University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2022
Program: B.Sc. Engineering (Civil)

Course Title: Project Planning and Management | Course Code: CE 401
Time: 3 Hours | Credit Hours: 3.00 | Full Marks: 150

Answer all the questions.

1. (i) Distinguish between Act and Rules and in this connection explain the functionality of PPA 2006 and PPR 2008. **[08]**

   (ii) What are the provisions to extend Tender Validity Period? Briefly describe in accordance with Public Procurement Rules (PPR), 2008. **[07]**

2. The network of a bridge construction project is shown in **Figure 1**, along with the duration of each activity. Analyze the network to determine the Earliest and Latest Event Time of each activity. **[20]**

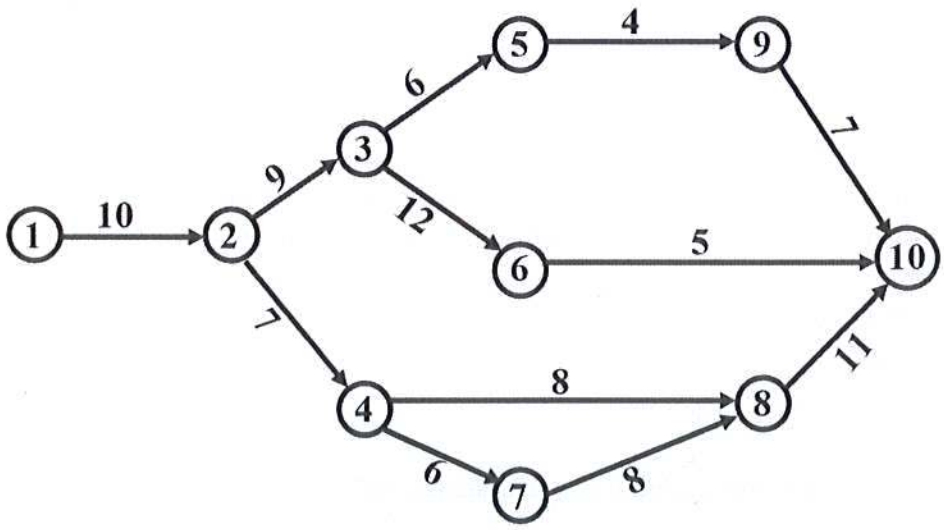

Figure 1

3. (i) Analyze the network shown in **Figure 1** to compute the followings:

   (a) Activity Time (EST, EFT, LST, LFT) of each activity. **[20]**
   (b) Total Float of each activity. **[05]**

   (ii) Detect the critical path on the network. **[05]**

4. The XYZ Company has been a producer of picture tubes for television sets and certain printed circuits for radios. The company has just expanded into full scale production and marketing of AM and AM-FM radios. It has built a new plant that can operate 48 hours per week. Production of an AM radio in the new plant will require 2 hours and production of an AM-FM radio will require 3 hours. Each AM

radio will contribute Tk. 40 to profits while an AM-FM radio will contribute Tk. 80 to profits. The marketing department, after extensive research has determined that a maximum of 15 AM radios and 10 AM-FM radios can be sold each week.

(i) Figure out the objective function and constraint equations as a linear programming problem for the above-mentioned case. **[05]**

(ii) Investigate using **Graphical method** to find out the number of radios of each type that should be produced by the company to achieve the maximum profit. **[15]**

5. Suppose that your company is planning to make investment to a new project. The initial cash outflow for the project will be Tk. 280,000. The cash inflows at first, second, third and fourth years are expected to be Tk. 72,000, Tk. 97,000, Tk.105,000 and Tk. 110,000 respectively.

Investigate the above-mentioned information to determine the followings:

(i) Net Present Value (NPV) for a discount rate of 13%. **[15]**

(ii) Internal Rate of Return (IRR). **[20]**

6. (i) Explain the necessity of a multi-professional team in conducting Feasibility Study. Differentiate between Financial Feasibility and Economic Feasibility. **[07+08]**

(ii) The ABC Company estimates its annual holding cost at 10% of its acquisition cost and ordering cost at Tk. 5 per order. The estimated half yearly requirement is 200 units at a price of Tk. 1 per unit.

Analyze the above data/information to calculate the followings:

(a) Economical Order Quantity (EOQ) in units. **[05]**
(b) Economical Order Quantity (EOQ) in Tk. **[04]**
(c) Number of orders per year. **[03]**
(d) Time elapsed between orders. **[03]**

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University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2022
Program: B. Sc. Engineering (Civil)

Course Title: Structural Engineering III Credit Hours: 3.0 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 rotation of joint ***a*** and ***c*** of the frame ***abcd*** loaded as shown in ***Fig.1***, if the joint ***c*** is a circular foundation of radius 4.5 ft on the surface of subsoil (half-space) with shear wave velocity (v_s) equals to 900 ft/sec
[Given: $EI = 45 \times 10^3$ *k-ft²*, $\gamma_{soil} = 120$ *pcf*, Poisson's ratio of soil, $\nu = 0.25$].

2. Determine the degree of kinematic indeterminacy (**doki**) and show the corresponding deflections and rotations of the 2D frames (***Fig.2*** and ***Fig.6***) and 3D frame (***Fig.3***) for the following cases
   (i) Not considering boundary conditions
   (ii) Considering boundary conditions
   (iii) Neglecting axial deformations.

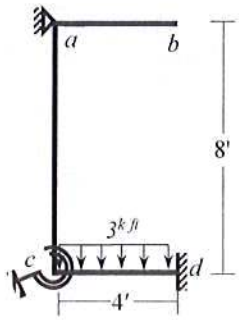


Fig.1


Fig.2

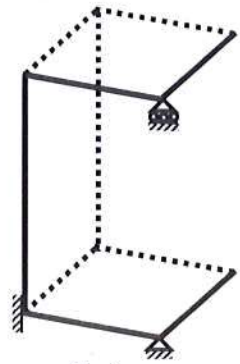


Fig.3

3. Use Stiffness Method considering flexural deformations only to calculate the unknown deflection at ***c*** and rotation at ***b*** of the frame ***abc*** loaded as shown in ***Fig.4***
[Given: $EI = 45 \times 10^4$ *k-ft²*]

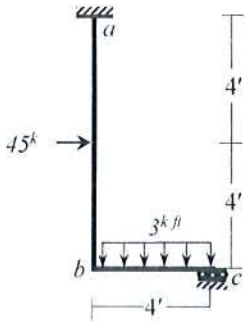


Fig.4

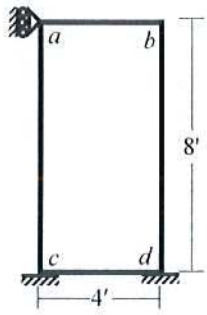


Fig.5


Fig.6

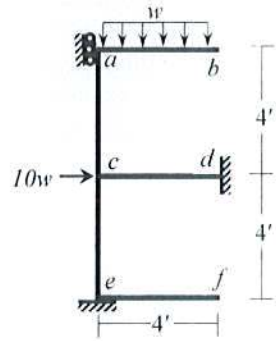


Fig.7

4. Calculate 1st natural frequency of the frame ***abcd*** shown in ***Fig.5*** using consistent mass matrices (Considering rotations at ***a*** and ***b*** only)
[Given: $EI = 45 \times 10^3$ *k-ft²*, $\mu = 0.0045$ *k-sec²/ft²*].

5. Use Stiffness Method (neglecting axial deformations) considering geometric nonlinearity to calculate w required for buckling of the frame ***abcdef*** loaded as shown in ***Fig.7***
[Given: EI = 60×10^3 *k-ft²*].

6. Frame structure ***abcde*** shown in ***Fig.8*** is subjected to uniformly distributed dynamic load, $w = 4.5e^{t}$ *(k/ft)*. Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***c*** at time $t = 0.10$ sec [Given: $EI = 45\times10^{4}$ *k-ft²*, $\mu = 0.0045$ *k-sec²/ft²*, *Damping ratio of the system = 4.5%*].

7. In the frame ***abcd*** loaded as shown in ***Fig.9***, use the Energy Method to calculate the load
   (i) ***w*** needed to form beam mechanism,
   (ii) ***P*** needed to form the sidesway mechanism
   [Given: $M_{P\,(beam)} = 100$ *k-ft*, $M_{P\,(column)} = 200$ *k-ft*].

8. Calculate Yield Moment and Plastic Moment capacity of the section shown in ***Fig.10*** if the section is made of elastic-fully plastic material
   [Given: $\sigma_y = \sigma_{yp} = 50$ *ksi*].

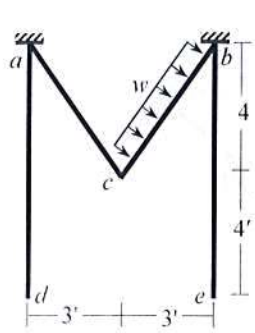


Fig.8

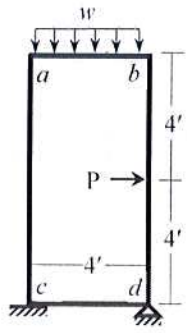


Fig.9

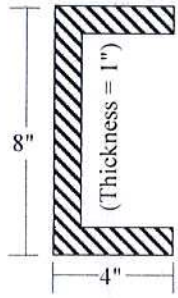


Fig.10

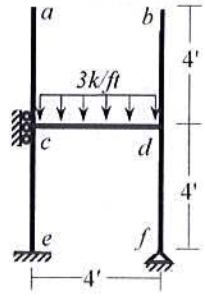


Fig.11

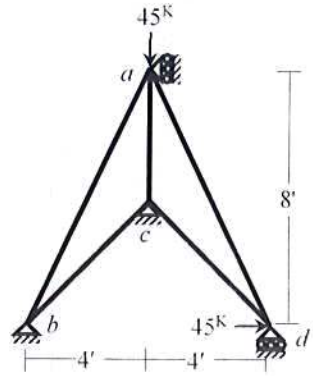


Fig.12

3'

9. Use Stiffness Method considering geometric nonlinearity and flexural deformations only to calculate the unknown rotations at ***d*** and ***f*** of the frame ***abcdef*** loaded as shown in ***Fig.11***
   [Given: $EI = 45 \times 10^{3}$ *k-ft²*].

10. In the 2D truss ***abcd*** loaded as shown in ***Fig.12***
    (i) Identify zero-force members.
    (ii) Determine the displacements of joints ***a*** and ***d***.
    (iii) Calculate all member forces
    [Given: $EA/L = 1200$ *k/ft*].

List of Useful Formulae for CE 411

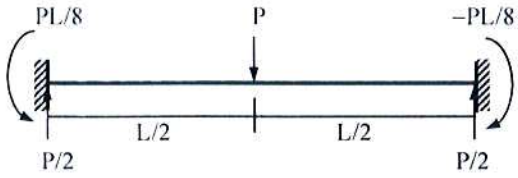
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

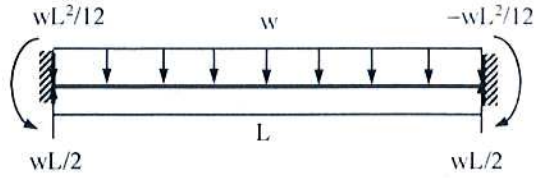
$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

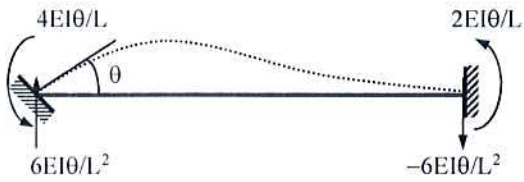
and Truss member force, $P_{AB} = S_x [(u_B - u_A) C + (v_B - v_A) S]$

[where $C = \cos\theta$, $S = \sin\theta$]

Fixed End Reactions for One-dimensional Prismatic Members under Typical Loadings







* The stiffness matrix of a 3D truss member in the global axes system [using $C_x = \cos\alpha$, $C_y = \cos\beta$, $C_z = \cos\gamma$] is

$$\mathbf{K_m}^G = S_x \begin{pmatrix} C_x^2 & C_xC_y & C_xC_z & -C_x^2 & -C_xC_y & -C_xC_z \\ C_yC_x & C_y^2 & C_yC_z & -C_yC_x & -C_y^2 & -C_yC_z \\ C_zC_x & C_zC_y & C_z^2 & -C_zC_x & -C_zC_y & -C_z^2 \\ -C_x^2 & -C_xC_y & -C_xC_z & C_x^2 & C_xC_y & C_xC_z \\ -C_yC_x & -C_y^2 & -C_yC_z & C_yC_x & C_y^2 & C_yC_z \\ -C_zC_x & -C_zC_y & -C_z^2 & C_zC_x & C_zC_y & C_z^2 \end{pmatrix}$$

$C_x = L_x/L$, $C_y = L_y/L$, $C_z = L_z/L$
where $L = \sqrt{[L_x^2 + L_y^2 + L_z^2]}$

* Member force $P_{AB} = S_x [(u_B - u_A) C_x + (v_B - v_A) C_y + (w_B - w_A) C_z]$
* Torsional stiffness $T_l = GJ/L$
* Ignoring axial deformations, the matrices $\mathbf{K_m}^L$ and $\mathbf{G_m}^L$ of a frame member in the local axis system are

$$\mathbf{K_m}^L = \begin{pmatrix} S_1 & S_2 & -S_1 & S_2 \\ S_2 & S_3 & -S_2 & S_4 \\ -S_1 & -S_2 & S_1 & -S_2 \\ S_2 & S_4 & -S_2 & S_3 \end{pmatrix} \qquad \mathbf{G_m}^L = (P/30L) \begin{pmatrix} 36 & 3L & -36 & 3L \\ 3L & 4L^2 & -3L & -L^2 \\ -36 & -3L & 36 & -3L \\ 3L & -L^2 & -3L & 4L^2 \end{pmatrix}$$

where $S_1 = 12EI/L^3$, $S_2 = 6EI/L^2$, $S_3 = 4EI/L$, $S_4 = 2EI/L$

* $\mathbf{K_{total}} = \mathbf{K} + \mathbf{G}$, buckling occurs (i.e., $P = P_{cr}$) when $|\mathbf{K_{total}}| = 0$

* For sections of Elastic-Fully-Plastic material, $A_t = A_c = A/2$, and $M_p = A_c\, \bar{y}_c + A_t\, \bar{y}_t$
* For RC sections, $M_p = A_s f_y (d - a/2)$, where $a = A_s f_y/(0.85 f_c' b)$
* Virtual work done by external forces (δW_E) = Virtual work done by internal forces (δW_I)
* For simply supported beams under (i) concentrated midspan load $P_u = 4 M_p/L$, and (ii) UDL $w_u = 8 M_p/L^2$
* For fixed-ended beams under (i) concentrated midspan load $P_u = 8 M_p/L$, and (ii) UDL $w_u = 16 M_p/L^2$
* For hinged-fixed ended beams under UDL $w_u = 11.66 M_p/L^2$

* Using CAA Method, $(m + c\Delta t/2 + k\Delta t^2/4)a_{i+1} = f_{i+1} - ku_i - (c + k\Delta t)v_i - (c\Delta t/2 + k\Delta t^2/4)a_i$
  [m = Total mass, c = Damping = $2\xi\sqrt{(km)}$, where ξ = Damping Ratio]
  Also $v_{i+1} = v_i + (a_i + a_{i+1})\Delta t/2$, and $u_{i+1} = u_i + v_i \Delta t + (a_i + a_{i+1})\Delta t^2/4$, starting with $a_0 = (f_0 - cv_0 - ku_0)/m$

* Lumped- and Consistent-Mass matrix for axial rod

$$\mathbf{M_m} = (\mu L/2) \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad \mathbf{M_m} = (\mu L/3) \begin{pmatrix} 1 & 0.5 \\ 0.5 & 1 \end{pmatrix}$$

Consistent-Mass matrix for beam [μ = Mass per unit length]

$$\mathbf{M_m} = (\mu L/420) \begin{pmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{pmatrix}$$

* At natural frequency (i.e., $\omega = \omega_n$), $|\mathbf{K} - \omega_n^2 \mathbf{M}| = 0$
* Stiffness of Circular Surface Foundations on Half-Space

Motion	Horizontal	Vertical	Rotational	Torsional
$K_{Halfspace}$	$8G_sR/(2-\nu)$	$4G_sR/(1-\nu)$	$8G_sR^3/(3-3\nu)$	$16G_sR^3/3$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2022
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) Write, in short, three purposes of subsurface exploration (geotechnical). Step down the phases (mention names only) of geotechnical subsurface exploration. 3+2 = 5

   (b) Make a comparison on the extent and significant depths up to which exploration is generally intended from the perspective of geotechnical engineering with other types of exploration as such in the field of agricultural and petroleum engineering. 6

   (c) Mention four observations that should be noted by a good geotechnical engineer while visually inspecting the site as a part of reconnaissance phase of a subsurface exploration program. 4

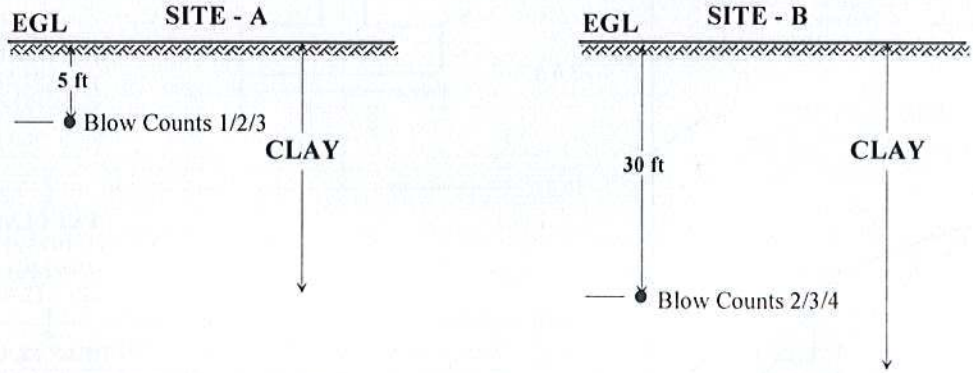
   (d) Write a short note about your understanding on disturbed and undisturbed samples. 6

   (e) Write short notes (any two): 4

   (i) Drilling & logging (ii) Pressuremeter test

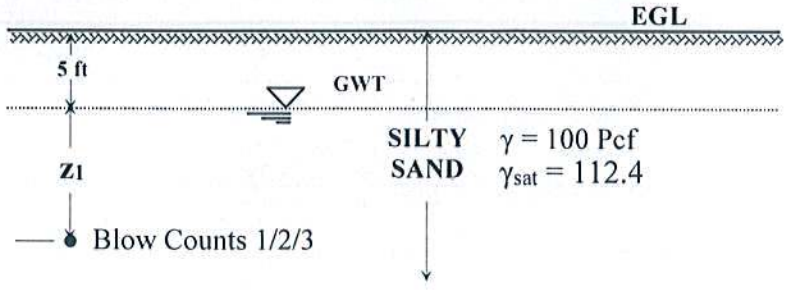
2. (a) Column load at a location for a site is estimated to be 288 Kips. The site is explored to a depth of 20 feet below EGL. Assuming an anticipated bearing capacity of 2.0 ksf for a square footing check whether the exploration is sufficient or not. Assume the foundation level to be about 5 feet below EGL. Justify your answer in consideration to 10% stress criterion. 7

   (b) A sample was collected from a site, **SITE - A** having a borehole diameter of 4 inches and hammer efficiency of 0.5. CF_{60} for this site was estimated to be 0.75. Determine whether liner was used or not at this site. With the same sampler, having same hammer efficiency another sample was sampled from **SITE - B**. CF_{60} for this site was estimated to be of 1.15. Determine the diameter of the borehole drilled at the second site. Also estimate the shear strength parameters (c) for these two sites. 6

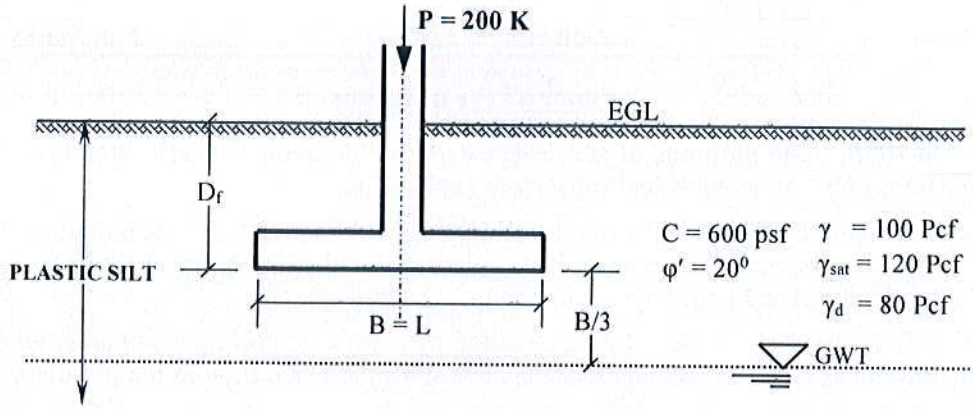


   (c) A standard penetration test (SPT) was conducted at a site. Using the following information relevant to this test, compute z_1. 7

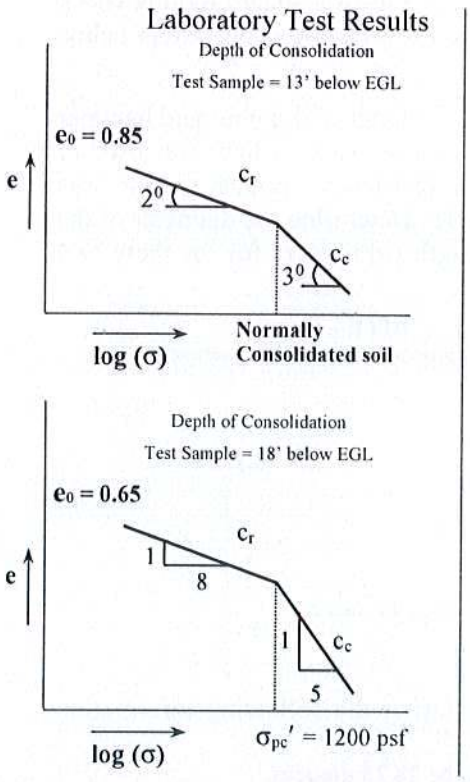
   - Angle of internal friction of the sand sample was estimated to be 28.25 degrees.
   - CF_{60} was estimated to be 1.0

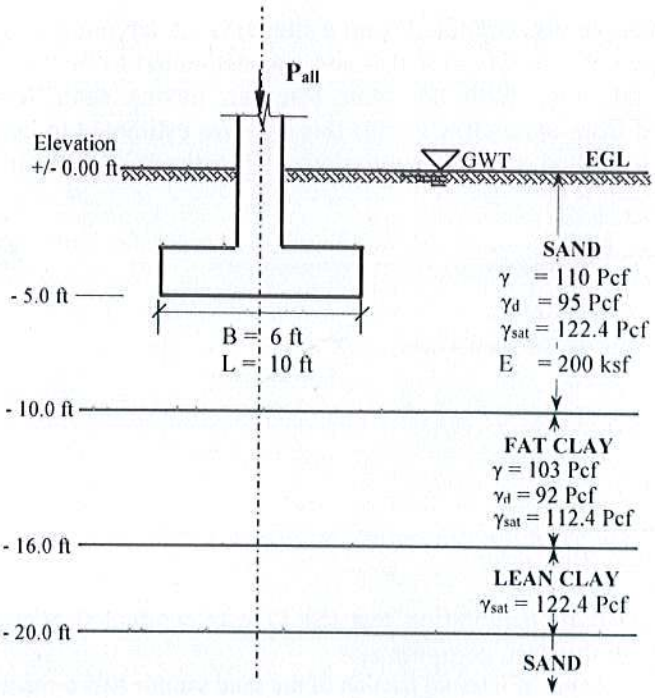


3. (a) Using General Bearing Capacity Equation (GBCE), design the size of the square footing for the conditions as shown below. Use a factor of safety of 2.5 and B = 2 D_f. Assume D_f/B < or =1. 11



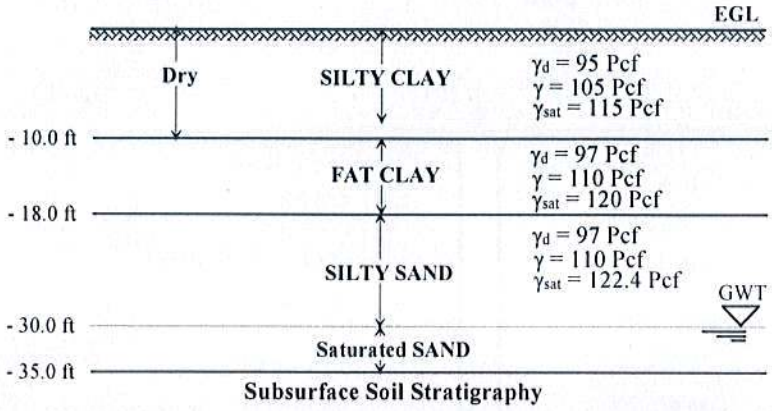
(b) A footing designed as per allowable bearing capacity based on shearing failure is shown in the following figure. Estimate settlements for both sand and clay layers. Use $q_a = p = 2.4$ ksf. 14



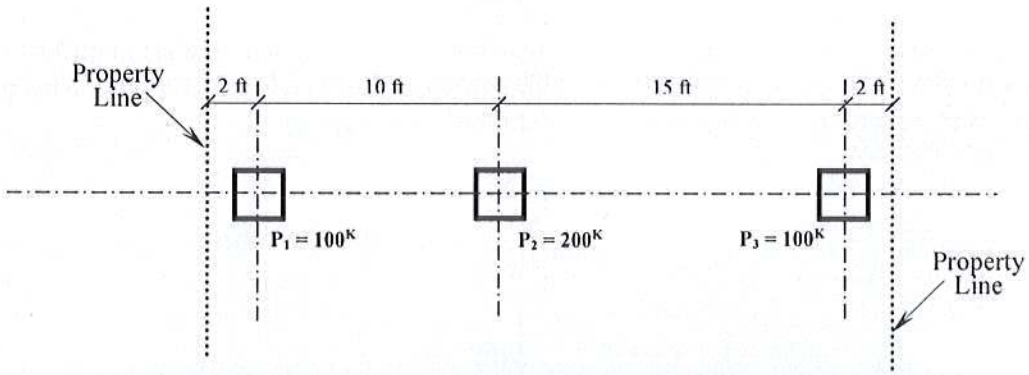


4. (a) Depict and write short notes on general and local shear failure patterns for shallow foundation. 5

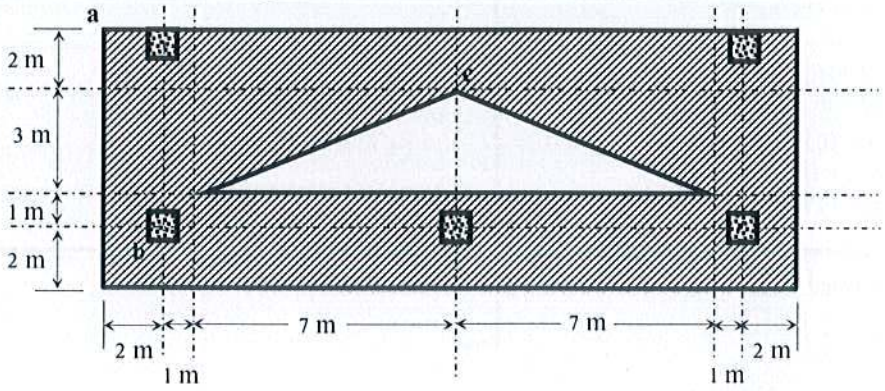
(b) For fully compensated condition and soil stratigraphy as shown below, determine whether the bearing capacity is adequate for a 15-storied building. Consider depth of bottom of a mat foundation 33 ft below EGL and uniformly distributed floor load 300 psf. 5



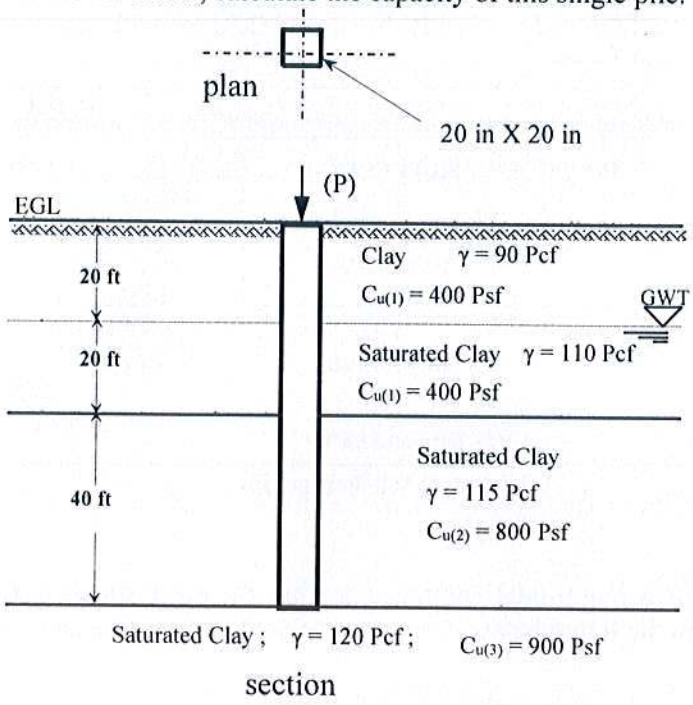
5. (a) Design the size of a trapezoidal combined footing for the loading, geometric and boundary conditions as shown in the figure below. Consider allowable bearing capacity as 3.0 ksf. 8



(b) The plan of a mat foundation is shown below. Column load for all corner columns is 400 kN each and other column is 800 kN. Size of each columns 800 mm by 800 mm. Calculate soil pressures at points a, b, c and at the geometric centroid of the mat foundation. 12

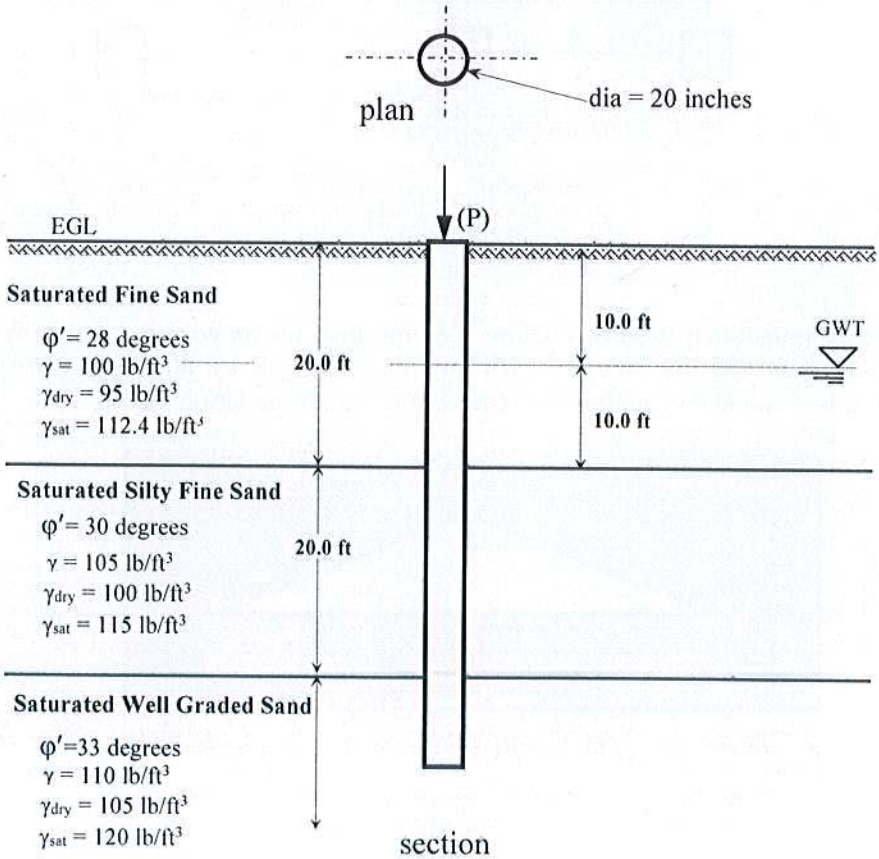


6. (a) The plan and X-section of an 80-foot long single pre-cast driven pile (square) is shown below. For the soil stratigraphy as shown below, calculate the capacity of this single pile. 8



section

(b) The plan and X-section of a 50-foot long single bored concrete pile (circular) in different sand deposits are shown below. Estimate the allowable capacity of the single pile. (Nq* = 25 for φ′= 28 degrees; Nq* = 32 for φ′= 30 degrees; Nq* = 52 for φ′= 33 degrees) 12



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University of Asia Pacific
Department of Civil Engineering
Final Examination – Fall 2022
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 3 hours | Credit Hour: 3:00 | Full Marks: 120

1. a) Briefly discuss differrent materials used for ballast. (5)

   b) What are the main causes of rail failure and how railway wear can be reduced? (2.5+2.5)

   c) A 8 degree curve branches off from a 4 degree main curve in an opposite direction in the layout of M.G yard. Find out the maximum speed of the train on branch line and also determine the speed restriction on the main line. Assume cant as 15 cm and allowable cant defficiency as 80 mm. (15)

   d) A ***2-8-2*** Locomative is required to haul a train at 225 kmph. The axle load of the driving wheels of the engine is 70 tonnes. The train is to run on a 3.5 degree B.G curved track. Calculate the maximum permissible train load that the engine can pull. If the train climbs a gradient of 1 in 250 and six degree curvature, then determine the reduced speed of the train. (15)

2. You are the pavement engineer of a World Bank project. The project involves constructing a 6-lane urban divided highway from Dhaka to Khulna. Axle load distribution on that road for two-way traffic is given in table 1. Determine ESAL for the design period of 30 years with uniform growth rate of 4%. Assume SN = 4, P_t = 2.5. (20)

Table 1 Axle Load Distribution

Axle Load Group (Kip)		Number of Axles, N
Single Axle	0 – 4	15
	4 – 7	169
	7 – 9	476
	10 – 14	1574
	15 – 17	1200
Tandem Axle	0 – 4	62
	4 – 7	273
	7 – 9	530
	10 – 14	1963
	15 – 17	1485

3. A section of a two-lane rural highway is to be realigned and replaced by a four-lane highway with a full depth asphalt pavement. The AADT is 1.0 and the cumulative traffic on that road for the design period is calculated as 3000 commercial vehicles. It is expected that construction will be competed five years from now. If the traffic growth rate is 5% and the effective CBR of the subgrade on the new alignment is 12, **design the pavement using the AASHTO method**. Take the design life of the pavement as 20 years. The resilient modulus of the asphalt is 300,000, for base course is 27,000 and for sub base course is 18,000. CBR for base course and sub base course is 60 and 50 respectively. It is estimated that it takes about a week for water to be drained from within the pavement and the pavement structure will be exposed to moisture levels approaching saturation for 30% of the time. Assume the percentage of traffic on the design lane is 35%, the design serviceability loss is 3.0, load equivalency factor as 1.0 and a reliability level of 95%. (20)

4. A 9-inch layer of granular material is to be used as subbase for a rigid pavement constructed on an arterial road having moderate traffic. The monthly values for the roadbed soil resilient modulus and the subbase elastic (resilient) modulus are given in the following table. If the rock depth is located 2 ft below the subgrade surface and the projected slab thickness is 10 in, **estimate the effective modulus of subgrade reaction**, using the AASHTO method. (20)

Month	Roadbed Modulus (lb/in^2)	Sub-base Modulus (lb/in^2)
January	15,000	90,000
February	10,000	65,000
March	20,000	50,000
April	6,000	30,000
May	3,000	45,000
June	2,000	18,000
July	7,000	25,000
August	4,500	30,000

5. The sieve analysis result for the soil on which the pavement will be constructed is: 80% passing No.: 10 sieve, 62% passing No.: 40 sieve, and 12% passing No.: 200 sieve, the sample is non-plastic. **Determine the classification and group index of soil sample by AASHTO method**. Also comment whether that can be used as subbase or base course. (10)

6. State the significance of – (2X5 = 10)

   i) Ductility test of bitumen
   ii) Loss on heating test
   iii) Aggregate impact value test
   iv) Specific gravity test of aggregate
   v) CBR test

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2022
Program: B.Sc. Engineering (Civil)

Course title: Irrigation and Flood Control | Course code: CE 461
Time: 3 Hours | Full marks: 100

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

1. a) Choose one irrigation method that is most appropriate for Bangladesh during non-monsoon period. Justify your choice and explain the selected irrigation method in detail. 8

   b) An irrigation project located in Lalmanirhat district of Bangladesh divert surface water from Teesta river through a canal for irrigating an area of 3500 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: 14

   - Consumptive Water Use (C_U);
   - Consumptive Irrigation Requirement (C.I.R.);
   - Net Irrigation Requirement (NI.R.);
   - Field Irrigation Requirement (F.I.R.);
   - Gross Irrigation Requirement (G.I.R.);
   - Volume of water required to be diverted from the head works.

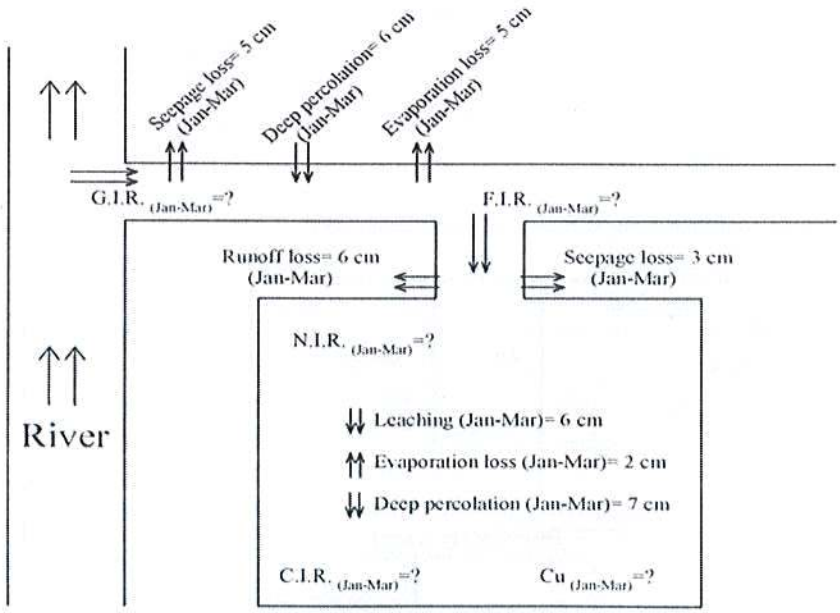

Figure 1

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	23.0	8.00	1	0.72
February	19.7	7.70	0.55	0.76
March	24.5	8.10	1.25	0.65

c) Find out the following by analyzing the data and information provided in **figure 2** below: 14

- Discharge required at the carrot field (Q_1);
- Discharge required at the corn field (Q_2);
- Discharge required at wheat field (Q_3);
- Actual discharge required at the head of the distributary canal (Q);
- Design discharge required at the head if time factor is 0.75;
- Average discharge required at the head of the distributary canal if capacity factor is 0.79.

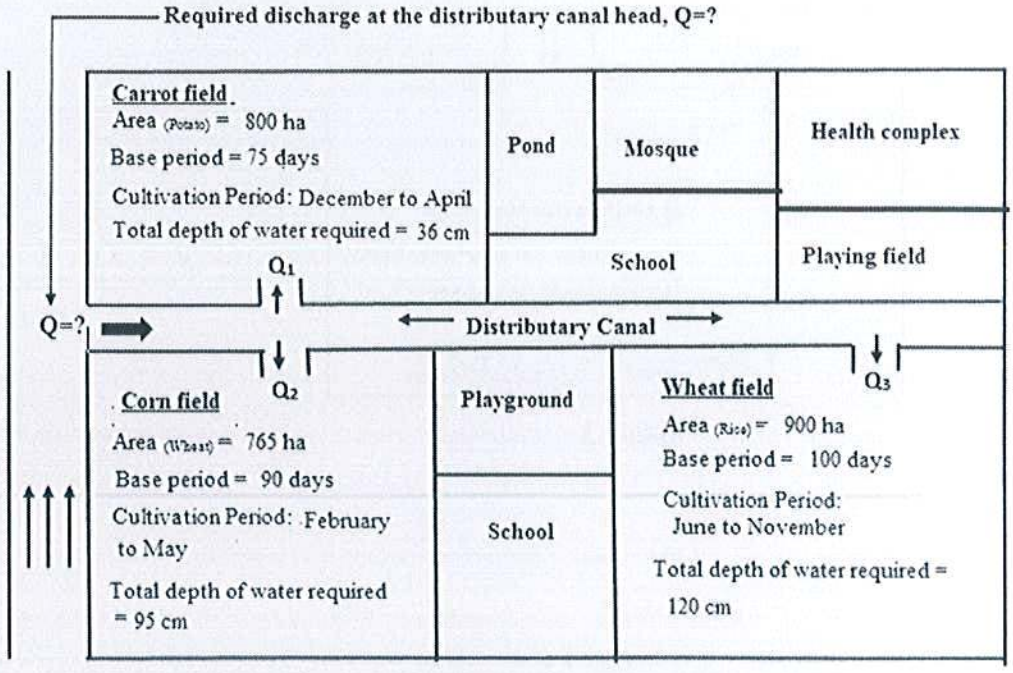

Figure 2

2. a) Explain the procedures for determining the required discharge capacity and number of spillways. 6

b) You are recently recruited as an assistant engineer in the design circle of the Bangladesh Water Development Board (BWDB) and posted in Gazipur, Bangladesh. Executive engineer of BWDB, Gazipur office, assigned you a task to design a lined canal on alluvial soil having the following data: 12

- Full supply discharge = **R** m^3/sec
- Side slope = 1.25:1
- Bed slope = 1 in 5000
- Rugosity coefficient = 0.018
- Permissible velocity = **B** m/sec
- **R** = 43 + last digit of your registration number
- **B** = 1.32 + sum of last two digits of your registration number

Design the canal.

3. a) Justify the importance of cross-drainage works. 6

b) Through analyzing the data and information provided in **figure 3**, find out the following: 12

- water conveyance efficiency
- water application efficiency
- water storage efficiency
- water distribution efficiency

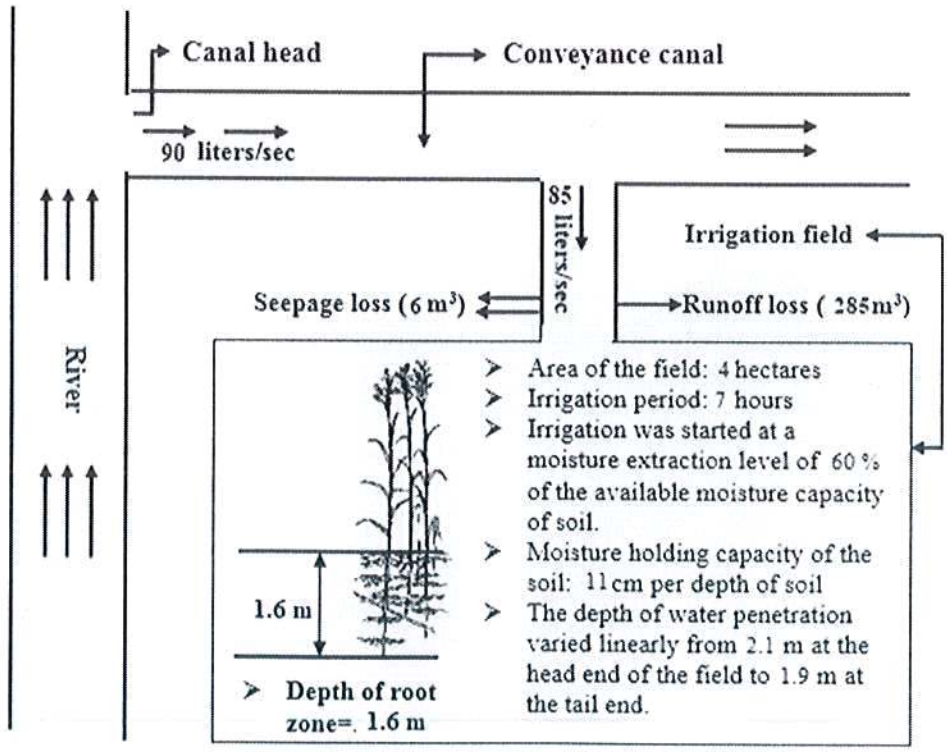

Figure 3

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. 10

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 a sustainable flood management in Bangladesh. 10

   b) Identify and explain the target and related indicators of United Nations Sustainable Development Goal (SDG) 6 that are most relevant to transboundary cooperation and integrated water resources management in international river basin. 8