University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2024
Program: B. Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II | Course Code: CE 441
Time: 3 Hours | Credit Hours: 3.0 | Full Marks: 120

Answer all the questions

1. (a) Discuss soil disturbances in light of stress (overburden) release, aggregate packing and sampler for cohesive and cohesionless soils. 6

   (b) Mention drilling type and summarize logging in geotechnical subsurface exploration. 3

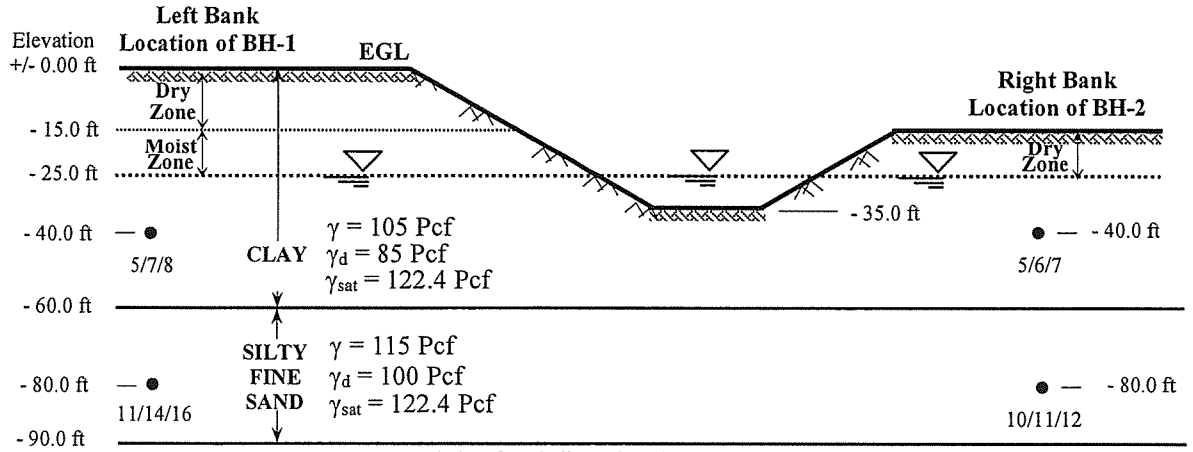
   (c) Write short notes on any three of the following: 9

   (i) Geotechnical subsurface exploration (ii) Location of boreholes
   (iii) In-situ Testing (iv) Preliminary information required for a building project

   (d) Consider the following scenario as found for a geotechnical subsurface exploration: 7
   - Theoretical depth of exploration as calculated using 10% stress criterion, $D_E = 24.3$ ft
   - Depth of foundation (square footing) considered, $D_f = 7$ ft
   - Considered ultimate bearing capacity of soil, $q_u = 12{,}000$ psf

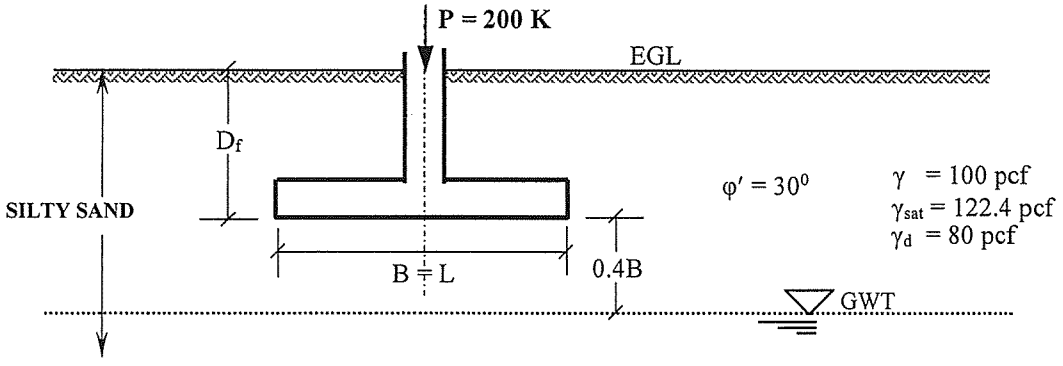
   Determine the footing dimension considered for estimating depth of exploration. Also calculate the allowable bearing capacity considered.

2. A preliminary geotechnical site investigation was conducted at a site, in Bangladesh, as shown below. Determine cohesion and angle of internal friction at corresponding depths (for both boreholes) of the cohesive and cohesionless deposits, respectively, based on the available data (Use empirical correlations as provided in Appendix). Use hammer efficiency as 58%. No liner was used. 10

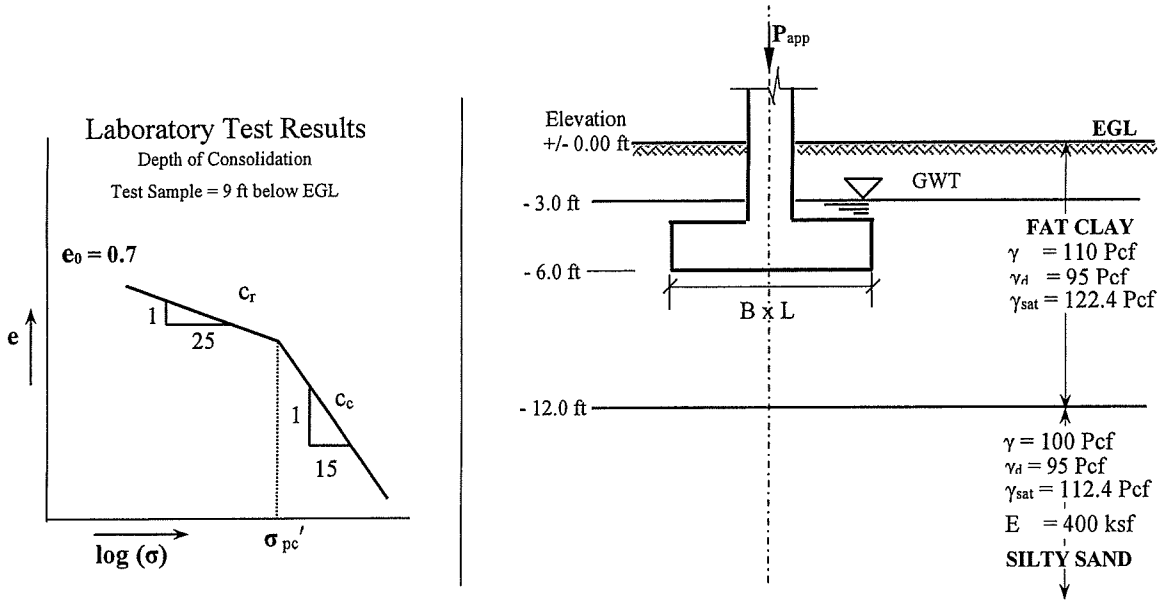


Subsurface Soil Stratigraphy

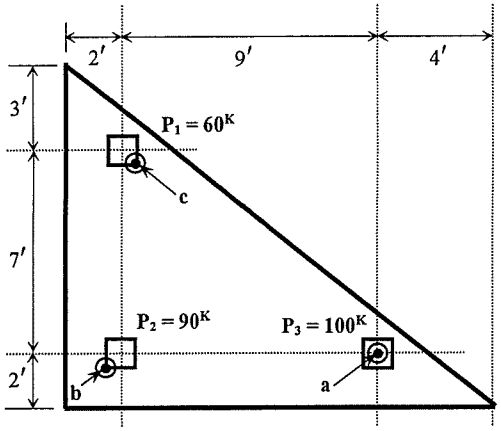
3. Using General Bearing Capacity Equation (GBCE), design the size of the square footing for the following condition. Use $B = 2D_f$. 10



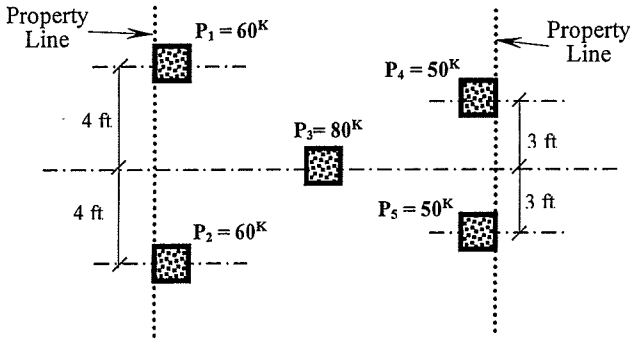
4. (a) A rectangular footing (8 ft X 12 ft), designed as per allowable bearing capacity based on shearing failure, is shown in the following figure. OCR of the cohesive deposit is 2.0. Estimate settlements for both sand and clay layers. Use $q_a = p_{app} = 5.0$ ksf. 13



(b) The plan of a mat foundation with column loads and dimensions is shown in the figure below. Calculate the soil pressures at points a, b and c and at the geometric centroid of the foundation (All the columns are of 12 by 12 inches in size). 10

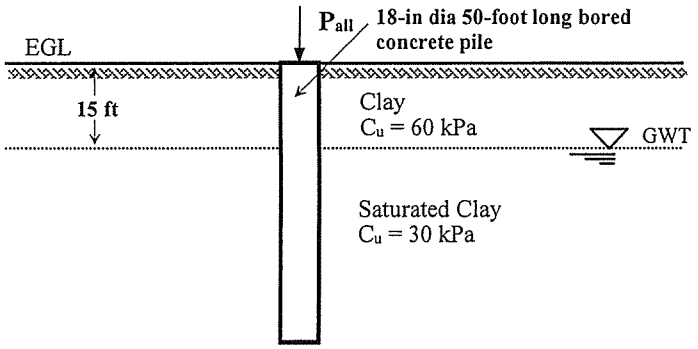


(c) Design the size of a combined trapezoidal footing for the following conditions. All columns have x-sectional dimension of 12 in by 12 in. Use q_a =3.0 ksf. 7

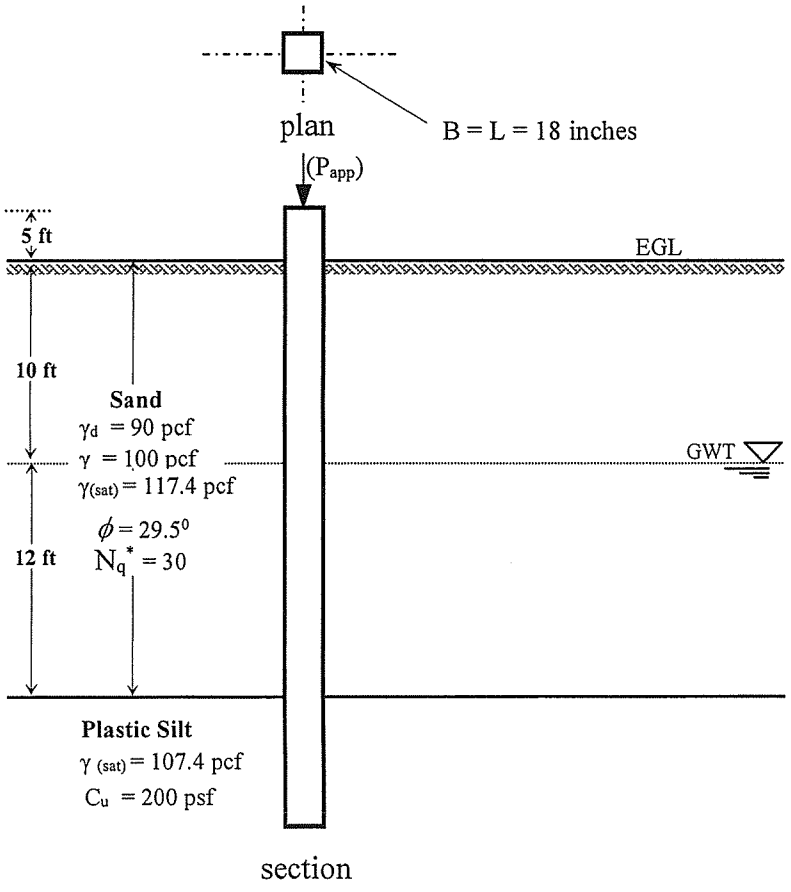


5. (a) Classify pile foundations. 4.5

(b) For the following condition, calculate the allowable capacity of a single pile. Assume reasonable factor of safeties for end bearing and skin resistance. Also calculate the capacity considering group effect of pile group consisting of six piles forming a block. Use spacing of piles = 2.5 times the diameter of the piles. Finally estimate the design capacity. 12.5

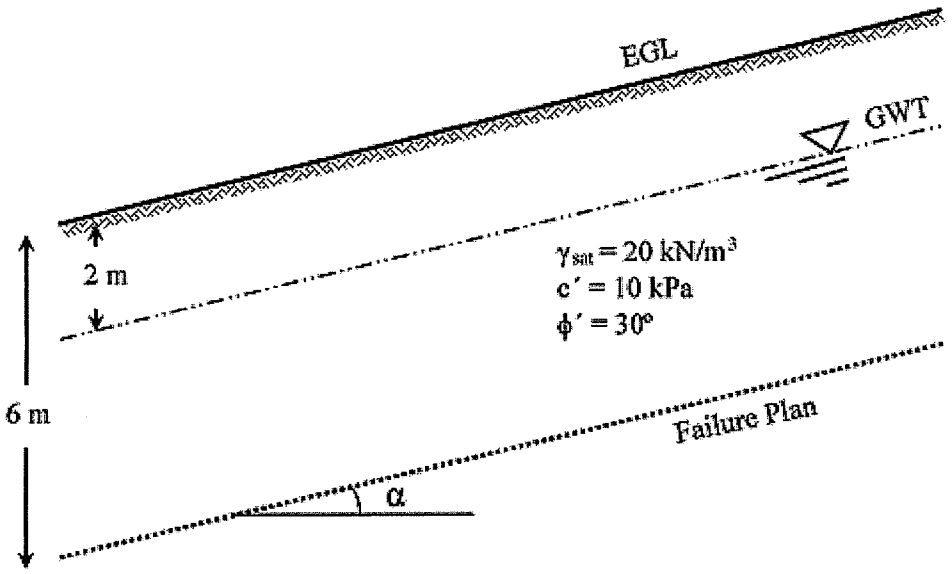


(c) A solid concrete driven pile is installed as shown below. Calculate the theoretical length of the pile to achieve an allowable capacity (Q_a) of 50 Kips. Consider factor of safety of 2.5 for both skin friction and end bearing resistance. 10

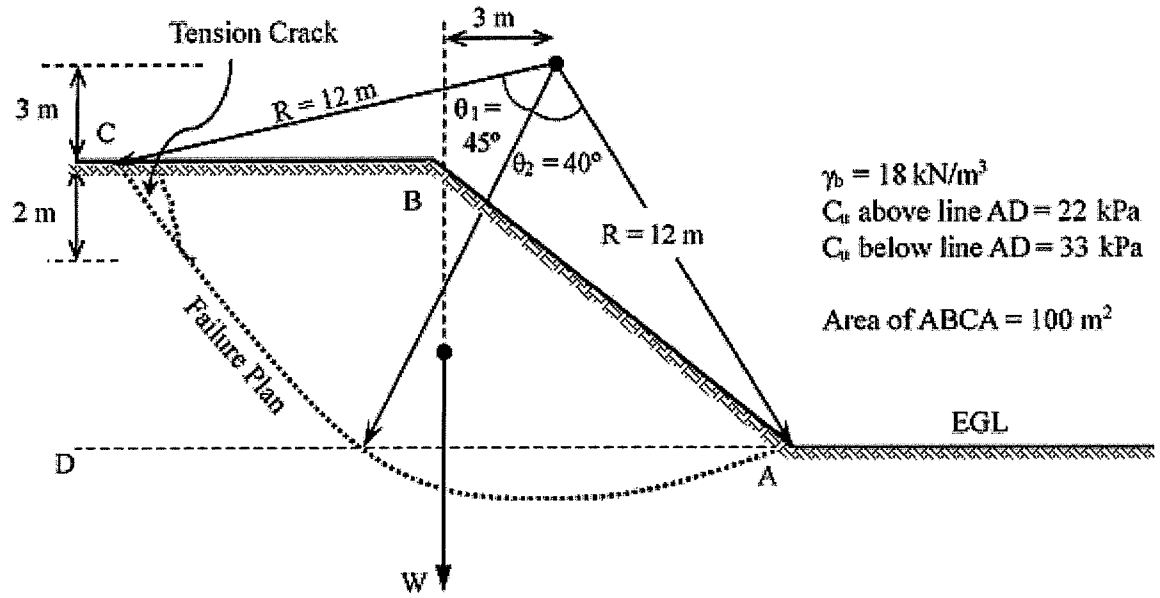


section

6. (a) An infinite slope in a (c-ϕ) soil is shown in the figure. Determine the maximum allowable slope angle that will provide a factor of safety (FOS) of 1.5, given that the water table is located 2 meters below the ground surface. 8



(b) Determine the factor of safety for the cohesive slope shown in the figure using the Swedish Slip Circle Method. The finite slope contains a 2-meter-deep tension crack, which is fully filled with water. Assume the angle, $\theta_1 = 38°$. 10



University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 1st Semester

Course Title: Irrigation and Flood Control | Course Code: CE 461
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 120

Answer all the questions

QUESTION 1 [30 MARKS]

a. Outline a distribution system for canal irrigation with proper notation. [6]

b. Design a trapezoidal irrigation canal on alluvial soil with the following data using Kennedy's method. [20]
Full supply discharge = 45 cumec
Rugosity coefficient, n= 0.023
Critical velocity ratio= 1.0
Side slope= 0.5:1
Bed slope= 1:3500
Assume other reasonable value. Show your design in a diagram with proper freeboard extent from Table 1. Complete at least two trials.

$[V_0=0.546mD^{0.64},\ C=\frac{\frac{1}{n}+(23+\frac{0.00155}{S_0})}{1+(23+\frac{0.00155}{S_0})\frac{n}{\sqrt{R}}}]$

Table 1: Freeboard extent based on discharge

Discharge (m^3/s)	Extent of freeboard (m)
1 to 5	0.50
5 to 10	0.60
10 to 30	0.75
30 to 150	0.90

c. Specify two key differences between Kennedy's and Lacey's method of design. [4]

QUESTION 2 [30 MARKS]

a. Illustrate different components of a canal head regulator through a diagram. [8]

b. A pump lifts 40 litres of water per second against a total head of 25 m and the pump has an efficiency of 75%. Given motor efficiency 85% and delivery efficiency 95%. [6]

If total frictional head loss of pipes is 2.5 m, compute the energy input to motor in kilowatt.

c. For a wide rectangular channel, the discharge is given as $Q = ky^{5/3}$. [3+3+4]
Irrigation water discharge flowing over a v-notch is represented as $q = CH^{5/2}$.
The depth in the distributary channel is 1.0 m. The head over the weir is 0.3 m.
For the information given above, calculate the followings.
   i) Setting
   ii) Proportionality of the outlet
   iii) With 20 cm increase in water level of distributary channel, the rate of change of outlet discharge

d. Explain the characteristics of a flood event and a few reasons behind increased damage due to a flood event in Bangladesh [6]

QUESTION 3 [30 MARKS]

a. Explain how sustainable urban drainage system differ from traditional one. [6]

b. i) Elaborate the process of leaching with description and a diagram. [6+6]
ii) Calculate the irrigation requirement of a rice crop when the leaching requirement of the rice soil is 32% and the soil water has been depleted 50%. The available water holding capacity of the root zone is 50 cm.

c. i) Compare between border-strip flooding and furrow irrigation. [4+8]
ii) Determine the time required to irrigate a strip of land of 0.5 hectares in area from a tube-well with a discharge of 0.65 cumec. The infiltration capacity of the soil may be taken as 0.35 m/h and the average depth of flow on the field as 25 cm. Also determine the maximum area that can be irrigated from this tube well. If each strip is designed as 100x15, how many strips need to be constructed?
$[t = 2.3\frac{y}{f} log\ (\frac{Q}{Q-fA}),\ L_{max} = Q/fw]$

QUESTION 4 [30 MARKS]

a. Explain the following parameters with definition and equation if applicable. [3+3]
   i. Silt factor
   ii. Regime channel

b. Design an unlined canal having the following data: [12]
Discharge of the canal = 40 cumec
Permissible mean velocity = 0.95 m/sec
Chezy's constant, C = 45
Side slope = 1:1
B/D ratio = 6.5

c. Design a lined canal having the following data utilizing Table 2 or Table 3: [12]
Full supply discharge = 100 cumec
Side slope = 1:1
Bed slope = 1 in 3600
Rugosity coefficient = 0.013
Permissible velocity = 2 m/sec

Table 2: Design parameters for triangular section

Design parameter	**Side slope**		
	1:1	**1.5:1**	**1.25:1**
Sectional area (A)	$1.785 \times D^2$	$2.088 \times D^2$	$1.925 \times D^2$
Wetted perimeter (P)	$3.57 \times D$	$4.176 \times D$	$3.85 \times D$
Hydraulic mean depth or radius (R)	$0.5 \times D$	$0.5 \times D$	$0.5 \times D$
Velocity (V)	$V = (1/n) \times R^{2/3} \times S^{1/2}$	–	–
Discharge (Q)	$A \times V$	–	–

Table 3: Design parameters for trapezoidal section

Design parameter	**Side slope**		
	1:1	**1.5:1**	**1.25:1**
Sectional area (A)	$BD + 1.785 \times D^2$	$BD + 2.088 \times D^2$	$BD + 1.925 \times D^2$
Wetted perimeter (P)	$B + 3.57 \times D$	$B + 4.176 \times D$	$B + 3.85 \times D$
Hydraulic mean depth or radius (R)	A/P	A/P	A/P
Velocity (V)	$V = (1/n) \times R^{2/3} \times S^{1/2}$	–	–
Discharge (Q)	$A \times V$	–	–

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2024
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering III | Credit Hours: 3 | Course Code: CE 411
Time: 3 hours | Full Marks: 100 (10 × 10)

ANSWER ALL THE QUESTIONS. Any missing data can be assumed reasonably.

1. Use Stiffness Method (neglect axial deformations) to calculate rotations (θ_a, θ_c) of joints ***a*** and ***c*** of the 2D frame ***abcde*** loaded as shown in ***Fig.1***
   [Given: $EI = 49\times10^3$ *k-ft*^{2}].

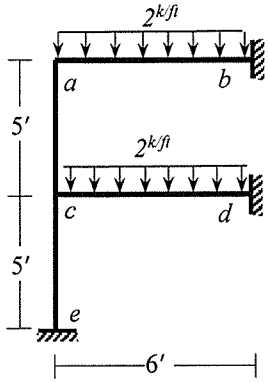


Fig.1

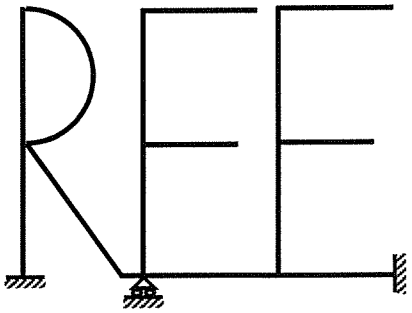


Fig.2

2. Determine the degree of kinematic indeterminacy (**doki**) and show the corresponding deflections and rotations of the 2D frame (***Fig.2***) and 3D frame (***Fig.7***) for the following cases
   (i) Not considering boundary conditions
   (ii) Considering boundary conditions
   (iii) Neglecting axial deformations.

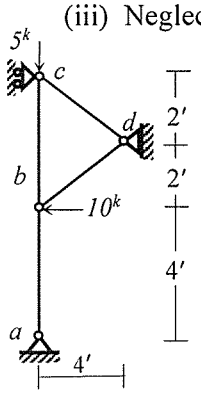


Fig.3

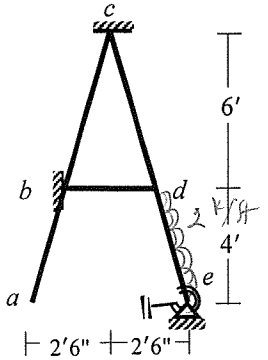


Fig.4

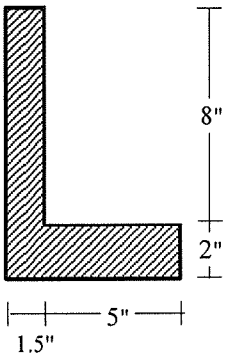


Fig.5

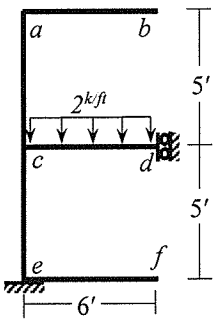


Fig.6

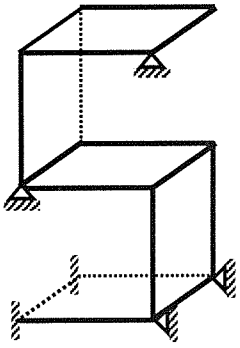


Fig.7

3. For the 2D truss loaded as shown in ***Fig.3***, determine the displacements of joint ***b*** and ***c***. Also calculate member force of ***cd***
   [Given: $EA/L = 1200$ *k/ft*].

4. Use Stiffness Method (neglect axial deformations) to calculate rotation at joint *d* and *e* of the frame loaded as shown in ***Fig.4***, if the joint *e* is a circular foundation of radius 3 ft on the surface of subsoil (half- space) with shear wave velocity(v_s) equal to 1175 ft/sec
   [Given: EI of the frame members = 49×10^3 *k-ft*^{2}, Unit weight of soil = *120 pcf*, Poisson's ratio of soil material= *0.35*].

5. Calculate Yield Moment and Plastic Moment capacity of the section shown in ***Fig.5*** if the section is made of elastic-fully plastic material [Given: σ_{yp} = 49 ksi].

6. Use Stiffness Method considering geometric nonlinearity and flexural deformations only to calculate the unknown rotation at ***c*** and deflection at ***d*** of the frame ***abcdef*** loaded as shown in ***Fig.6***
[Given: $EI = 49 \times 10^3$ *k-ft*^{2}].

7. Use the Energy Method to calculate the plastic moment (i) needed to prevent beam mechanism of ***ab*** and ***bc***, (ii) needed to prevent the sidesway mechanism in the frame ***abcd*** loaded as shown in ***Fig.8.***

8. Frame structure ***abcd*** shown in ***Fig. 9*** is subjected to a dynamic load, $w = 10t$ (*k/ft*).
Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***b*** at time $t = 0.10$ sec
[Given: $EI_{bd} = 49 \times 10^3$ *k-ft*^{2}, $EI_{abc} = 49 \times 10^2$ *k-ft*^{2}, $\mu = 0.0049$ *k-sec*^{2}*/ft*^{2},
Damping ratio of the system = 4.9%].

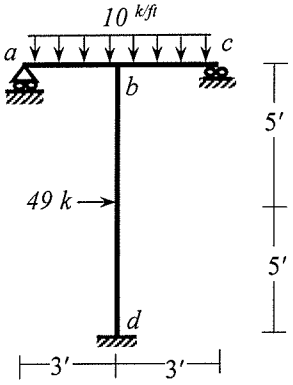


Fig.8

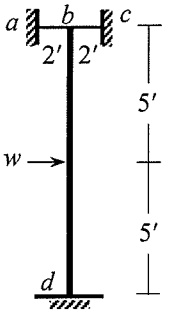


Fig.9

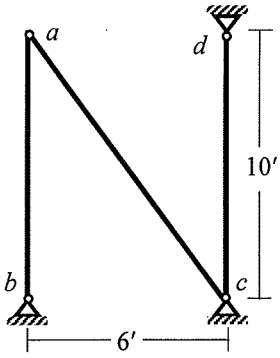


Fig.10

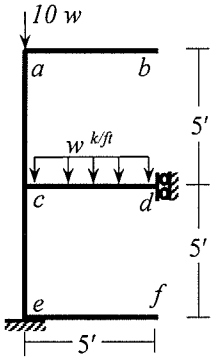


Fig.11

9. Calculate 1st natural frequency of the truss ***abcd*** shown in ***Fig.10*** using consistent mass matrices.
[Given: $EA/L = 1200$ *k/ft*, $\mu = 0.0049$ *k-sec*^{2}*/ft*^{2}].

10. Use Stiffness Method (neglecting axial deformations) to calculate the value of applied load ***w*** required to cause buckling of the frame ***abcdef*** loaded as shown in ***Fig.11***
[Given: $EI = 49 \times 10^3$ *k-ft*^{2}].

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 1st Semester

Course Title: Professional Practices and Communication | Course Code: CE 403
Time: 2 hours | Credit Hour: 2.00 | Full Marks: 100

Answer all the questions

QUESTION 1 [10 MARKS]

Apply the provided Bill of Quantities (BOQ) (**Table 1**) for a residential building foundation to calculate the total estimated cost of the foundation work. **[10]**

Table 1. BoQ for a residential building foundation

Item Description	Unit	Quantity	Unit Rate (BDT)
Site Clearance & Preparation	Sq.m	300	150
Excavation	Cu.m	180	350
Shoring/Support System	Lin.m	80	1,200
Lean Concrete (Plain)	Cu.m	40	4,200
Formwork (Foundation)	Sq.m	120	800
Reinforced Concrete (RCC)	Cu.m	60	8,500
Reinforcement Steel	Kg	5,000	85
Waterproofing Membrane	Sq.m	100	600
Backfilling	Cu.m	150	280
Compaction of Backfill	Cu.m	150	120

QUESTION 2 [10 MARKS]

Employ the retrenchment and discharge termination guidelines provided in the ***Bangladesh Labour Act.*** to analyze the following two scenarios:

a. A factory worker who has been employed continuously for three years is laid off due to a significant decrease in orders. **[5]**

b. An office employee, who has worked for five years, develops a severe mental health condition that renders him unable to perform his duties. **[5]**

For each scenario, determine the employer's legal obligations regarding notice and financial benefits.

QUESTION 3 [15 MARKS]

Apply the regulations related to Welfare and Social Protection outlined in the ***Bangladesh Labour Act*** to analyze the following scenarios within a large construction company operating multiple sites in Bangladesh:

a. A construction site employing 120 workers does not have a designated eating area or canteen. **[5]**

b. The company employs 800 workers across all its sites, and 650 of them submit a written application requesting the formation of a Provident Fund but company is not responding. [5]

c. A worker falls from scaffolding on a construction site and suffers a broken leg, resulting in a temporary disability that prevents him from working. Company is not bearing treatment cost. [5]

For each scenario, determine whether the company is in compliance with the provided regulations, and justify your conclusions by referencing specific elements of the regulations.

QUESTION 4 [20 MARKS]

Apply the criteria of a profession to evaluate the professional status of a software developer specializing in artificial intelligence. Justify your evaluation by comparing and contrasting their contributions to those of a cricketer and a carpenter. [12+8]

QUESTION 5 [20 MARKS]

Demonstrate the concept of 'moonlighting' and its potential conflicts of interest to analyze the following scenario:

An engineer, employed full-time by a construction firm specializing in bridge design, also works part-time for a software development company that creates project management tools used by competing construction firms.

a. Determine whether this engineer's moonlighting activity creates a conflict of interest and support your reasoning. [10]

b. Discuss how the engineer could mitigate or avoid these potential conflicts of interest. [10]

Support your analysis and decisions with relevant explanations.

QUESTION 6 [25 MARKS]

You are an Environmental Engineer working for a large construction company involved in a major coastal development project. Your responsibilities include ensuring compliance with environmental regulations, conducting impact assessments, and recommending mitigation measures. During a recent site survey, you discover that the company's dredging operations are significantly damaging a nearby mangrove forest, a vital ecosystem for local fisheries and coastal protection. Your data indicates that the sediment plumes from dredging are far exceeding the permitted levels, leading to increased turbidity and covering the mangrove roots, which will eventually kill them. Your project manager, under pressure to meet tight deadlines and minimize costs, dismisses your concerns. He argues that the mangrove damage is "temporary" and "negligible" compared to the economic benefits of the project. He instructs you to revise your environmental impact report to downplay the damage and emphasize the project's economic contributions. He also suggests you to focus on the positive aspects of the project's mitigation measures, even though they are largely ineffective. He states, "We can't afford any delays. This project is crucial for the company's future. Any negative publicity will risk our contracts and cause job losses.

Apply the ***NSPE Code of Ethics*** to answer the following questions:

a. What are the ethical issues presented in this scenario? [10]

b. How should you respond to your project manager's directives, considering your professional obligations and the potential environmental consequences? [15]

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University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2024
Program: B. Sc. Engineering (Civil)
4th Year 1st Semester

Course Title: Environmental Engineering III — Course Code: CE 431
Time: 2 Hours — Credit Hour: 2.00 — Full Mark: 100

There are Three questions. Answer all the questions [30+30+40 = 100].
(Assume any missing data)

QUESTION 1 [30 MARKS]

a. Demonstrate through line diagram pathways how humans are exposed to hazardous waste through lifestyle and environmental exposure. List down the possible ways of reducing the exposure through each of the pathways. [10]

b. Explain the different categories of hazardous waste and make a priority hierarchy for the categories with difficulty in management and treatment from high to low. Discuss ways to eliminate the uses of hazardous waste. [10]

c. Provide a system flow diagram for "Industrial Waste Management" showing the possible management locations to minimize the burden on disposal. Explain the concept of "Cradle to Grave" in Life Cycle Analysis. [10]

QUESTION 2 [30 MARKS]

a. Following table shows a comparison of costs for trucks making one, two or three trips per day to the disposal site. Perform an economic analysis for each of the options (1, 2 or 3 trips) by estimating the annual cost per ton of waste and annual cost per household using the given information. Also discuss each of the options in terms of their suitability for optimum cost and time illustrating the option to provide with the maximum benefit. [12]

Number of trips per day	Houses served per truck	Minimum truck size (yd^3)	Total waste (ton)	Annual Truck cost ($/yr)	Annual Labor Cost ($/yr)
1	2050	35	3200	164,556	99,840
2	1700	15	2600	82,643	99,840
3	1350	8	2000	55,338	99,840

b. Discuss the major environmental impacts and economic costs associated with the solid waste collection systems. Also provide a comparative analysis of the different solid waste collection methods categorized based on availability of services. [10]

c. Mention the factors that you must consider while planning and designing transfer station. Discuss "preventive" versus "breakdown" modes of maintenance of collection vehicles. [8]

QUESTION 3 [40 MARKS]

a. Compare between "composting" and "anaerobic digestion". Explain how composting contributes to the three R's (Reduce, Recycle and Reuse)? Consider you are responsible for designing a composting plant for a city, which environmental factors would you deem necessary for implementation of the concept? [10]

b. Explain the industrial waste reuse, recovery and recycle opportunities. Describe the problems and options of disposal and treatment of hazardous waste. [10]

c. Estimate the theoretical volume of methane (CH_4), carbon-di-oxide (CO_2) and Ammonia (NH_3) that would be expected from anaerobic digestion of per ton of waste having the composition $C_{60}H_{194.3}O_{37.8}N$ (using the formula below). Also estimate the percentage composition (volume fractions of each gas) of the resulting gas mixture. The density of CH4, CO_2 and NH_3 at standard temperature and pressure (STP) are 0.7167 kg/m^3, 1.9783 kg/m^3 and 0.696 kg/m^3 respectively. [10]

$$C_aH_bO_cN_d + \frac{4a - b - 2c + 3d}{4} H_2O \rightarrow \frac{4a + b - 2c - 3d}{8} CH_4 + \frac{4a - b + 2c + 3d}{8} CO_2 + d\, NH_3$$

d. The following five soil layers are lying between the base of a landfill and the underlying aquifer. Evaluate how long it will take for leachates to migrate to the aquifer. [10]

Layers of soil	Depth (m)	Porosity (%)	Permeability (m/s)
Layer A	2.5	40	2.5×10^{-8}
Layer B	1.5	45	1.9×10^{-7}
Layer C	1.8	42	5.3×10^{-7}
Layer D	2.8	39	3.8×10^{-5}
Layer E	3.0	41	4.1×10^{-8}

Given Formulae:

$$CRF = \left[\frac{i(1+i)^n)}{(1+i)^n)-1}\right] \quad A = P\left[\frac{i(1+i)^n)}{(1+i)^n)-1}\right]$$

Where, A = Annual cost (BDT/yr)
P = Purchase price, (BDT)
i = interest rate, discount rate (yr^{-1})
n = amortization period (yr)
CRF = Capital Recovery factor

Average interstitial velocity, $v_p = k/\alpha$

Equivalent permeability, $K_e = \frac{\sum d_i}{\sum \frac{d_i}{k_i}}$

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 1st Semester

Course Title: Structural Engineering V | Course Code: CE 415
Time: 2 hours | Credit Hour: 2.00 | Full Marks: 50

Answer all the questions

QUESTION 1 [25 MARKS]

a. Design a final version of the post-tensioned prestressed concrete beam, based on the preliminary section shown in **Figure 1. The tensile stress of the beam has to be considered.** [Given, f_b = - 13.5 MPa, f_t = -12 MPa, f_0 = 1040 Mpa, f'_b = 1.75 MPa, f'_t = 2.0 MPa, M_G = 300 kN-m, M_T = 450 kN-m, h = 920 mm, F = 800 kN, F_0 = 960 kN]

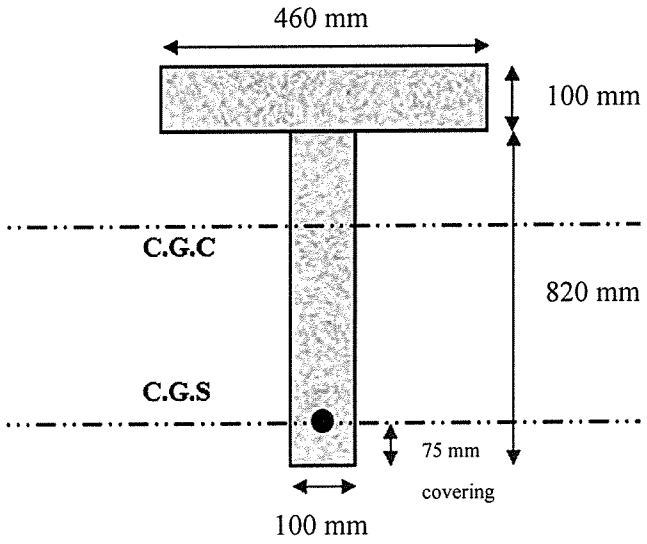

Figure 1: Preliminary section of a T-beam

b. Design and sketch a preliminary section of a pre-tensioned prestressed concrete beam. [Given, f_c = -12 MPa, f_0 = 1040 MPa, f_{se}= 900 MPa, M_G = 60 kN-m, M_T = 450 kN-m, h = 800 mm]

c. Design a final version of the pre-tensioned prestressed concrete beam, based on the preliminary section shown in **Figure 2. The tensile stress of the beam need not to consider.** [Given, f_b = - 13.5 MPa, f_t = -12 MPa, f_0 = 1000 MPa, f_{se} = 800 MPa, M_G = 100 kN-m, M_T = 520 kN-m, h = 700 mm, F = 800 kN]

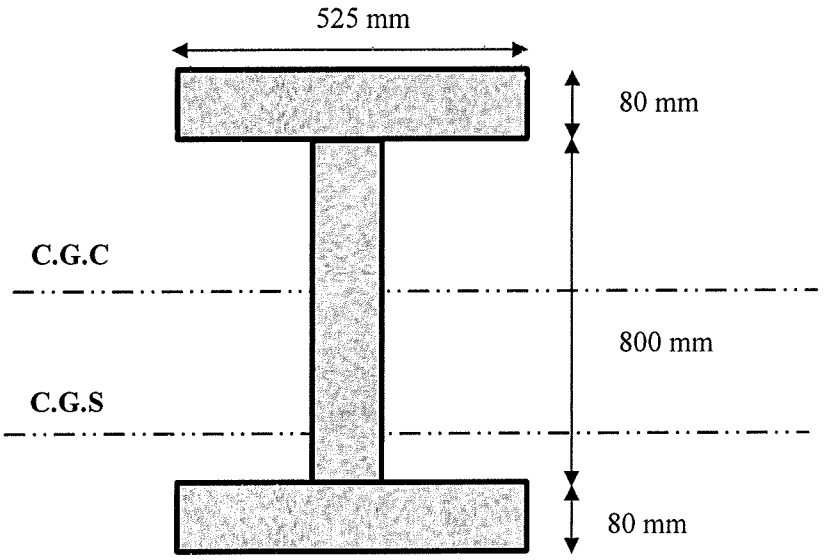

Figure 2: Preliminary section of an I-beam

QUESTION 2 [10 MARKS]

A concrete beam with cross-sectional area of 32000 mm^2 and the radius of gyration is 75 mm has been prestressed by a parabolic cable, carrying an effective stress of 2000 MPa. The span length of the beam is 10 m. The cable, composed of 10 wires of 6 mm diameter, has an eccentricity (e_1) of 50 mm at the centre and Zero at the supports (e_2). The unit weight of concrete is 24 kN/m^3. Neglecting all losses, calculate the **central deflection** of the beam for the following conditions.

i) Self weight + Prestress Force

ii) Self weight + Prestress Force + a live load of 3 kN/m.

QUESTION 3 [15 MARKS]

Calculate the shear strength capacity of the beam using the ACI code and compare it with the shear force for **section 1-1** of the beam shown in **Figure 3**. [Given, $F_e = 2000$ kN, n =8, e =350 mm, d = 750 mm, $f'_c = 50$ MPa, w = 5.65 kN/m including service load, $E_{steel} = 200000$ MPa, Vp = 14 kN, deflection 6.5 mm, radius of gyration is 351 mm, $b_w = 80$ mm, $Q = 23.4 \times 10^6$ mm^3, d = 920 mm, $\varphi = 0.85$]

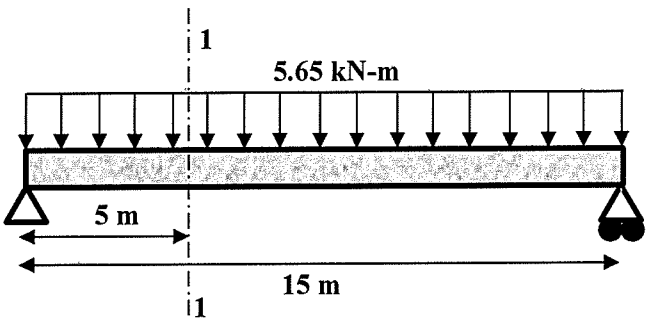

Figure 3: Long section of a beam

Set of Formulas

$$f_t'' = \sqrt{v^2 + \left(\frac{f_{Pc}}{2}\right)^2} - \left(\frac{f_{Pc}}{2}\right), f_{pc} = \frac{F_e}{A}, f_t'' = 4\sqrt{f_c'}\ ,\ v_{c\omega} = \frac{V_c + V_p}{b_\omega d}, v_U = \frac{V_u}{\phi b_\omega d}$$

$$e_1 = f_t' I / F_0 c_t = f_t' A k_b / F_0 \qquad e_2 = M_G / F_0 \qquad e_1 + e_2 = \frac{M_G + f_t' A k_b}{F_0}$$

$$f_b' I / c_b = f_b' A k_t \qquad F = \frac{M_T - f_b' A k_t}{a} \qquad f_b = \frac{F_0 h}{A_c c_t} + f_t' \frac{c_b}{c_t} \qquad A_c = \frac{F_0 h}{f_b c_t - f_t' c_b}$$

$$f_t = \frac{Fh}{A_c c_b} + f_b' \frac{c_t}{c_b} \qquad A_c = \frac{Fh}{f_t c_b - f_b' c_t}$$

$$e - k_b = M_G / F_0 \qquad A_c = F_0 h / f_b c_t \qquad F = \frac{M_T}{e + k_t}$$

$$A_c = Fh / f_t c_b \qquad A_c = \frac{F_0}{f_b}\left(1 + \frac{e - (M_G / F_0)}{k_t}\right)$$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2024
Program: B.Sc. in Engineering (Civil)
4th Year 1st Semester

Course Title: Structural Engineering X | Course Code: CE 425
Time: 2 hours | Credit Hour: 2.00 | Full Marks: 70

QUESTION 1 [10 MARKS]

(a) Explain the pozzolanic reaction that takes place when pozzolans are added into concrete. **[4]**

(b) Explain the effect of fly ash on fresh and hardened properties of concrete. **[6]**

QUESTION 2 [10 MARKS]

Explain the factors influencing Chloride-induced corrosion. **[10]**

QUESTION 3 [10 MARKS]

Write short note on segregation of concrete, explaining its cause, effects and control. **[10]**

QUESTION 4 [10 MARKS]

(a) State the purposes of non-destructive tests of concrete. **[4]**

(b) Ultrasonic Pulse Velocity Test is an effective NDT test for estimation of compressive strength of concrete – Do you agree or disagree? Justify your answer. **[6]**

QUESTION 5 [10 MARKS]

Explain how interfacial transition zone (ITZ) plays role in mechanical and durability properties of concrete. **[10]**

QUESTION 6 [20 MARKS]

A reinforced concrete wall needs to be constructed at a construction site. The following necessary data are provided for the wall and its formwork.

Cross sectional size of the wall: Thickness = 350 mm, Length = 10 m.

Height = 3 m

Concrete type: Blended cement containing 20% of fly ash with an accelerating admixture.

Form height = 3.5 m.

Density of concrete = 2400 kg/m^3.

Concrete temperature at placement = 30 °C.

Uniform volume supply rate = One 7 m^3 truck every 30 mins.

Table 1: Values of coefficients C1 and C2

Walls: C l = 1 .0	
Columns: C l = 1 .5	
Concrete:	**Value of C2**
Ordinary Portland Cement (OPC) without admixture	0.3
OPC with any admixture, except a retarder	0.3
OPC with a retarder	0.45
Blended cement containing less than 70% slag or 40% fly ash without admixture	0.45
Blended cement containing less than 70% slag or 40% fly ash with any admixture, except a retarder	0.45
Blended cement containing less than 70% slag or 40% fly ash with a retarder	0.6
Blended cement containing more than 70% slag or 40% fly ash	0.6

(a) Calculate the concrete lateral pressure and draw the pressure envelope as a function of height for form work design. **[12]**

(b) Explain the effect of workability of concrete on the lateral pressure of formwork. **[8]**

Formula:

$$P_{max} = D\left[C_1\sqrt{R} + C_2 K\sqrt{H - C_1\sqrt{R}}\right] \quad \text{and} \quad D \times h$$

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 1st Semester

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 120

Answer all the questions. Submit annexures with relevant parts of answer scripts.

PART A

QUESTION 1 [20 MARKS]

a. A 2-4-2 locomotive is required to haul a train at 65 km/h on a level, curved 5-degree broad-gauge track. The axle load of the driving wheels of the engine is 30 tons. If the train encounters a gradient of 1 in 180, determine the reduction in speed required to haul the train. [10]

b. Determine the tensile stress developed in a concrete pavement at night due to a circular wheel load of 2000 lb applied at the edge of the pavement, using (a) Westergaard equation, and (b) Ioannides equation, given the following dimensions and properties.
Pavement thickness = 3"
Modulus of elasticity of concrete = 6×10^6 lb/in^2
Modulus of subgrade reaction = 80 lb/in^3
Radius of loaded area = 6" [10]

QUESTION 2 [20 MARKS]

Design a concrete pavement for a rural expressway using the AASHTO method. An 8-inch layer of bituminous-treated granular material is used as a subbase layer. The monthly values for the resilient modulus of roadbed soil and sub-base are given in Table 1. The depth to rock is 7 ft below the subgrade surface, the projected slab thickness is 10 inches, and the potential loss of subbase support is 2.

i) Estimate the effective modulus of the subgrade reaction.

ii) Determine whether the projected slab thickness is sufficient for this type of pavement.

Given: Cumulative 18-kip ESAL = 10×10^6; Elastic modulus of the concrete = 4×10^6 lb/in^2; Modulus of rupture of concrete = 750 lb/in^2; Load transfer coefficient = 3.5, Drainage coefficient = 0.8; Reliability = 90%; Standard deviation = 0.4. Assume any reasonable value if needed. [20]

Table 1: Monthly Resilient Modulus Values for Pavement Layers.

Month	Roadbed Modulus (lb/in^2)	Sub-base Modulus (lb/in^2)
January	10,000	25,000
February	12,000	32,000
March	16,000	50,000
April	20,000	60,000
May	7,000	20,000

PART B

QUESTION 3 [35 MARKS]

a. Explain the difficulties encountered in providing superelevation on a railway track when a branch line diverges from the main track. [8]

b. Explain which type of sleeper is more suitable for modern rail and why? [5]

c. Discuss the significance of - i) Check rail, ii) Coning of rail, and iii) Tilting of rail [12]

d. A 10-degree curve branches off from a 5-degree main curve in the layout of the N.G. yard in the opposite direction. Find out the maximum speed of the train on the branch line if the speed restriction on the main line is 65 km/h. Assume any reasonable value if needed. [10]

QUESTION 4 [20 MARKS]

Suppose you are the pavement engineer of a World Bank project. The project involves constructing an 8-lane divided interstate highway. Axle load distribution on that road for two-way traffic is given in Table 1. Estimate the ESAL for the peak direction if the design period is 30 years. Assume SN = 5, Pt = 2.5. [20]

Table 1: Axle Load Distribution

Axle Load Group (Kip)		Number of Axles, N	Growth rate %
Single Axle	0 – 4	150	4
	5 – 9	290	3
	10 – 14	320	2
	15 – 21	1574	5
Tandem Axle	0 – 6	62	4
	6 – 14	190	3
	15 – 25	510	2

QUESTION 5 [25 MARKS]

Design a suitable pavement of an asphalt mixture surface within a limited budget with an elastic modulus of 300,000 lb/in^2, a base layer with a structural coefficient of 0.15 on a subgrade having a resilient modulus of elasticity of 12000 lb/in^2. It takes about 2 hours for the base course and 1 week for the sub-base course to drain out the water with a saturation of 4%. Use a reliability level of 85%. Consider the value of design ESAL as calculated in question no 4 (Q4). The CBR value of the sub-base course is 20. The resilient modulus of the base course and sub-base course is 30000 lb/in^2 and 20000 lb/in^2 respectively. [25]

Formula:

$$\sigma_e = \frac{0.572P}{h^2}\left[4\log_{10}\left(\frac{\ell}{b}\right) + \log_{10} b\right]$$

$$\sigma_e = \frac{0.572P}{h^2}\left[4\log_{10}\left(\frac{\ell}{b}\right) + 0.359\right]$$

$$\sigma_i = \frac{0.316P}{h^2}\left[4\log 10\left(\frac{\ell}{b}\right) + 1.069\right]$$

$$\sigma_e = \frac{0.803P}{h^2}\left[4\log_{10}\left(\frac{\ell}{a}\right) + 0.666\frac{a}{\ell} - 0.034\right]$$

$$\sigma_e = \frac{0.803P}{h^2}\left[4\log_{10}\left(\frac{\ell}{a}\right) + 0.282\frac{a}{\ell} + 0.650\right]$$

$Y = X^3/6RL$

(1) $L = 7.20e$
(2) $L = 0.073D\ V_{max}$
(3) $L = 0.073e\ V_{max}$

$S = L^2/24R$

For BG

$S.E. = 1.315\ V^2/R$

For MG

$S.E. = 0.80V^2/R$

For NG

$S.E. = 0.60V^2/R$

For BG and MG $V = 4.4\sqrt{R-70}$

For NG $V = 3.6\sqrt{R-6}$