks: 60)

(Answer any three questions including Q. No. 1)

			Marks	CLOs
1.	a)	Explain the necessity of numerical methods in civil engineering.	(5)	1
	b)	A team of civil engineers comes to visit a damaged building. They conduct a test on a beam to find its deflection f(x) under different loads. $$f(x)=e^{x}-4x$$ Find out the load, x corresponding to zero deflection using method of false position/ Regula Falsi. Correct to three decimal places. Take initial values $x_0 = 0$ and $x_1 = 1$.	(15)	2
2.	a)	Explain Round off Error, Truncation Error and Total Error graphically with example.	(5)	1
	b)	Use the Bisection method to find a root of the following equation - $$f(x)=x^4+2x^3-x-1$$ Given that a root lies between 0 and 1. Perform 3 (three) iterations.	(15)	2
3.	a)	Briefly discuss 'Direct' and 'Indirect' methods of Numerical Analysis.	(5)	1
	b)	Three students from BAUST Civil Engineering Department compared their marks (x, y, z) in the mid quiz exam of a course. The combinations of their marks is given below. $$\begin{bmatrix} 2 & 3 & -1 \\ 4 & 4 & -3 \\ 3 & -4.5 & 1.5 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \\ -1.5 \end{bmatrix}$$ Determine marks of the three students using Gauss Elimination method.	(15)	2
4.	a)	Compare graphically the difference between Regula Falsi and Bisection methods.	(5)	1
	b)	In a strain test the load is being applied to a steel member. The strain (x) of the member follows the equation. $$f(x)=e^{-x}-x$$ Find out the strain corresponding to zero stress using Secant Method with initial estimates of $x_{-1}=0$ and $x_0=1$.	(15)	2

PART- B (Marks: 60)

(Answer any three questions including Q. No. 5)

		Marks	CLOs
5.	Determine the value of y using Heun's and midpoint method when $x = 0.1$ given that $y(0)=1$ and $y'=x^2+y$. Here step size is $h=0.05$.	(20)	3

Evaluate $= \int_0^1 \int_0^1 e^{x+y}\, dx\, dy$. Use (20) 2

i. Trapezoidal rule
ii. Simpson's rule

Assume $h = k = 0.5$.

7. a) Derive Simpson's rule for numerical integration with necessary diagrams. (10) 1

b) Calculate $I = \int_0^1 \sqrt{1-x^2}\, dx$, using the trapezoidal rule taking $h=0.1$ and compare it with the exact solution. (10) 2

8. a) Evaluate $I = \int_0^1 \frac{1}{1+x} dx$, use Simpson's rule take $h = 0.125$. (10) 2

b) Differentiate $f(x) = 1.2 - 0.25x - 0.5x^2 - 0.15x^3 + 0.1x^4$, using centered, forward differentiation method from $x=0$ to 0.5. Assume $h=0.5$. (10) 2

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Department of Civil Engineering

Final Examination, Summer 2022

Course Code: CE 3141 **Level-3 Term-I**

Time: 03 (Three) hours **Full Marks: 180**

Course Title: Environmental Engineering I

N.B.
- The questions are of equal value.
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course learning outcomes (CLOs) are given in the right most column.

PART- A (Marks: 90)

(Answer any three questions including Q. No. 1)

			Marks	CLOs
1.	a)	As a water supply engineer of Saidpur Pourashava, explain to an electronic media person about the influence of local factors (seasonal change, industrial development, metering of water, bill of water) on national water demand estimation.	(15)	1
	b)	Distinguish between i) Temporary hardness and permanent hardness ii) Plain sedimentation and chemical sedimentation iii) Adsorption and absorption.	(15)	2
2.	a)	Explain different pump heads with figure(s).	(15)	3
	b)	Design a suitable set of pumping unit to deliver 4,50,000 gph from an intake well of a river bank to the treatment plant. Total length of rising main from the intake well to the treatment plant is 800 ft and the static head is 60 ft. Design also the cast iron main. Assume: Velocity of water = 12 fps; Friction factor = 0.0075; Efficiency = 70%	(15)	3
3.	a)	Draw a sedimentation tank and explain its different zones. OR Draw a Slow Sand Filter (SSF) and explain its different elements.	(20)	2
	b)	"Chlorination is the most common and widely adopted method of disinfection for public water supply in Bangladesh" --Explain	(10)	2
4.	a)	Explain water demand management for a water supply system. Using a flow diagram, show the locations of water losses in a piped water supply system.	(7.5+7.5)	3
	b)	Describe shortly water safety plan (WSP). Develop a WSP for tubewell technology as a water supply option.	(7.5+7.5)	3

PART- B (Marks: 90)

(Answer any three questions including Q. No. 5)

			Marks	CLOs
5.	a)	Draw a neat sketch of Pond Sand Filter (PSF). "Ponds should be selected carefully for efficient operation of PSF"—justify the statement.	(7.5+7.5)	3
	b)	Briefly explain the challenges of Rain Water Harvesting System (RWHS) as an alternative water supply option. A family of 8 persons in an arsenic and saline affected area of Bangladesh have planned to install rain water harvesting system (RWHS) as an alternative water supply option. Calculate the minimum capacity of storage tank required for the purpose with the following data: water demand = 10 lpcd of rainwater; yearly rainfall intensity = 2.5 m and the rainfall distribution is such that at least 35% of	(7.5+7.5)	3

the rainwater must be stored for uninterrupted water supply throughout the year.

6. a) Explain the objectives of a water supply system (WSS). Draw the figure showing all the elements of a WSS. (5+10) 1

   b) Differentiate between confined and unconfined aquifer (Figure required). A tubewell is 450 mm in diameter. The unconfined aquifer is of 20 m depth. After drawdown, depth of water is 12 m in the well. Calculate the discharge of the tubewell if permeability of soil is 24.5 m/d and radius of circle of influence is 275 m. (5+10) 1

7. Explain with neat sketches the different methods of water transmission and distribution. Explain which one of these methods is suitable for a city corporation area. (20+10) 3

8. a) Explain the mechanism of filtration process. (15) 2

   b) State the methods of population prediction. Predict the population of Saidpur Pourashava for the year 2041 from the following population data: (5+10) 1

Year	1971	1981	1991	2001	2011	2021
Population (million)	7	10	12	13	16	18

Marks (9)

Bangladesh Army University of Science and Technology

Department of Civil Engineering

Final Examination, Summer 2022

Course Code: CE 3113 **Level-3 Term-I**

Time: 03 (Three) hours **Full Marks: 180**

Course Title: Reinforced Concrete Structures I

N.B.
- The questions are of equal value.
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- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course learning outcomes (CLOs) are given in the right most column.

PART - A (Marks: 90)

(Answer any three questions including Q. No. 1)

			Marks	CLOs
1.	a)	State the fundamental assumptions for the design of reinforced concrete structures.	(10)	1
	b)	The cross-sectional area of a cantilever beam is given in Fig. 1. Calculate its ultimate moment carrying capacity and convert it into a UDL on the beam. Clear cover =1.5" Given: f_y = 60,000 psi f_c' = 4,000 psi	(20)	2

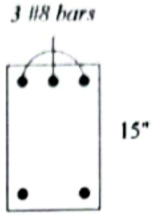

Fig. 1

2.		A floor system as shown in Fig. 2 below consists of a 4" slab supported by a continuous T beam with a 25 ft span, 48" on centers. Web dimensions are- b_w = 10" and d = 20". Design the tensile steel reinforcement required to resist a factored moment of 6400 kip-in. Given: f_y = 60,000 psi and f_c' = 4,000 psi.	(30)	2

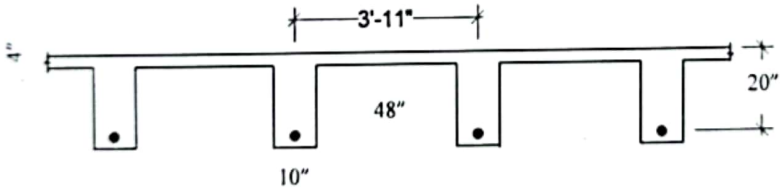

Fig. 2

3.		A simply supported beam of span length 20' is subjected to an unfactored dead load of 1.50 kip/ft (including self-weight) and an unfactored live load of 2.50 kip/ft. Calculate the factored moment and check whether it is a singly reinforced or doubly reinforced beam. Finally, calculate the amount of steel area required. Assume cross sectional dimension of beam = 10"x 12" Material properties are: f_y = 60,000 psi and f_c' = 4,000 psi.	(30)	2
4.	a)	Describe briefly the reason of providing steel reinforcement in concrete.	(10)	1
	b)	Explain the design criteria of a T-beam.	(10)	1
	c)	Illustrate the flexural behavior of RCC beam using figures for the state "Stress elastic and section cracked".	(10)	1

PART- B (Marks: 90)

(Answer any three questions including Q. No. 5)

			Marks	CLOs
5.	a)	Explain the necessities of lapping in reinforcement. Mention the ACI Code provisions for lapping lengths in tension and compression bars.	(8)	3
	b)	Design a 12 ft simply supported one way slab to carry a uniformly distributed dead load (excluding self weight) of 120 psf and uniformly distributed live load of 100 psf. Use f_c'=4 ksi, f_y=60 ksi, λ=1.0 and the ACI Code limitations.	(14)	4
	c)	Sketch the bar details /drawing with all dimensions in terms of span length L for both straight bar and bent bar) for above one-way slab (show only main rebars).	(8)	3
6.	a)	Mention ACI Code special provision for anchorage of web reinforcement	(4)	3
	b)	A simply supported beam has a rectangular section with b = 12 in, d = 21.5 in and h = 24 in is reinforced with four No. 8 bars. Check if the section is adequate for each of the following factored shear forces. If it is not adequate, design the required shear reinforcement in the form of U stirrups. Consider normal weight concrete with λ=1.0 and f_c'=4 ksi. Use f_y=60 ksi. (a) V_u= 12 K, (b) V_u= 24 K, (c) V_u= 54 K, (d) V_u= 77 K	(26)	2
7.	a)	Explain the importance and layout of corner reinforcement in two-way slab.	(5)	4
	b)	A monolithic reinforced concrete floor is to be composed of rectangular bays measuring 21′ × 26′, as shown in Fig. 3 Beams of width 12 in and depth 24 in are provided on all column lines. The floor is to be designed to carry a service LL of 137 psf uniformly distributed over its surface, in addition to its own weight. Use, f_c' = 3 ksi, f_y = 60 ksi. Find required slab thickness and reinforcement for the corner panel shown in Fig. 3.	(25)	4

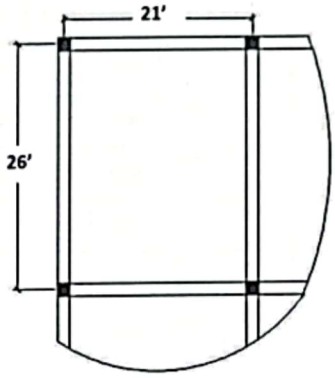

Fig. 3

8.	a)	Explain the term - development length. Mention the factors which influences the development length.	(10)	3
	b)	A beam-column joint in a continuous building frame is shown in Fig. 4. The negative steel required at the end of the beam is 2.90 in^2, two No. 11 bars are used, providing A_s = 3.12 in^2. The beam design include No. 3 stirrups spaced four at 3 in., followed by a constant 5 in. spacing in the region of the support with 1.5 in. clear cover. Given, f_c'=4 ksi and f_y=60 ksi. Find the minimum distance l_d at which negative bars can be cut off, based on development of required steel area at the face of the column using both simplified equation and basic equation.	(20)	3

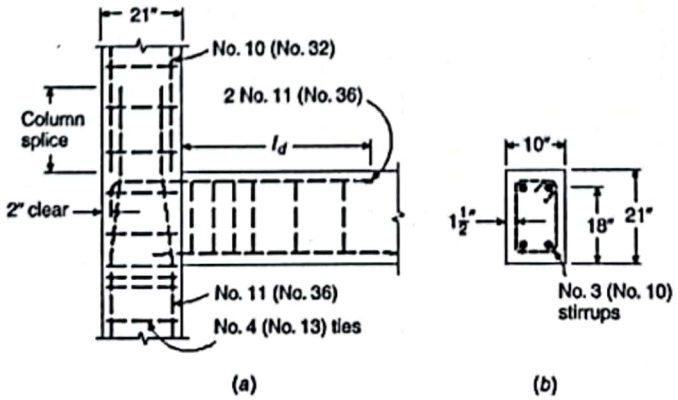

Fig. 4

	No. 6 (No. 19) and Smaller Bars and Deformed Wires†	No. 7 (No. 22) and Larger Bars
Clear spacing of bars being developed or spliced $\geq d_b$, clear cover $\geq d_b$, and stirrups or ties throughout l_d not less than the Code minimum	$l_d = \left(\frac{f_y \psi_t \psi_e}{25\lambda\sqrt{f'_c}}\right) d_b$	$l_d = \left(\frac{f_y \psi_t \psi_e}{20\lambda\sqrt{f'_c}}\right) d_b$

$$l_d = \left(\frac{3}{40}\frac{f_y}{\sqrt{f'_c}\left[\frac{(c + K_{tr})}{d_b}\right]}\right) d_b$$

Table 1 - Coefficients for Negative Moments in Slabs

$M_a^- = C_{a,neg} w_u l_a^2$
$M_b^- = C_{b,neg} w_u l_b^2$
where w_u = total factored uniform load (DL + LL)

Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,neg}$	-	0.045	0.076	0.050	0.075	0.071	0.071	0.033	0.061
	$C_{b,neg}$		0.045		0.050				0.061	0.033
0.95	$C_{a,neg}$	-	0.050	0.072	0.055	0.079	0.075	0.067	0.038	0.065
	$C_{b,neg}$		0.041		0.045				0.056	0.029
0.90	$C_{a,neg}$	-	0.055	0.070	0.060	0.080	0.079	0.062	0.043	0.068
	$C_{b,neg}$		0.037		0.040				0.052	0.025
0.85	$C_{a,neg}$	-	0.060	0.065	0.066	0.082	0.083	0.057	0.049	0.072
	$C_{b,neg}$		0.031		0.034				0.046	0.021
0.80	$C_{a,neg}$	-	0.065	0.061	0.071	0.083	0.086	0.051	0.055	0.075
	$C_{b,neg}$		0.027		0.029				0.041	0.017
0.75	$C_{a,neg}$	-	0.069	0.056	0.076	0.085	0.088	0.044	0.061	0.078
	$C_{b,neg}$		0.022		0.024				0.036	0.014
0.70	$C_{a,neg}$	-	0.074	0.050	0.081	0.086	0.091	0.038	0.068	0.081
	$C_{b,neg}$		0.017		0.019				0.029	0.011
0.65	$C_{a,neg}$	-	0.077	0.043	0.085	0.087	0.093	0.031	0.074	0.083
	$C_{b,neg}$		0.014		0.015				0.024	0.008
0.60	$C_{a,neg}$	-	0.081	0.035	0.089	0.088	0.095	0.024	0.080	0.085
	$C_{b,neg}$		0.010		0.011				0.018	0.006
0.55	$C_{a,neg}$	-	0.084	0.028	0.092	0.089	0.096	0.019	0.085	0.086
	$C_{b,neg}$		0.007		0.008				0.014	0.005
0.50	$C_{a,neg}$	-	0.086	0.022	0.094	0.090	0.097	0.014	0.089	0.088
	$C_{b,neg}$		0.006		0.006				0.010	0.003

Table 3 - Coefficients for Live Load Positive Moments in Slabs

$M_{a,LL}^+ = C_{a,LL} w_{LL} l_a^2$
$M_{b,LL}^+ = C_{b,LL} w_{LL} l_b^2$
where w_{LL} = uniform factored Live Load (LL)

Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,LL}$	0.036	0.027	0.027	0.032	0.032	0.035	0.032	0.028	0.030
	$C_{b,LL}$	0.036	0.027	0.032	0.032	0.027	0.032	0.035	0.030	0.028
0.95	$C_{a,LL}$	0.040	0.030	0.031	0.035	0.034	0.038	0.036	0.031	0.032
	$C_{b,LL}$	0.033	0.025	0.029	0.029	0.024	0.029	0.032	0.027	0.025
0.90	$C_{a,LL}$	0.045	0.034	0.035	0.039	0.037	0.042	0.040	0.035	0.036
	$C_{b,LL}$	0.029	0.022	0.027	0.026	0.021	0.025	0.029	0.024	0.022
0.85	$C_{a,LL}$	0.050	0.037	0.040	0.043	0.041	0.046	0.045	0.040	0.039
	$C_{b,LL}$	0.026	0.019	0.024	0.023	0.019	0.022	0.026	0.022	0.020
0.80	$C_{a,LL}$	0.056	0.041	0.045	0.048	0.044	0.051	0.051	0.044	0.042
	$C_{b,LL}$	0.023	0.017	0.022	0.020	0.016	0.019	0.023	0.019	0.017
0.75	$C_{a,LL}$	0.061	0.045	0.051	0.052	0.047	0.055	0.056	0.049	0.046
	$C_{b,LL}$	0.019	0.014	0.019	0.016	0.013	0.016	0.020	0.016	0.013
0.70	$C_{a,LL}$	0.068	0.049	0.057	0.057	0.051	0.060	0.063	0.054	0.050
	$C_{b,LL}$	0.016	0.012	0.016	0.014	0.011	0.013	0.017	0.014	0.011
0.65	$C_{a,LL}$	0.074	0.053	0.064	0.062	0.055	0.064	0.070	0.059	0.054
	$C_{b,LL}$	0.013	0.010	0.014	0.011	0.009	0.010	0.014	0.011	0.009
0.60	$C_{a,LL}$	0.081	0.058	0.071	0.067	0.059	0.068	0.077	0.065	0.059
	$C_{b,LL}$	0.010	0.007	0.011	0.009	0.007	0.008	0.011	0.009	0.007
0.55	$C_{a,LL}$	0.088	0.062	0.080	0.072	0.063	0.073	0.085	0.070	0.063
	$C_{b,LL}$	0.008	0.006	0.009	0.007	0.005	0.006	0.009	0.007	0.006
0.50	$C_{a,LL}$	0.095	0.066	0.088	0.077	0.067	0.078	0.092	0.076	0.067
	$C_{b,LL}$	0.006	0.004	0.007	0.005	0.004	0.005	0.007	0.005	0.004

Table 2 - Coefficients for Dead Load Positive Moments in Slabs

$M_{a,DL}^{+} = C_{a,DL} w_{DL} l_a^2$

$M_{b,DL}^{+} = C_{b,DL} w_{DL} l_b^2$

where w_{DL} = uniform factored Dead Load (DL)

Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
										
1.00	$C_{a,DL}$	0.036	0.018	0.018	0.027	0.027	0.033	0.027	0.020	0.023
	$C_{b,DL}$	0.036	0.018	0.027	0.027	0.018	0.027	0.033	0.023	0.020
0.95	$C_{a,DL}$	0.040	0.020	0.021	0.030	0.028	0.036	0.031	0.022	0.024
	$C_{b,DL}$	0.033	0.016	0.025	0.024	0.015	0.024	0.031	0.021	0.017
0.90	$C_{a,DL}$	0.045	0.022	0.025	0.033	0.029	0.039	0.035	0.025	0.026
	$C_{b,DL}$	0.029	0.014	0.024	0.022	0.013	0.021	0.028	0.019	0.015
0.85	$C_{a,DL}$	0.050	0.024	0.029	0.036	0.031	0.042	0.040	0.029	0.028
	$C_{b,DL}$	0.026	0.012	0.022	0.019	0.011	0.017	0.025	0.017	0.013
0.80	$C_{a,DL}$	0.056	0.026	0.034	0.039	0.032	0.045	0.045	0.032	0.029
	$C_{b,DL}$	0.023	0.011	0.020	0.016	0.009	0.015	0.022	0.015	0.010
0.75	$C_{a,DL}$	0.061	0.028	0.040	0.043	0.033	0.048	0.051	0.036	0.031
	$C_{b,DL}$	0.019	0.009	0.018	0.013	0.007	0.012	0.020	0.013	0.007
0.70	$C_{a,DL}$	0.068	0.030	0.046	0.046	0.035	0.051	0.058	0.040	0.033
	$C_{b,DL}$	0.016	0.007	0.016	0.011	0.005	0.009	0.017	0.011	0.006
0.65	$C_{a,DL}$	0.074	0.032	0.054	0.050	0.036	0.054	0.065	0.044	0.034
	$C_{b,DL}$	0.013	0.006	0.014	0.009	0.004	0.007	0.014	0.009	0.005
0.60	$C_{a,DL}$	0.081	0.034	0.062	0.053	0.037	0.056	0.073	0.048	0.036
	$C_{b,DL}$	0.010	0.004	0.011	0.007	0.003	0.006	0.012	0.007	0.004
0.55	$C_{a,DL}$	0.088	0.035	0.071	0.056	0.038	0.058	0.081	0.052	0.037
	$C_{b,DL}$	0.008	0.003	0.009	0.005	0.002	0.004	0.009	0.005	0.003
0.50	$C_{a,DL}$	0.095	0.037	0.080	0.059	0.039	0.061	0.089	0.056	0.038
	$C_{b,DL}$	0.006	0.002	0.007	0.004	0.001	0.003	0.007	0.004	0.002

TABLE A.5a

Flexural resistance factor: $R = \rho f_y \left(1 - 0.588 \frac{\rho f_y}{f'_c}\right)$ psi

	f_y = 40,000 psi				f_y = 60,000 psi			
	f'_c, psi				f'_c, psi			
ρ	3000	4000	5000	6000	3000	4000	5000	6000
0.0005	20	20	20	20	30	30	30	30
0.0010	40	40	40	40	59	59	60	60
0.0015	59	59	60	60	88	89	89	89
0.0020	79	79	79	79	117	118	118	119
0.0025	98	99	99	99	146	147	147	148
0.0030	117	118	118	119	174	175	176	177
0.0035	136	137	138	138	201	204	205	206
0.0040	155	156	157	157	229	232	233	234
0.0045	174	175	176	177	256	259	261	263
0.0050	192	194	195	196	282	287	289	291
0.0055	211	213	214	215	309	314	317	319
0.0060	229	232	233	234	335	341	345	347
0.0065	247	250	252	253	360	368	372	375
0.0070	265	268	271	272	385	394	399	403
0.0075	282	287	289	291	410	420	426	430
0.0080	300	305	308	310	435	446	453	457
0.0085	317	323	326	329	459	472	479	485
0.0090	335	341	345	347	483	497	506	511
0.0095	352	359	363	366	506	522	532	538
0.0100	369	376	381	384	529	547	558	565
0.0105	385	394	399	403	552	572	583	591
0.0110	402	412	417	421	575	596	609	617
0.0115	419	429	435	439	597	620	634	643
0.0120	435	446	453	457	618	644	659	669
0.0125	451	463	471	476	640	667	684	695
0.0130	467	480	488	494	661	691	708	720
0.0135	483	497	506	511	681	714	733	746
0.0140	499	514	523	529	702	736	757	771
0.0145	514	531	540	547	722	759	781	796
0.0150	529	547	558	565	741	781	805	821
0.0155	545	563	575	582	760	803	828	845
0.0160	560	580	592	600		825	852	870
0.0165	575	596	609	617		846	875	894
0.0170	589	612	626	635		867	898	918
0.0175	604	628	642	652		888	920	942
0.0180	618	644	659	669		909	943	966
0.0185	633	660	676	686		929	965	989
0.0190	647	675	692	703		949	987	1013
0.0195	661	691	708	720		969	1009	1036
0.0200	675	706	725	737		988	1031	1059