Sylhet Engineering College, Sylhet
(Shahjalal University of Science & Technology)
Department of Civil Engineering

Final Examination, 2024 — **3rd Year 1st Semester**
Course No.: CE 565 — **Course Title: Open Channel Flow**
Time: 03 (Three) hours — **Full Marks: 60**

N.B. : (i) Answer any three questions from each PART (ii) Use separate answer scripts for each PART
(iii) Marks allotted are indicated in the margin (iv) Special Instruction (if any)----------N/A----------

PART- A

(Answer any three questions)

1. **(a)** A trapezoidal channel has a bottom width of 6 m and side slopes of 2:1. Compute the discharge and determine the state of flow in this channel if the depth of flow is 1.5 m and the mean velocity of flow is 2.30 m/s. If elementary waves are created in this channel, determine the speed of the wave fronts upstream and downstream. **05**

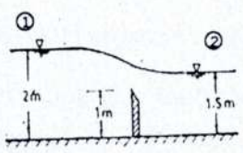
   (b) Classify flow according to combined Effect of Viscosity and Gravity. . **03**

   (c) Define: Steady flow, unsteady flow, uniform flow, varied flow **02**

2. **(a)** Write down the momentum equation with proper notations. **02**

   (b) Explain specific energy curve with appropriate figure. **03**

   (c) Figure given below shows a sharp-crested weir in a rectangular channel. If the discharge per unit width of the weir is 4 m^2/s, estimate the energy loss due to the weir and force on the weir plate for the submerged flow condition as shown. **05**



3. **(a)** What are the factors that affecting Manning's n? Define conveyance and section fector. **04**

   (b) An open channel lined with concrete (d_{50} = 1.5 mm) is laid on a slope of 0.1%. The channel is trapezoidal with b = 6 m and s = 2. Compute the uniform flow discharge in the channel if the depth of flow is 2 m. Also compute the numerical values of Chezy's C and friction factor f. **04**

   (c) What is best hydraulic section? Mention channel parameters such as A,B,D,R,P for rectangular and trapezoidal channels. **02**

4. **(a)** Write down the procedure for designing a trapezoidal channel (erodible channels which scour but do not silt). **03**

   (b) What are the types of bottom slope & what are the types of flow profiles? **03**

   (c) A trapezoidal channel is to be laid on a slope of 1 in 1000 and carry a discharge of 20 m^3/s. It is to be excavated in earth containing moderately rounded coarse non-cohesive particles with d_{50} = 2 cm, d_{75} = 2.5 cm and n = 0.025. Determine the section dimensions of the channel. (take ψ = 33° Assume s = 2 and b/h_n = 4, maximum shear stress on sides is $0.75\gamma h_n S_0$) **04**

PART- B

(Answer any three questions)

5. **(a)** Define hydrulic jump. What are its practical applications? Classify jumps in horizontal rectangular channels. **02**

   (b) Show that the best hydraulic rectangular section is one-half of a square. **03**

   (c) Water flows in a horizontal rectangular channel 6 m wide at a depth of 0.52 m and a velocity of 15.2 m/s. If a hydraulic jump forms in this channel, determine (i) the type of jump, (ii) the downstream depth needed to form the jump, (iii) the horse-power dissipation in the jump, (iv) the efficiency of the jump, (v) the relative height of the jump, and (vi) the length of the jump. **05**

6. **(a)** What is stilling basin. What are typical designs considered in design of stilling basin? **03**

(b) A trapezoidal channel lined with concrete (n = 0.013) and laid on a slope of 1 in 3600 carries a discharge of 100 m^3/s. Determine the section dimensions of the channel (a) taking b = 6m and side slopes of 1:1, (b) for the best hydraulic section when the side slope is 1:1, and (c) when the side slope is 1:1 and the bottom width 8.23m, take $A = \left(2\sqrt{1+s^2} - s\right)h^2$, **05**

$b = 2h\left(\sqrt{(1+\ s^2} - s\right)$,

$$AR^{\frac{2}{3}} = \frac{[(b + sh)h]^{\frac{5}{3}}}{\left(b + 2\sqrt{1 + s^2 h}\right)^{\frac{2}{3}}}$$

(c) Describe practical rigid boundary channel section. **02**

7. **(a)** Prove that shear stress ratio $= \sqrt{1 - \frac{\sin^2\phi}{\sin^2\psi}}$. **03**

(b) Draw flow profile of following slopes: (1) steep-horizontal (2) mild-milder-steep (3) mild-steep (4) mild-horizontal-free overfall **05**

(c) Define sluice gate, broad- crested weir. Mention their functions. **02**

8. **(a)** What is the process of Alluvial channel design? **02**

(b) Describe velocity distribution in a Channel Section. Draw necessary sketches. **04**

(c) A parabolic channel with a discharge of 20 m^3 /s and n = 0.025; is laid on a bottom slope of 0.0025. The profile of the channel is given by l = 4z. Compute the normal depth and velocity by applying trial-and-error method. **04**

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Final Examination, 2024 — **3rd Year 1st Semester**
Course No.: CE 541 — **Course Title: Geotechnical Engineering I**
Time: 03 (Three) hours — **Full Marks: 60**

N.B. : (i) Answer any two questions from each PART (ii) Use separate answer scripts for each PART
(iii) Marks allotted are indicated in the margin (iv) Special Instruction (if any)----------N/A----------

PART- A
(Answer any three questions)

1. (a) What do you mean by soil mechanics? Describe the application of soil mechanics in Civil Engineering. **2**

(b) Prove that (i) $Se = wG_s$ and (ii) $\Upsilon_d = \frac{G_s \gamma_w}{1+e}$ **3**

(c) If n=0.5 for a soil and another soil has a void ratio value (e) =0.5, what percentage of the volume of void is contained in each soil? Answer your own judgment. **2**

(d) The moist unit weight & degree of saturation of soil is given in the following table- **3**

Unit weight (kN/m^3)	Degree of saturation (s)
25	45
22	60

Determine (i) void ratio, (ii) specific gravity of soil and (iii) porosity

2. (a) What is flow index? How do you can calculate the flow index value? **1**

(b) The in-situ porosity of a sand deposit is 0.5. If the maximum and minimum dry densities of sand as determined from the laboratory test are 19.61 kN/m^3 and 11.77 kN/m^3 respectively, determine the relative density value. Assume $G_s = 2.74$. Indicate the state of compaction of sand deposit. **2**

(c) A clean sand (fines = 0%) sample having mean diameter of particle (D_{50}) is 0.40 mm. Determine maximum and minimum void ratio value of this sand. **2**

(d) The following results on consistency tests are available for two fine grained soils A and B.

Test	Soil sample A	Soil sample B
Liquid limit	52	30
Plastic limit	19	32
Flow index	11	6
Natural water content (%)	32	40

5

Which soil is- (i) more plasticity and plastic state; (b) better shear strength and shear strength value and (iii) shrinkage limit value.

3. (a) Write the factors that affect field compaction and show the relationship between dry unit weight and number of roller passes. **2**

(b) What is zero air void line? How to develop a 90% degree of saturated line?Expaline mathematically. **2**

(c) A sand sample shows a coefficient of uniformity value (C_u) of 4.5. Estimate the optimum moisture content and maximum dry density value of the sand using the standard proctor test. **3**

(d) For constructing an embankment, the soil is transported from a borrow area using a truck which can carry 6 m^3 of soil at a time with the following details. Determine the number of truck loads of soil required to obtained 100 m^3 of compacted earth fill and the volume of the borrow pit. **3**

Property	Borrow area (in-situ)	Field (compacted)
Unit weight (kN/m^3)	16.6	18.21
Water Content (%)	8	14

4. (a) What do you mean by coarse grained soil and fine grained soil? Expalin it. What is group index ? **2**

(b) Classify the following two inorganic soils according to unified soil classification system (USCS) 6

Soil A	Soil B
Percent finer No. 200 sieve (0.075 mm)= 93 Liquid limit = 58 Plastic limit = 23	Percent finer No. 4 sieve (4.75 mm)= 92 Percent finer No. 10 sieve (2.0 mm)= 60 Percent finer No. 40 sieve (0.425 mm)= 30 Percent finer No. 200 sieve (0.075 mm)= 10 Liquid limit= 37 Plastic limit= 26

(c) What is group index? Explaine the importance of group index value in subgrade quality identification. 2

PART- B

(Answer any three questions)

5. (a) Describe the importance of share strength parameter in soil mechanics and write different factors that affect the value of share stregth of soil. 2

(b) Draw Mohr Coulumb failure envelope for cohessionless soil, cohessive soil and c-φ soil. 2

(c) Triaxial test on a sturarted caly, test result is given below. 3

Specimen	σ'_3 (lb/ft^2)	Deviator stress $(\Delta\sigma d)_f$ (lb/ft^2)
I	60	150
II	120	210

Determine the value of c and φ.

(d) For a normally consolidated clay, φ=24°. In a drained triaxial test, the specimen failed at a deviator stress 175 kN/m^2. What was the chamber confining pressure σ_3? 3

6. (a) Describe Darcy's law with mathematical equation and also draw the relationship nature of variation of velocity and hydraulic gradient. 3

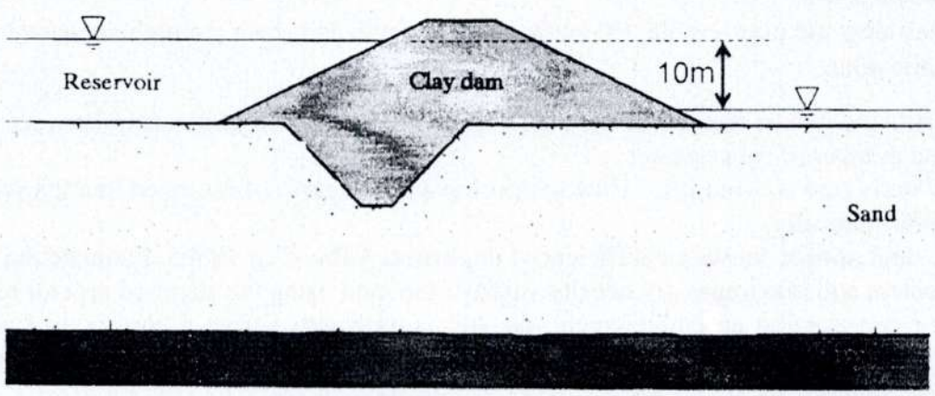
(b) Define the three stages of consolidation. 2

(c) The following data were recorded in a constant head permeability test: 5
Internal diameter of permeameter = 7.5 cm, head loss over a sample length of 18 cm = 24.7 cm, quantity of water collected in 60 s = 626 ml. Calculate the coefficient of permeability of the soil sample.

7. (a) Define the terms: (i) aquifuge and (ii) unconfined aquifer 2

(b) What is flow net? Write the main criteria to construct flow net. 3

(c) Determine the seepage value from the following structure where k=1x10^{-3} cm/s 5



8. (a) Write short notes with appropriate figure on (i) coefficient of volume compressibility, (ii) compression index coefficient of consolidation and (iii) swell index 1.5

(b) Write the Terzaghi's assumption for one dimensional consolidation. 1.5

(c) Show the variation of total stress, pore water pressure, and effective stress in a clay layer drained at top and bottom as the result of an added stress with respect to time with accurate figures and dimension. 3

(d) The time required for 50% consolidation of a 25-mm-thick clay layer (drained at both top and bottom) in the laboratory is 2 min. 20 sec. How long (in days) will it take for a 3-m-thick clay layer of the same clay in the field under the same pressure increment to reach 50% consolidation in the field? There is a rock layer at the bottom of the clay. 4

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Final Examination, 2024 — **3rd Year 1st Semester**
Course No.: CE 531 — **Course Title: Environmental Engineering-I**
Time: 03 (Three) hours — **Full Marks: 60**

N.B. : (i) Answer any three question from each PART (ii) Use separate answer scripts for each PART
(iii) Marks allotted are indicated in the margin (iv) Special Instruction (if any)----------N/A-------

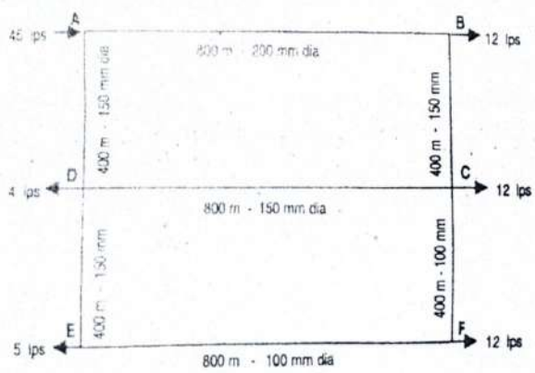
PART- A
(Answer any three questions)

1. **(a)** Define Environmental Engineering. Which elements are essential for water supply & Briefly describe essential elements of water supply system with fig. **04**
   (b) Which variable are dependent for various types of water consumption. **02**
   (c) What factor are affecting per capita water consumption? **02**
   (d) Calculate the peak water demand for a design period of 10 yrs of a rural village having a present population of 75250. The average per capita water consumption is 50 lpcd with peak factor of 3. The population growth rate 2.022%. and the loss and wastage is 30%. **02**

2. **(a)** What are the types of groundwater exploration? Which problem are arises groundwater development? **04**
   (b) Express the confined steady flow discharge equation with fig. **03**
   (c) A 100 mm diameter tubewell is sunk 40m below static groundwater level. The depth of water in the tubewell while pumping is 33 m. The radius of drawdown is 30 m and the coefficient of permeability of the aquifer is 0.5 lps/m^2. Calculate the discharge of the tubewell. **03**

3. **(a)** Explain shallow tubewell technology with working principle **03**
   (b) Define of a well screen & which parameters are used design of well screen? **03**
   (c) Which types of alternative water supply technologies are use in Bangladesh? **02**
   (d) Design a strainer for a 30mm diameter tubewell to be operated by a No. 6 handpump at the rate of 35 lpm slot no.8 strainer having a 30% open area is to be used. The entrance velocity should be around 0.015 m/see. **02**

4. **(a)** What types of service connection are used in distribution to the consumers? **02**
   (b) Calculate the flow in each of the pipes in the following looped pipe network. **08**



PART- B
(Answer any three questions)

5. **(a)** Define Surface water collection Intake. Which points should be considered while selecting the site for intake? **03**
   (b) Briefly describe the classification of transmission and distribution systems. **03**
   (c) What are the advantages & disadvantages of branched and looped distribution network? **02**
   (d) Short Note: Sources and significance of four water quality parameters. (a)Turbidity (b) TDS (c) Chloride (d) Alkalinity **02**

6. **(a)** Which factor are involved for influence disinfection of water? **02**
   (b) Which types of method are applied common water treatment? **02**

(c) A water treatment plant filtration unit produces $3x10^6$ lit/day. How much bleaching powder with 35% available chlorine will be required per year to treat this water with a chlorine dose of 0.6 mg/L? **03**

(d) Write down the basic requirements of drinking water. **03**

7. (a) Why coagulation process are applied for treatment of water? **02**

(b) Which common types of flocculation process are applied for treatment? **02**

(c) Briefly describe the characteristics of slow sand filter & total design procedure of a slow sand filter with fig. **03**

(d) What are the principal of particle of setting in water for plain sedimentation? **03**

8. (a) Define filtration? Write down the characteristics of Slow Sand Filtration (SSF) and Rapid Sand Filtration (RSF)? **03**

(b) Mention the water treatment methods? What is disinfection? Write down the process of Coagulation and chlorination? **04**

(c) Calculate the dimension of a rectangular settling tank to treat 100 m3of raw water per hour when the overflow rate is 0.75 m/hr and the detention time 03 hours. Assume, L/B = 4; Where L = Length of the tank, B = Width of the tank. **03**

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Final Examination, 2024 — **3rd Year 1st Semester for 2021-22**
Course No.: CE 523 — **Course Title: Reinforced Concrete Design- I**
Time: 03 (Three) hours — **Full Marks: 60**

N.B. (i) Answer three questions from each part (ii) Use a separate answer script for each part
(iii) Marks allotted indicated in the margin (iv) Special Instruction (if any).....N/A..

PART A
(Answer any 3 from this part)

1.a) Determine the minimum effective depth required and the corresponding area of tension reinforcement for a rectangular beam having a width of 10 in to resist an ultimate moment of 145 kip-ft, using f_y= 60 ksi and f_c'= 3 ksi. **05**

1.b) A rectangular beam of 3000 psi concrete is 10 in wide and 20 in deep overall. Four #6 steel bars of 60 grade are provided as tension reinforcement at an effective **clear cover** of 2 in. Find the depth of the neutral axis. **03**

1.c) What are the values of α, β, β1, and γ for f_c'= 3000 psi? Why do the values of α and β decrease with the increase of f_c'? **02**

2.a) Compare the cracking moment based on the gross section properties and the transformed section properties with four No. 11 bars as shown in Figure- 01. Concrete tensile capacity is 7.5 $\sqrt{f_c'}$. **05**

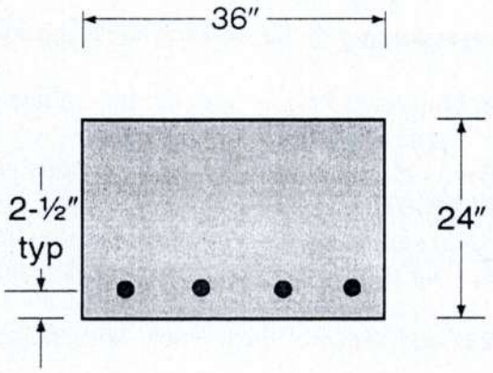

Figure- 01

2.b) How are bar cutoff points determined for monolithic beams? Explain it by drawing typical longitudinal sections of a beam. **03**

2.c) Write about safety considerations in RC design in the USD method. **02**

3.a) A simply supported rectangular beam (10″x24″) with a span of 24 ft supports a uniform dead load of 1.5 kip/ft, including self-weight. It also has to support a live load of 1.25 kip/ft. If f_y= 40 ksi, f_c'= 3 ksi, determine whether the beam is singly or doubly. Design the beam **using USD.** **05**

3.b) Briefly discuss the factors influencing the development length of tension bars. **03**

3.c) What is the balanced steel ratio for a beam? How is this concept applied to beam design? **02**

4.a) An isolated T beam is composed of a flange 28 in wide and 6 in. deep cast monolithically with a web of 10 in width that extends 24 in below the bottom surface of the flange to produce a beam of 30 in total depth. The concrete has a strength of 3,000 psi, and the yield strength of the steel is 60,000 psi. What tensile steel area is required at midspan to resist a factored moment of 9370 in-kips? Use the **USD method**. **05**

4.b) Calculate the nominal moment of resistance of a singly reinforced concrete beam having 12 in width and 16 in effective depth. It is reinforced with 3 bars of ½ in diameter. f_y= 60 ksi and f_c'= 3 ksi are used. Use the **USD method**. **03**

4.c) Draw different types of standard bar hooks for main reinforcement and stirrups of beams according to the ACI Code. **02**

PART B

(Answer any 3 from this part)

5.a) A rectangular beam 12 in x 24 in is reinforced with 3 nos. of #6 bars on the tension side. Estimate the moment of resistance of the section by the **working stress method**. Use f_y= 60 ksi and f_c' = 3 ksi, n= 8. **05**

5.b) Write about safety factors in RC design. **03**

5.c) Differentiate between one-way and two-way slabs with necessary sketches. **02**

6.a) A simply supported rectangular beam with a span of 18 ft supports a uniform dead load of 1 kip/ft, including self-weight. It also must support a live load of 1 kip/ft. If f_s= 20 ksi, f_c'= 3 ksi, n= 8, design the beam as a singly reinforced beam **using WSD**. **05**

6.b) A column, 12"X12", reinforced with 6,#8 bars. If f_y= 60 ksi and f_c' = 3 ksi, what is its ultimate axial load capacity? **03**

6.c) Express your idea about brittle failure and ductile failure. **02**

7.a) A simply supported beam of 20 ft length must carry a live load of 2 kip/ft and a dead load of 1.5 kip/ft, including its self-weight. If f_y= 60 ksi and f_c'= 3 ksi, design the shear reinforcement of the beam **in USD** with the complete necessary sketches. **07**

7.b) What is a balanced section according to the working stress theory? **02**

7.c) How is 'Temperature and Shrinkage Reinforcement' determined for a slab? **01**

8.a) A reinforced concrete slab is built integrally with its supports and consists of two equal spans, each with a clear span of 15 ft. The service live load is 100 psf, and 4000 psi concrete is specified for use with steel with a yield stress equal to 60,000 psi. Design the slab, following the provisions of the ACI Code. Express your results with the necessary sketches. **07**

8.b) Compare 'web shear crack' and 'flexural shear crack' with the necessary sketch. **02**

8.c) What are the lapping criteria of steel bars in the tension zone? **01**

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Final Examination, 2023 — **3rd Year 1st Semester**
Course No.: CE 511 — **Course Title: Structural Analysis I**
Time: 03 (Three) hours — **Full Marks: 60**

N.B. : (i) Answer any three questions from each PART (ii) Use separate answer scripts for each PART
(iii) Marks allotted are indicated in the margin (iv) Special Instruction (if any)----------N/A-------

PART- A

(Answer any three questions)

1. (a) A 3-storey moment-resisting frame is subjected to lateral loads acting horizontally at each floor level shown in figure below. Columns are identical and continuous from base to roof. Using Cantilever Method, analyze this multi-storied frame. **10**

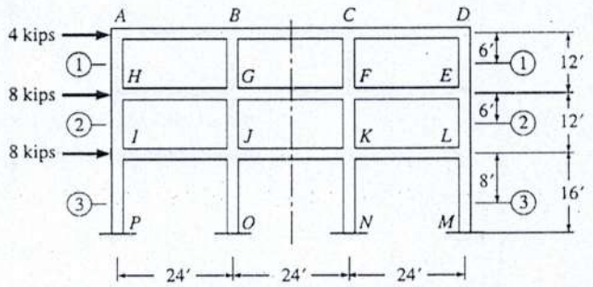


Figure: 1

2. (a) A six-story reinforced concrete (RC) residential building is located in Sylhet, Bangladesh, which lies in Seismic Zone 4 according to BNBC 2020. Each story of the building has a height of 3 m, and the depth of the foundation below ground level is 2 m. The plan dimensions of the building are 20 m × 20 m. The damping correction factor (η) is 1.2. The dead load, including the self-weight of the structural components, is 10 kN/m², while the live load is 2 kN/m² for the typical floors and 1 kN/m² for the roof. The site has an average SPT (N_{30}) value of 13. In accordance with the provisions of BNBC 2020, determine the design earthquake base shear and the lateral forces at each story level using the Equivalent Lateral Force Procedure. The necessary reference tables and information's are provided. **06**

(b) Draw the qualitative influence line diagram for the vertical reactions at supports *A* and *B* and for the shears and bending moments at points *D* and *F* of the beam shown in Figure 2 below. **04**

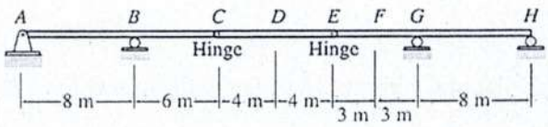


Figure:2

3. (a) The cable in Figure 3, supports four simply supported girders uniformly loaded with 6 kips/ft. (i) Determine the minimum required area of the main cable *ABCDE* if the allowable stress is 60 kips/in.2. (ii) Determine the cable sag at point *B*. **05**

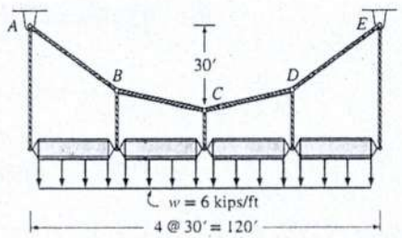


Figure: 3

(b) A cable-supported roof carries a uniform load $w = 0.6$ kip/ft (Figure 4). If the cable sag at midspan is set at 10 ft, what is the maximum tension in the cable (*i*) between points *B* and *D* and (*ii*) between points *A* and *B*? use general cable theorem. **05**

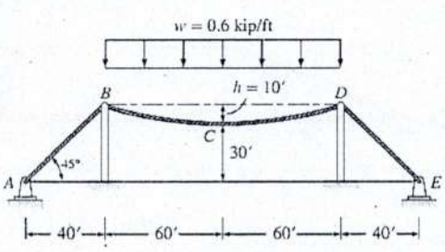


Figure: 4

4. **(a)** Determine the reactions at the supports for the structures shown in figure 5. **05**

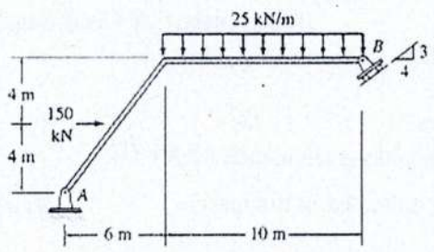
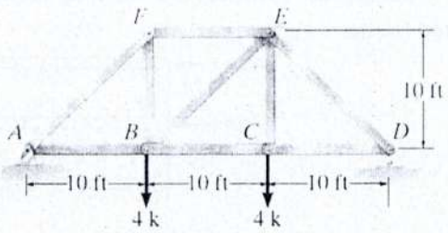


Figure: 5

(b) Find the vertical displacement at C. Consider, A= 0.5 in^2, E=29(10^3) ksi. **05**



PART- B

(Answer any three questions)

5. **(a)** For the arch and loading in Figure 7, compute the reactions and determine the height of each point. The maximum height permitted at any point along the arch, *h* zmax, is 20 m. **05**

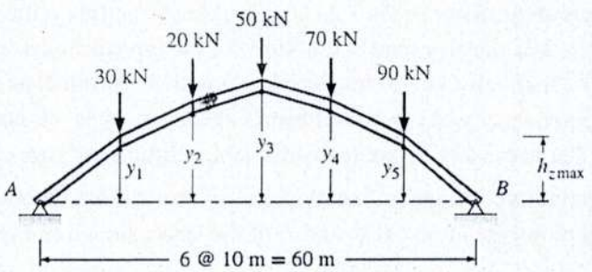


Figure: 7

(b) Determine the horizontal component of the deflection at joint *B* of the truss shown in Figure 8. Use virtual work method. **05**

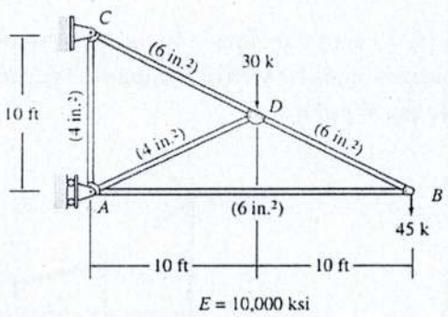


Figure: 8

6. **(a)** Determine the bar forces of AB, AI, BI, IJ, BC, BJ of the following truss shown in Fig 9. **06**

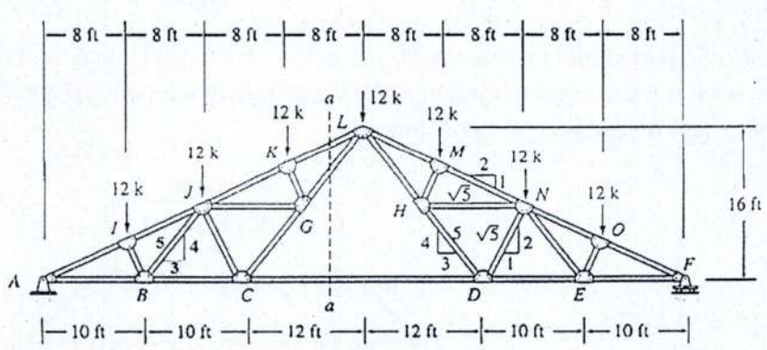


Figure: 9

(b) Draw the influence lines for the shear and bending moment at point C and the shears just to the left of support D of the beam shown in Figure 10. **04**

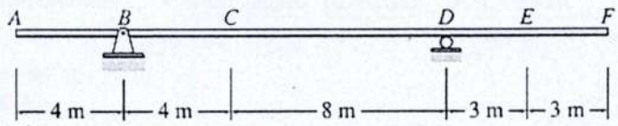


Figure: 10

7. (a) Using the method of virtual work, determine the vertical deflection at joint E of the frame shown in Figure 11. **10**

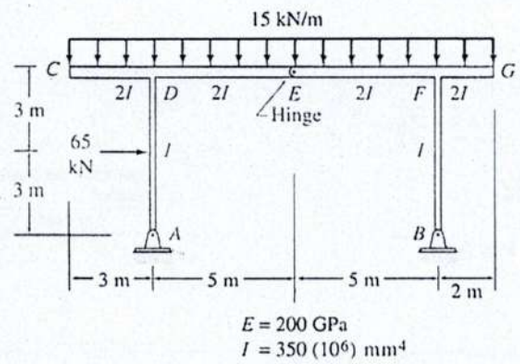


Figure: 11

8. (a) A simply supported beam has a span of 15 m. A uniformly distributed load (UDL) of 40 kN/m and 5 m in length moves from left to right across the span. **04**

(i) Draw the influence line diagram for shear force and bending moment at a section located 6 m from the left support.

(ii) Determine the maximum shear force and maximum bending moment at this section due to the moving UDL.

(b) Determine the absolute maximum moment produced in a simply supported beam with a span of 30 ft by the set of loads shown in Figure 12. **04**

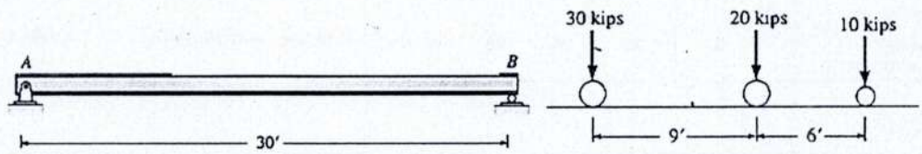


Figure: 12

Classify each of the given structures (figure 13 and 14) as externally unstable, statically determinate, or statically indeterminate. If a structure is statically indeterminate externally, determine its degree of external indeterminacy. **02**

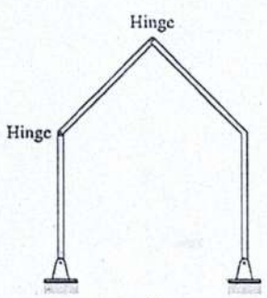


Figure: 13

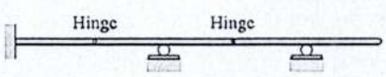


Figure: 14

Table 6.2.13: Site Classification Based on Soil Properties

Site Class	Description of soil profile up to 30 meters depth	Average Soil Properties in top 30 meters		
		Shear wave velocity, V_s (m/s)	SPT Value, N (blows/30cm)	Undrained shear strength, S_u (kPa)
SA	Rock or other rock-like geological formation, including at most 5 m of weaker material at the surface.	> 800	--	--
SB	Deposits of very dense sand, gravel, or very stiff clay, at least several tens of metres in thickness, characterised by a gradual increase of mechanical properties with depth.	360 – 800	> 50	> 250

2.5.7.3 Seismic weight

Seismic weight, W, is the total dead load of a building or a structure, including partition walls, and applicable portions of other imposed loads listed below:

(a) For live load up to and including 3 kN/m², a minimum of 25 percent of the live load shall be applicable.

(b) For live load above 3 kN/m², a minimum of 50 percent of the live load shall be applicable.

(c) Total weight (100 percent) of permanent heavy equipment or retained liquid or any imposed load sustained in nature shall be included.

$$C_S = S\left(1 + \frac{T}{T_B}(2.5\eta - 1)\right) \quad \text{for} \quad 0 \le T \le T_B$$

$$C_S = 2.5S\eta \quad \text{for} \quad T_B \le T \le T_C$$

$$C_S = 2.5S\eta\left(\frac{T_C}{T}\right) \quad \text{for} \quad T_C \le T \le T_D$$

$$C_S = 2.5S\eta\left(\frac{T_C T_D}{T^2}\right) \quad \text{for} \quad T_D \le T \le 4\ sec$$

Table 6.2.16: Site Dependent Soil Factor and Other Parameters Defining Elastic Response Spectrum

Soil type	S	$Ta(s)$	$Tc(s)$	$Tb(s)$
SA	1.0	0.15	0.40	2.0
SB	1.2	0.15	0.50	2.0
SC	1.15	0.20	0.60	2.0
SD	1.35	0.20	0.80	2.0
SE	1.4	0.15	0.50	2.0

Table 6.2.17: Importance Factors for Buildings and Structures for Earthquake design

Occupancy Category	Importance factor I
I, II	1.00
III	1.25
IV	1.50

Table 6.2.18: Seismic Design Category of Buildings

Site Class	Occupancy Category I, II and III				Occupancy Category IV			
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
SA	B	C	C	D	C	D	D	D
SB	B	C	D	D	C	D	D	D
SC	B	C	D	D	C	D	D	D
SD	C	D	D	D	D	D	D	D
SE, S_1, S_2	D	D	D	D	D	D	D	D

Seismic Force-Resisting System	Response Reduction Factor, R	System Overstrength Factor, Ω_o	Deflection Amplification Factor, C_d	Seismic Design Category B	Seismic Design Category C	Seismic Design Category D
				Height limit (m)		
4. Special reinforced concrete moment frames	8	3	5.5	NL	NL	NL
5. Intermediate reinforced concrete moment frames	5	3	4.5	NL	NL	NP
5. Ordinary reinforced concrete moment frames	3	3	2.5	NL	NP	NP

Table 6.2.20: Values for Coefficients to Estimate Approximate Period

Structure type	C_t	m	
Concrete moment-resisting frames	0.0466	0.9	Note: Consider moment resisting frames as frames which resist 100% of seismic force and are not enclosed or adjoined by components that are more rigid and will prevent the frames from deflecting under seismic forces.
Steel moment-resisting frames	0.0724	0.8	
Eccentrically braced steel frame	0.0731	0.75	
All other structural systems	0.0488	0.75	

Site Class	Description of soil profile up to 30 meters depth	Average Soil Properties in top 30 meters		
		Shear wave velocity, V_s (m/s)	SPT Value, N (blows/30cm)	Undrained shear strength, S_u (kPa)
SC	Deep deposits of dense or medium dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres.	180 – 360	15 - 50	70 - 250
SD	Deposits of loose-to-medium cohesionless soil (with or without some soft cohesive layers), or of predominantly soft-to-firm cohesive soil.	< 180	< 15	< 70
SE	A soil profile consisting of a surface alluvium layer with V_s values of type SC or SD and thickness varying between about 5 m and 20 m, underlain by stiffer material with V_s > 800 m/s.	--	--	--