

4-1

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B.Sc. Engineering (Civil)

Course Title: Professional Practices and Communication
 Time: 2 Hours

Credit Hours: 2.00

Course Code: CE 403
 Full Marks: 100

Answer all the questions.

1. Construct a flow chart illustrating the tendering process. [10]
2. Demonstrate how the Bangladesh Labour Law (BLL) safeguards the rights of women workers in the workplace. [10]
3. What strategies will you employ as a Civil Engineer to implement Occupational Safety and Health (OSH) measures at a construction site? [10]
4. Apply your understanding of the concept of a profession to distinguish it from non-professional occupations, and hence demonstrate “Engineering” as a profession. [20]
5. Mr. ‘X’ is an engineer in a large construction firm. He has been assigned the task of being the sole person to recommend cement brand for the construction of a large apartment building. After some research and testing, he decides to recommend ‘ABC Cement’ manufactured by ‘ABC Company Ltd.’ for the job, which he determines is of the lowest cost and highest quality. On the day after Mr. X’s decision was made, an ‘ABC Company Ltd.’ representative visits him and gives him a voucher for an all-expense-paid trip to the annual technical conference of American Society of Civil Engineers (ASCE), which is going to be held in the USA. The trip will have considerable educational value, but will also provide day trips to the beach and other tourist places in the USA.

Apply Code of Ethics to answer the following questions:

- (i) If Mr. ‘X’ accepts the voucher, will it be considered as a bribe? [10]
- (ii) What will be the best ethical response from Mr. ‘X’? [15]
6. You are a Civil Engineer working in an engineering consultancy company. The company had a contract with a reputed foreign NGO to design a new road. You finished the preliminary design (Figure – 1) for the new road and presented it to your boss. But your

boss didn't like it because the new road is quite far from the NGO's land; so, he told you to modify it and make it close to the NGO's land (*Figure – 2*).

You said no to your boss because in that case two new bridges across the lake would need to be built (*Figure – 2*); hence the cost would be higher. Also, the road would not be practical. The boss was angry and told you if you didn't do what he wanted, the company would not get future contracts with the NGO and the staff would lose their jobs.

Investigate the provided scenario and determine the ethical implications of adhering to the boss's directive.

[25]

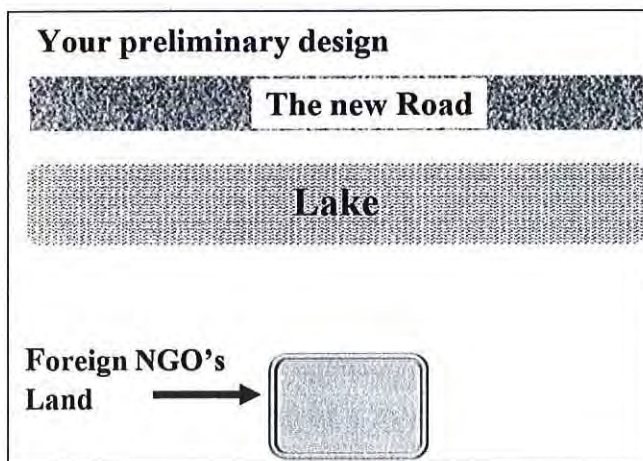


Figure – 1

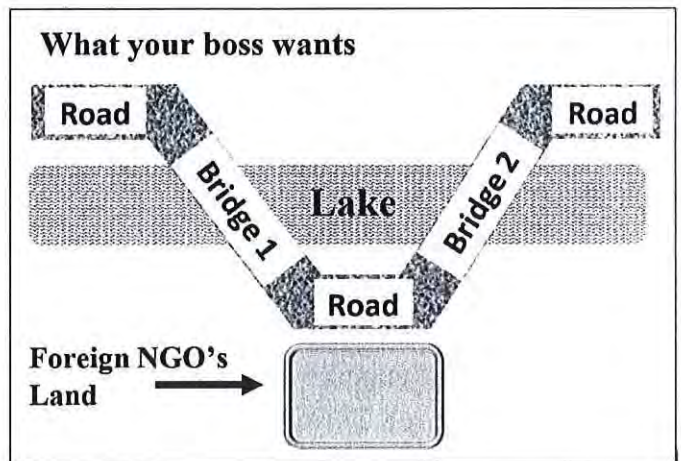


Figure – 2

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering III
 Time: 3 hours

Credit Hours: 3.0

Course Code: CE 411
 Full Marks: 100 (10× 10)

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

- Use the Energy Method to calculate the load (i) w needed to form beam mechanism, (ii) P needed to form the sidesway mechanism in the frames *abcdef* loaded as shown in **Fig.1**
 [Given: $M_{P(\text{beam})} = 100 \text{ k-ft}$, $M_{P(\text{column})} = 200 \text{ k-ft}$].
- Calculate Yield Moment and Plastic Moment capacity of the section shown in **Fig.2** if the section is made of elastic-fully plastic material
 [Given: $\sigma_{yp} = 47 \text{ ksi}$].

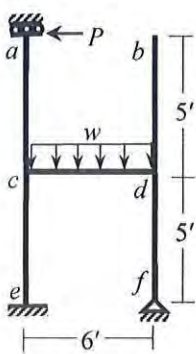


Fig.1

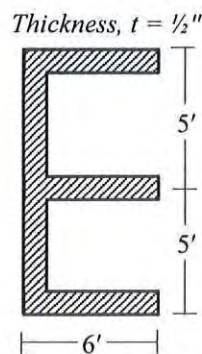


Fig.2

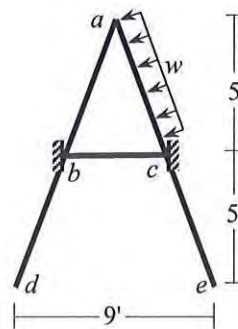


Fig.3

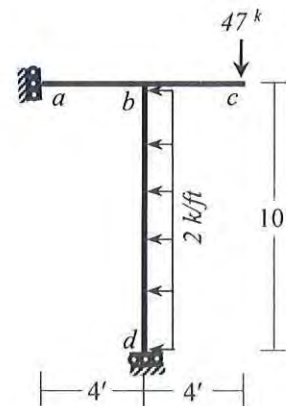


Fig.4

- Frame structure *abcde* shown in **Fig.3** is subjected to a dynamic load, $w = 5t^2 \text{ (k/ft)}$. Use *Constant Average Acceleration (CAA)* Method to calculate the rotation of joint *a* at time $t = 0.10 \text{ sec}$
 [Given: $EI = 47 \times 10^4 \text{ k-ft}^2$, $\mu = 0.01 \text{ k-sec}^2/\text{ft}^2$, *Damping ratio of the system* = 5%].
- Use Stiffness Method considering geometric nonlinearity and flexural deformations only to calculate the unknown rotation at *b* and displacements at *a* and *d* of the frame *abcd* loaded as shown in **Fig.4**
 [Given: $EI = 47 \times 10^3 \text{ k-ft}^2$].
- Determine the degree of kinematic indeterminacy (**doki**) and show the corresponding deflections and rotations of the 2D frame (**Fig.5**) and 3D frame (**Fig.8**) for the following cases
 - Not considering boundary conditions
 - Considering boundary conditions
 - Neglecting axial deformations.

6. Use Stiffness Method (neglect axial deformations) to calculate rotation at joint *a* of the frame *abcde* loaded as shown in Fig.6, if the joint *a* is a circular foundation of radius 4 ft on the surface of subsoil (half-space) with shear wave velocity (v_s) equal to 470 ft/sec
[Given: EI of the frame members = 47×10^3 k-ft², Unit weight of soil = 120 pcf, Poisson's ratio of soil material = 0.25].
7. Use Stiffness Method (neglecting axial deformations) to calculate the value of applied load *P* required to cause buckling of the frame *abc* loaded as shown in Fig.7
[Given: $EI = 47 \times 10^4$ k-ft²].

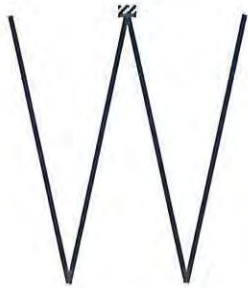


Fig.5

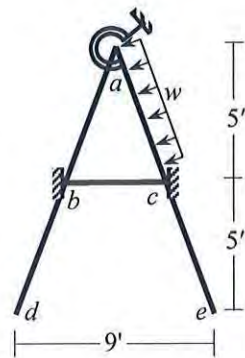


Fig.6

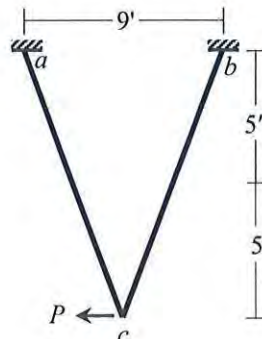


Fig.7

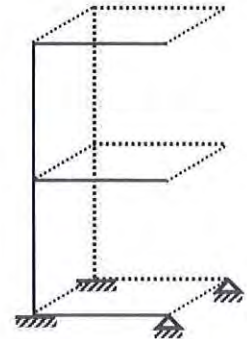


Fig.8

8. Use stiffness method (neglecting axial deformations) to calculate rotation at *c* of the 2D frame *abc* loaded as shown in Fig.7
[Given: $P = 100$ kips, $EI = 47 \times 10^3$ k-ft²].
9. Identify zero-force members of the 2D truss *abcde* loaded as shown in Fig.9. Determine the displacements of joint *c* and *d*.
[Given: $EA/L = 1200$ k/ft].
10. Calculate 1st natural frequency of the frame *abcd* shown in Fig.10 using lumped mass matrices
[Given: $EI = 47 \times 10^3$ k-ft, $\mu = 0.01$ k-sec²/ft²].

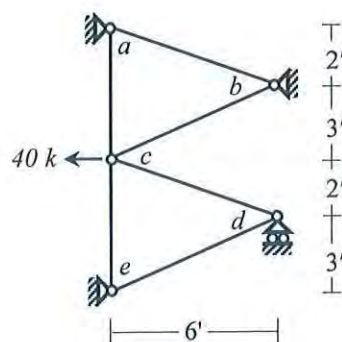


Fig.9

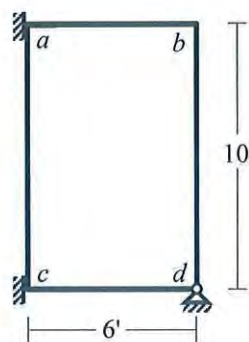


Fig.10

University of Asia Pacific
Department of Civil Engineering
Final Examination – Fall 2023
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II

Time: 3 hours

Credit Hour: 3:00

Course Code: CE 451

Full Marks: 120

1. a) Briefly discuss the economic and political advantages of railways. (5)
- b) Differentiate among different materials used for ballast. (10)
- c) Discuss rail wear and its reduction methods. (5)
- d) A 2-4-2 locomotive of N.G. is required to haul a train at 25 km/h. The axle load of the driving wheels of the engine is 50 tonnes. The train climbs a gradient of 1 in 200 where a 8 degrees curve exists. Find the maximum permissible train load that the engine can pull. (10)
- e) Compute the length of a transition curve required for a M.G. curve of five degrees. The maximum permissible speed on the curve is 210 km/h. This transition curve joins the ends of a 5° circular curve with the straight track. Set the transition curve with the straight-taking offsets at a maximum of 6 intervals. (15)
2. 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 = 3, 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

3. Design a suitable pavement structure of an asphalt mixture surface for a low-volume road with an elastic modulus of 200,000 lb/in². It rests on a subgrade having a resilient modulus of elasticity of 4000 lb/in². It takes about 1 day for the base course and 1 week for the sub-base course to drain out the water with a saturation of 6%. Alternatively, at the top layer the draining process is much quicker than the other layers. Use a reliability level of 85%. Consider the value of design ESAL as calculated in question no 2 (Q2). The R-value of the base course, sub-base course and subgrade is 75, 65, and 1 respectively. The resilient modulus of the base course and sub-base course is 30000 lb/in² and 20000 lb/in² respectively. (20)

4. Design a rigid pavement for a four-lane arterial road for a design period of 20 years using the PCA method assuming that the pavement thickness is adequate for fatigue analysis. The sub-base layer is cement treated and the thickness is 9 inches. Assume subgrade K value 50 lb/in³ and concrete modulus of rupture 690 lb/in². The pavement has asphalt shoulder on both sides of the road with doweled joints. The traffic data are as follows: (20)

Table 2: Axle Load Distribution

Single axle	Expected Repetitions
25	21,320
42.5	42,870
45	124,900
Tandem axle	Expected Repetitions
55	930,700
102	156,000
110	51,000

5. a) You have to construct a flexible pavement for the highway from Chittagong to Sylhet. The construction of the pavement will start in December (length 550 km). You need to find out the suitability of soil using AASTHO soil classification system. The results in Table 3 were obtained by a mechanical analysis. Classify the soil according to the AASHTO classification system and give the group index. Also, comment on whether you can use the soil as subgrade material in its natural state. (10)

Table 3: Sieve Analysis Report

Sieve Analysis, % Finer				
No. 10	No. 40	No. 200	Liquid Limit	Plastic Limit
84	58	8	-	N.P.

- b) What laboratory tests of soil will you conduct for the pavement construction mentioned in question 5(a)? Explain the significance of the test. (5)

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2023
Program: B. Sc. in Civil Engineering

Course Title: Environmental Engineering III

Course Code: CE 431

Time: 2.00 Hours

Credit Hour: 2.00

Full Mark: 100

Answer all the questions.

1. (a) Distinguish between aerobic and anaerobic digestion of solid waste. (5+5)
- (b) Explain the concept of 'cradle to grave' in life cycle inventory of industrial waste. (5)
- (c) Summarize the functional steps to be followed for an effective solid waste management system. (8)
- (d) Explain why bulk density of solid waste is higher in low-income countries than in industrialized countries. (5)

2. Suppose the annualized cost of purchasing, fuelling and maintaining a compactor truck is given by the following expression:

$$\text{Annualized Cost (tk /yr)} = 120,000 + 430,000 V$$

Where V is the truck volume in m^3 . Suppose, these trucks require 2 person crews, with labour charged at 5000 tk/week each.

Perform an economic analysis of the collection system in which a 15 m^3 truck collects refuse from 240 households each day. Each household generates 22 kg of refuse per week. The trucks and crew work 5 days per week and curb-side pickup is provided once a week for each house.

Determine the annual cost per ton of refuse collected and the annual cost per household.

$$[1000 \text{ kg} = 1 \text{ ton}, 1 \text{ yr} = 52 \text{ week}] \quad (5+5)$$

3. Determine the required net and gross area for landfill site for a community for the year 2023 from the following data:

Projected population: 1,00,000

Per capita waste generation rate: 4.1 lb/capita/day

30% of the generated solid waste is recycled.

Compacted waste density: 40 lb/ft^3

Assume a soil daily cover is used that accounts for 15% of the landfill volume and also 30% of the landfill site will consist of leachate treatment facility, control office building, electrical sub-station, roads etc.

$$1 \text{ ft}^2 = 2.295 \times 10^{-5} \text{ acre}; \quad 1 \text{ m}^2 = 0.000247 \text{ acre} \quad (5+5)$$

4. (a) Summarize the benefits of transfer station. (6)
- (b) As an engineer tasked with designing a solid waste management system for a newly developed community, propose two innovative strategies to ensure environmental sustainability and scalability for future needs. Discuss how each strategy addresses both present and future demands. (3+3)
- (c) Recommend improvements for the different stages of informal recycling in developing countries. (6)
5. (a) Explain the two procedures used by EPA to define wastes as “hazardous”. (3+3)
- (b) Summarize the healthcare waste management practices in Bangladesh. (6)
- (c) Explain briefly the treatment options for leachate of different categories. (7)
6. Estimate the energy content of a typical 50 kg sample of wet municipal solid waste. (15)

Type	Wet Mass (kg)	Moisture Content
Food Waste	40	70%
Paper	10	6%
Total	50	

Given:

Table: Typical data on ultimate analysis of combustible materials found in solid waste

Type	% by weight (dry basis)					
	C	H	O	N	S	Ash
Food Waste	73	11.5	14.8	0.4	0.1	0.2
Paper	43.3	5.8	44.3	0.3	0.2	6

$$\text{Energy Content (KJ/kg)} = 337 C + 1428 [H - (O/8)] + 9 S$$

Where C = carbon %, H = hydrogen %, O = oxygen % and S = sulfur %

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B. Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II

Time: 3 Hours

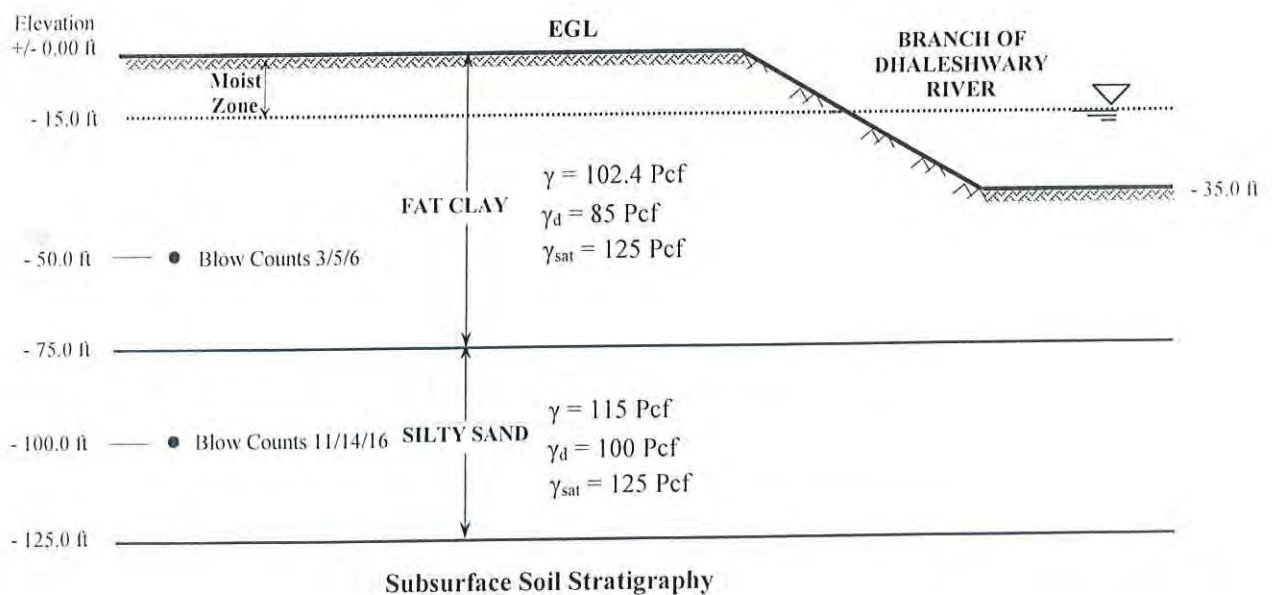
Credit Hours: 3.0

Course Code: CE 441

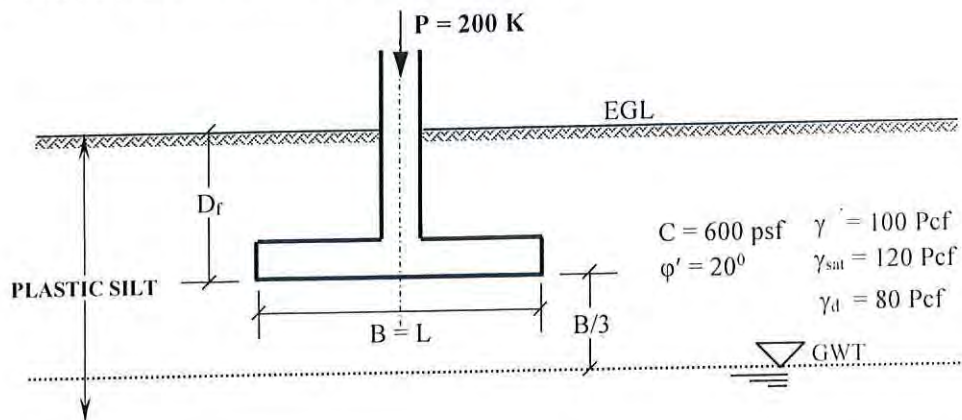
Full Marks: 120

Answer all the questions

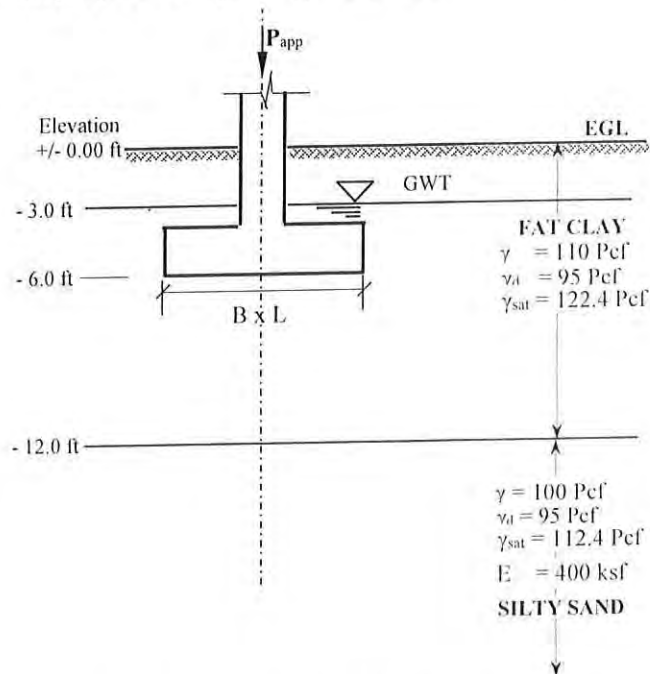
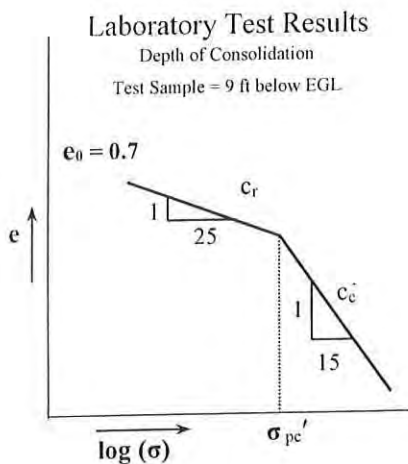
1. (a) Mention the name of the in-situ test most frequently used in Bangladesh. Write a short note on this test. 1 + 5 = 6
 (b) Compare on the extent and significant depth up to which exploration is generally intended from the perspective of geotechnical engineering with other types of exploration as such in the field of agronomy and petroleum engineering. 6
 (c) Write a very short note on the occurrence degree of disturbances that are inherent during sampling of cohesive and cohesionless soil. Is it possible to collect absolutely undisturbed sample? Justify your answer. 6
 (d) Mention the preliminary information that should be available to conduct a subsurface exploration program for a bridge project. 2
 (e) Write short note on any one of the following: 3
 (i) Location of boreholes for a conventional building project (ii) Cone penetration test
 (f) Column load at a location for a site is estimated to be 288 Kips. The site is explored to a depth of 20 feet below EGL. Assuming an anticipated bearing capacity of 2.0 ksf for a square footing check whether the exploration is sufficient or not. Assume the foundation level to be about 5 feet below EGL. Justify your answer utilizing 10% stress criterion. 7
2. Subsurface stratigraphy and other information as obtained at a site for BH-1 are summarized in the figure below. Using hammer efficiency 54%, determine the field SPT values and estimate the corrected SPT values as required for both boreholes. Also determine undrained cohesion and angle of internal friction for clay and sand. 10



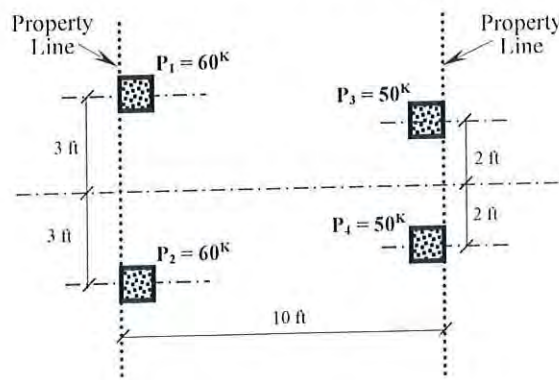
3. Using General Bearing Capacity Equation (GBCE), design the size of the square footing for long term condition as shown below. Use a factor of safety of 2.5 and $B = 2 D_f$. 15



4. 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 $q_a = p_{\text{app}} = 5.0 \text{ ksf}$. 15

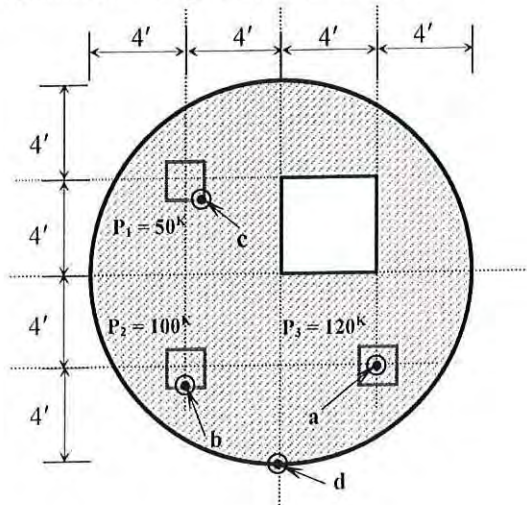


5. (a) Design the size of a combined footing for the loading, subsurface and boundary conditions as provided. All columns have x-sectional dimension of 12 in by 12 in. Use $q_a = 2.5 \text{ ksf}$. 9



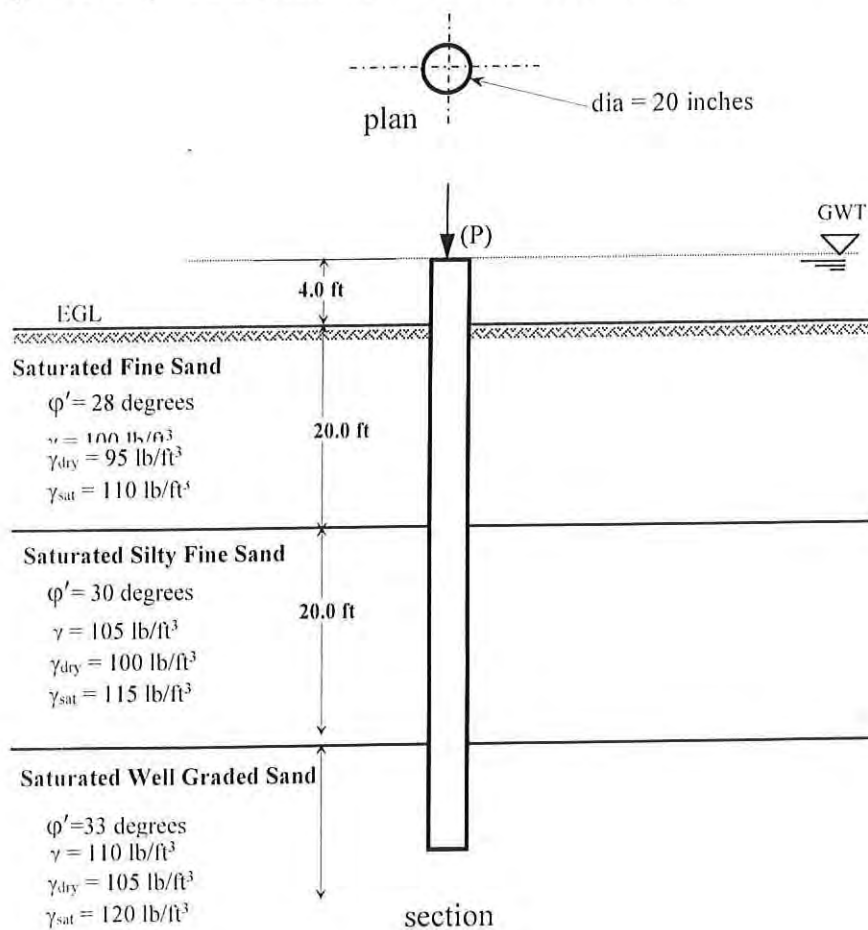
(b) The plan of a mat foundation with column loads and dimensions is shown in the following figure. Calculate the soil pressures at points a, b, c d and at the geometric centroid of the foundation (All the columns are 12 by 12 inches in size).

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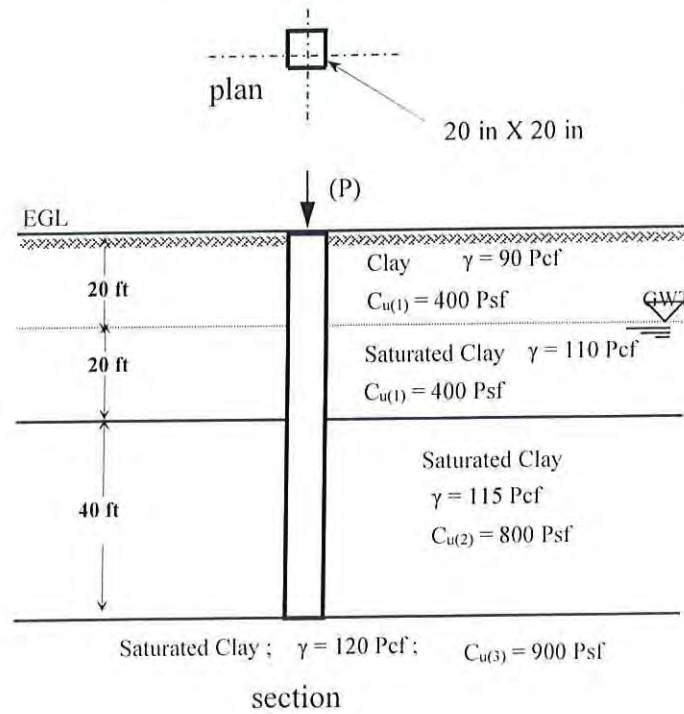
- 6 (a) The plan and X-section of a 54-foot long single bored concrete pile (circular) in different sand deposits are shown below. Estimate the allowable capacity of the single pile. ($N_q^* = 25$ for $\phi' = 28$ degrees; $N_q^* = 32$ for $\phi' = 30$ degrees; $N_q^* = 52$ for $\phi' = 33$ degrees)

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(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 nine piles. Use spacing of piles = 2.5 times the minimum dimension of the piles. Finally, estimate the design capacity.

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University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B.Sc. in Civil Engineering

Course Title: Structural Engineering V (Prestressed Concrete)

Time: 2 hours

Credit Hour: 2

Course Code: CE 415

Full Marks: 100

QUESTION 1

An I-shaped bonded beam, as shown in Figure 1, is prestressed by prestressing steel with an effective stress of 150 ksi where $A_{ps} = 3 \text{ in}^2$. The c.g.s. of the strands is 4 inch from the bottom of the beam. Analyze the beam to obtain the ultimate resisting moment following the ACI code. Material properties are, $f_{pu} = 270 \text{ ksi}$, $f'_c = 6 \text{ ksi}$. [20]

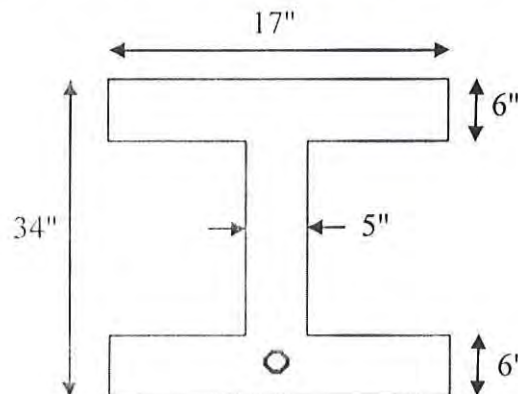


Figure 1

QUESTION 2

(a) Design a preliminary section of a prestressed concrete beam to resist a total moment of 350 k-ft including girder self-weight moment of 80 k-ft. Assume a trial depth of the section of 38 inch. The effective prestress (f_{se}) for steel is 120 ksi, and allowable compressive stress for concrete under working load (f_c) is (-)1.5 ksi. An I-section is preferred for the solution where the thickness of flanges and web not exceeding 4 inch. [10]

(b) Considering the preliminary section obtained in 2(a) and allowing tension in the concrete, design the final section of the beam. [20]

[Given, $f_t = -1.8 \text{ ksi}$, $f_b = -2 \text{ ksi}$, $f'_t = 0.35 \text{ ksi}$, $f'_b = 0.3 \text{ ksi}$, $f_{\theta} = 145 \text{ ksi}$, $F_{\theta} = 200 \text{ kips}$].

QUESTION 3

A 35 ft long simply supported beam, as shown in **Figure 2**, supports a superimposed dead load of 300 lb/ft and a short-term service live load of 600 lb/ft in addition to its own weight. The cross section of the beam is shown in **Figure 1**. The c.g.s. is 4 inch from the bottom fiber throughout the beam, and $A_{ps} = 3 \text{ in}^2$. Analyze the beam to obtain: [20]

(a) the ultimate shear strength of concrete at Section 1-1 of the beam.

(b) the initial and long-term deflections at midspan of the beam.

[15]

[Given, $f_{pi} = 180 \text{ ksi}$, $f_{se} = 150 \text{ ksi}$, $f_{pu} = 270 \text{ ksi}$, $f_c' = 6 \text{ ksi}$, creep coefficient = 3, $E_c = 4000 \text{ ksi}$, unit weight of concrete = 150 lb/ft^3]

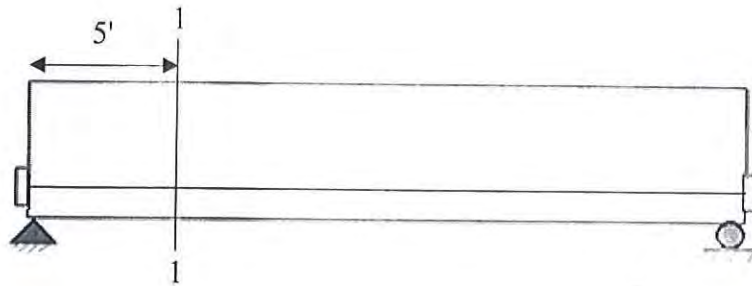


Figure 2

QUESTION 4

With neat sketches, explain the stress distribution of a composite prestressed section at different stages of loading. [15]

Formula

- $M_G/M_T \leq 20\%, F = \frac{M_L}{0.5h}$
- $M_G/M_T \geq 20\%, F = \frac{M_T}{0.65h}$
- $A_c = A_{ps} f_{se} / 0.5f_c$
- **Elastic design, allowing tension:**

$$e_1 + e_2 = \frac{M_G + f_t' A k_b}{F_0}, F = \frac{M_T - f_b' A k_t}{k_t + e}$$

$$A_c = \frac{F_0 h}{f_b c_t - f_t' c_b} \text{ (at transfer), } A_c = \frac{F h}{f_t c_b - f_b' c_t} \text{ (under working load)}$$

$$A_c = \frac{F_0}{f_b} \left(1 + \frac{e - (M_G/F_0)}{k_t} \right) \text{ (at transfer),}$$

[where f_b & f_t are absolute values]
- $v_{cw} = 3.5\sqrt{f_c'} + 0.3f_{pc} + \frac{V_p}{b_w d}$
- $V_{cw} = (3.5\sqrt{f_c'} + 0.3f_{pc}) b_w d + V_p$
- $v_u = \frac{V_u}{\Phi b_w d}, \Phi = 0.75$
- $M_{cre} = \frac{1}{y_t} (6\sqrt{f_c'} + f_{pe} - f_0)$
- $V_{ci} = 0.6 b_w d \sqrt{f_c'} + V_0 + \frac{V_{d+1} M_{cre}}{M_{d+1}}$
- $1.7\sqrt{f_c'} b_w d, 5\sqrt{f_c'} b_w d$
- $A_v = 0.75\sqrt{f_c'} \frac{b_w S}{f_{yt}} \quad A_v = \frac{50 b_w S}{f_{yt}} \quad A_v = \frac{A_{ps} f_{pu} S}{80 f_y d_p} \sqrt{\frac{d_p}{b_w}}$
- **Deflection at midspan of a simply supported beam due to uniform load, $\Delta = \frac{5wL^4}{384EI}$**
- **Deflection at midspan of a simply supported beam due to end moments, $\Delta = \frac{ML^2}{8EI}$**
- **Deflection at midspan of a simply supported beam due to concentrated load, $\Delta = \frac{PL^3}{48EI}$**
- $w = \frac{8Fh}{L^2}$
- $p_p = \frac{A_{ps}}{bd}$
- $T' = A_{ps} f_{ps}$
- $f_{ps} = f_{pu} (1 - 0.5 p_p \frac{f_{pu}}{f_c'})$
- $w_p = p_p f_{ps} / f_c' < 0.30$
- $A_{pf} = 0.85 f_c' (b - b_w) h / f_{ps}$
- $A_{pw} = A_{ps} - A_{pf}$
- $M_u = \Phi [A_{pw} f_{ps} (d - a/2) + 0.85 f_c' (b - b_w) h (d - h_f/2)]$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B.Sc. Engineering (Civil)

Course title: Irrigation and Flood Control
 Time: 3 Hours

Course code: CE 461
 Full marks: 50

There are FIVE (5) questions. Answer all questions. Assume any missing data.

1. a) In between *basin flooding irrigation method* and *drip irrigation method*, which irrigation method is most appropriate for Bangladesh? Justify your answer. 3
- b) An irrigation project located in Sirajganj district of Bangladesh diverts surface water from Jamuna river through a canal for irrigating an area of 6150 hectares, Based on the data and information provided in the **figure 1** and **table 1** below, calculate the following for the period from January to March: 5
 - Consumptive Water Use (C_u);
 - Consumptive Irrigation Requirement (C.I.R.);
 - Net Irrigation Requirement (N.I.R.);
 - Field Irrigation Requirement (F.I.R.);
 - Gross Irrigation Requirement (G.I.R.);
 - Volume of water required to be diverted from the head works.

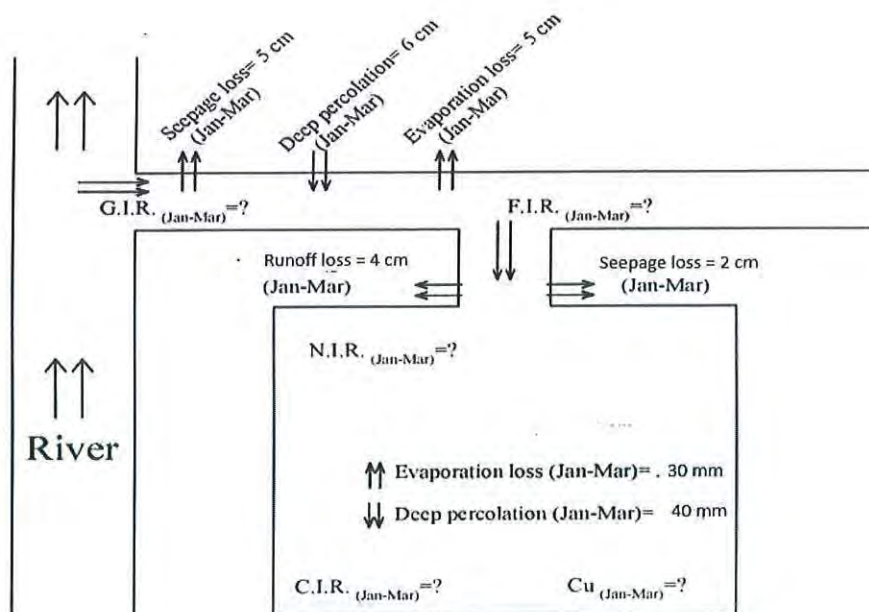


Figure 1

Table 1

Month	Monthly temperature (°C) averaged over the last 5 years	Monthly percent of day time hour of the year computed from the Sun-shine	Useful rainfall in cm averaged over the last 5 years	Crop factor
January	16.0	7	1.25	0.9
February	21	7.5	1.43	0.85
March	22.5	8	2.1	0.91

c) Find out the following by analyzing the data and information provided in **figure 2** below:

8

- Discharge required at the potato field (Q_1);
- Discharge required at the wheat field (Q_2);
- Discharge required at rice field (Q_3);
- Discharge required at sugarcane field (Q_4);
- Actual discharge required at the head of the distributary canal (Q);
- Design discharge required at the head if time factor is 0.89;
- Average discharge required at the head of the distributary canal if capacity factor is 0.84.

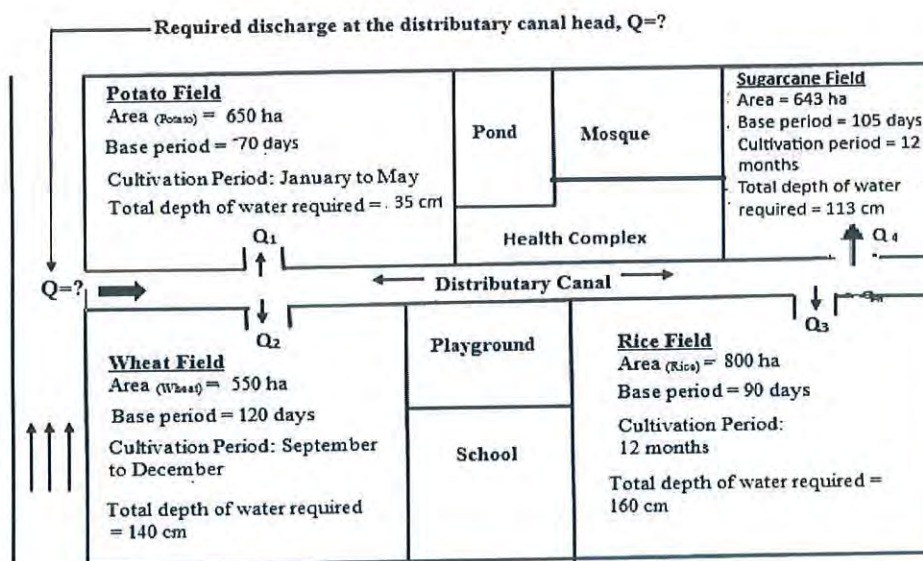


Figure 2

2. a) Explain the following: i) Regime channel; ii) Alluvial soil; iii) Critical velocity ratio. 4
- b) You are recently recruited as an assistant engineer in the design circle of the Bangladesh Water Development Board (BWDB) and posted in Barishal. Executive engineer of BWDB, Gazipur office, assigned you a task to design a lined canal on alluvial soil having the following data: 7
- Full supply discharge = $R \text{ m}^3/\text{sec}$
 - Side slope = 1.50:1
 - Bed slope = 1 in 5000
 - Rugosity coefficient = 0.018
 - Permissible velocity = 1.50 m/sec
 - $R = 50 + \text{last digit of your registration number}$
- Design the canal.
3. a) Explain the following with neat sketches: i) Aqueduct; ii) Level crossing. 3
- b) By analyzing the data and information provided in **figure 3**, find out the following: 8
- water conveyance efficiency
 - water application efficiency
 - water storage efficiency
 - water distribution efficiency

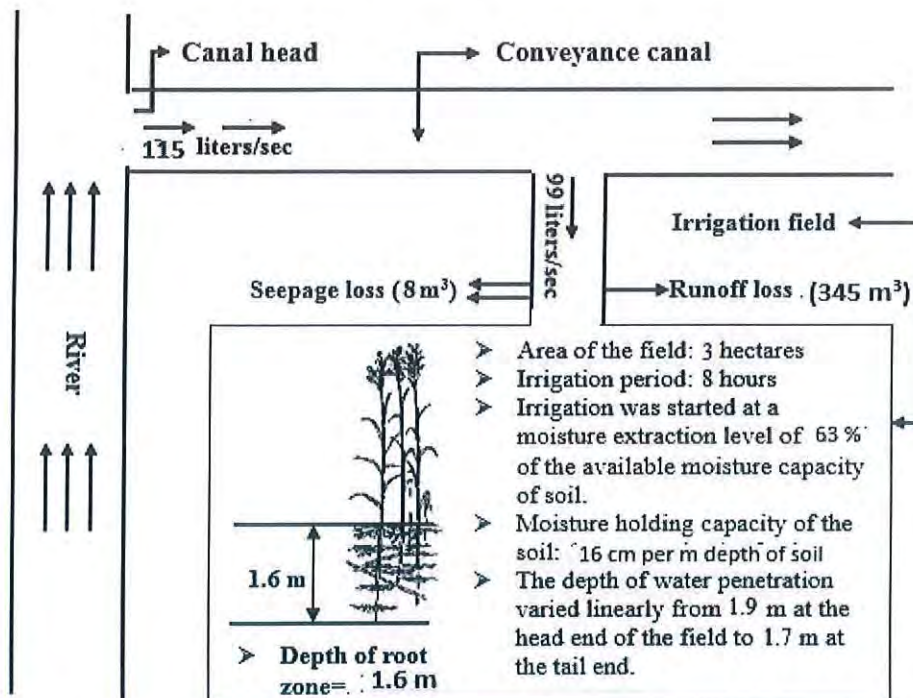


Figure 3

4. Select and explain three structural and three non-structural measures of flood management that you think are most important for flood management in Bangladesh. Justify your answer. 4
5. a) Explain with justification why integrated water resources management through involving all riparian countries of the Ganges basin (i.e., Nepal, India, and Bangladesh) is important for ensuring sustainable flood management in Bangladesh. 4
- b) Prepare the following for flood management in your own village/locality: 4
- Flood hazard map and risk map;
 - Flood risk management plan