University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2018
Program: B. Sc. Engineering (Civil)

Course Title: Project Planning & Management — Course Code: CE 401
Time: 3 Hours — Full Marks: 150

PART – A

Answer all of the following questions.
(Assume reasonable values for any missing data)

1. Construction of the elevated metro rail MRT Line-6 is underway in Dhaka under a fast track priority initiative of the Government of Bangladesh *(Figure 1)*. Once implemented, the MRT Line-6 will run from Uttara to Motijheel serving 16 stations along the way. What challenges can the project manager face in implementing the project. **(15)**

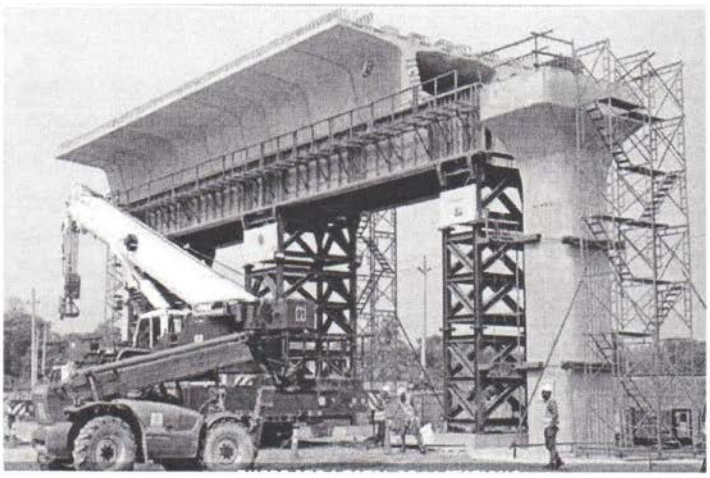


Figure 1: Construction of the elevated metro rail MRT Line-6 (left) and its alignment (right). (Courtesy: The New Age)

2. On March 15, 2017 one construction worker died and several were injured when the precast concrete girders of the then under-construction flyover at Malibagh-Moghbazar in Dhaka collapsed as shown in *Figure 2*. Perform accident analysis of the incident and prepare a detailed report. **(15)**

Figure 2: Collapsed portion of the MalibaghMoghbazar flyover (Courtesy: The Daily Star)

3. O'Neill's sells each of its *Hammer 3/2* wetsuit for \$180. The production and procurement cost per suit is \$110. Marketing department's forecast for sales during the spring season is 3200 units. Unsold inventory at the end of the season can be salvaged for \$90 per unit. What will be the demand for *Hammer 3/2* during the spring season? Also find the order quantity that maximizes expected profit. **(15)**

4. Write down the modern views of quality control and the general goals of *Six Sigma*. **(15)**

5. What are the elements of a legal contract? What are the best measures for an engineer to take when entering into a contract with a client? **(15)**

PART – B

Answer all of the following questions.
(Assume reasonable values for any missing data)

6. Project activity status of Mr. X, project manager for a hospital project, is shown below: **(20)**

Activity	Description	Activity Predecessor	Time (weeks)
A	Select admin staff	---	3
B	Site selection and survey	---	4
C	Select medical equipment	---	4
D	Prepare final construction plan	A	5
E	Bring utilities to sites	B	2
F	Interview for nursing and staff	C	6
G	Purchase and deliver equipment	D, E	3
H	Construct hospital	F, G	1

i. Draw the network diagram
ii. Find ES, EF and LS, LF time for each activity
iii. Find Total float, and Free float for each activity
iv. Find the critical path
v. Find the project completion time
vi. If the time required for activity F and G are reduced by 1 week each, find the project completion time and critical path as well.

7. **a.** The sales of a certain product during a 12 year period have been given below: **(10)**

Period	Sales	Period	Sales
1	1,000	7	1,900
2	1,150	8	2,400
3	1,320	9	2,650
4	1,600	10	3,040
5	1,750	11	3,500
6	2,050	12	4,050

Develop a regression analysis to forecast the demand and find the forecast for the 15th year period.

b. Consider the cash flow of two projects: **(10)**

Year	Cash Flow of A	Cash Flow of B
0	1,200	1,400
1	1,600	400
2	800	300
3	450	700
4	2,500	600
5	3,500	400

i. Construct the NPV profile for Projects A and B
ii. Construct the BCR for Projects A and B
iii. Which project would you choose if r is 12 percent?

8. **a.** A marketing manager wishes to allocate his annual advertising budget of Tk. 20,000 in two media A and B. The unit cost of a message in Media A is Tk. 1,000 and in B is Tk. 1,500. Media A is a monthly magazine and not more than one insertion is desired in one issue. At least 5 messages should appear in media B. The expected effective audience for unit messages for media A is 40,000 and for media B is 50,000. Formulate a LP model. **(9)**

b. A company produces two types of cow boy hats. Each hat of the first type require twice as much labor time as the second type. If all hats are of the second type only, the company can produce a total of 500 hats a day. The market limits daily sales of the first and second types to 150 and 250 hats. Assuming that the profits per hat are Tk. 8 for type 1 and Tk. 5 for type 2, formulate the problem as a LP model to determine the number of hats to be produced of each type so as to maximize the profit. **(9)**

c. Name the factors that affect capacity decision. **(2)**

9. **a.** What do you understand by SIC? Discuss different SIC system, their basis and uses. **(8)**

b. What do you understand by 'defender' and 'challenger' in replacement studies? Explain with examples. **(3)**

c. Write short notes on the following two:

i. IRR
ii. Salvage Value

(2x2= 4)

Standard Normal Probabilities

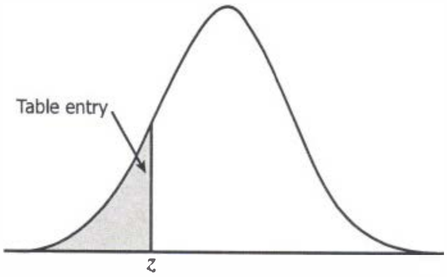


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Standard Normal Probabilities

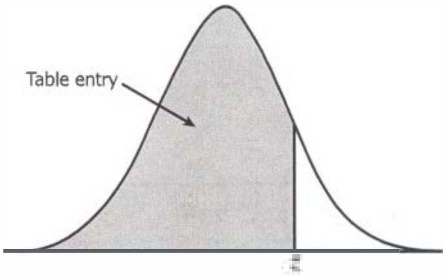


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2018
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

1. Frame structure ***abc*** shown in ***Fig.1*** is subjected to a dynamic load, $w = 10t^2$ (*k/ft*). Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***a*** at time $t = 0.10$ sec
[Given: $EI = 10^4$ *k-ft*^{2}, $\mu = 0.004$ *k-sec*^{2}/*ft*^{2}, *Damping ratio of the system* = 6%].

2. Ignore zero-force members and apply boundary conditions to form the stiffness matrix of the space truss ***abcdefghij*** shown in ***Fig.2***
[Given: S_x = *constant* = *500 kip/ft, Nodal Coordinates (ft) are a(5,12,-5), b(5,12,0), c(2.5,6,0), d(2.5,6,-5), e(7.5,6,-5), f(7.5,6,0), g(0,0,-5), h(0,0,0), i(10,0,-5), j(10,0,0)*].

3. Calculate 1st natural frequency of the frame ***ABC*** as shown in ***Fig.3*** using lumped mass matrices (neglecting axial deformation).

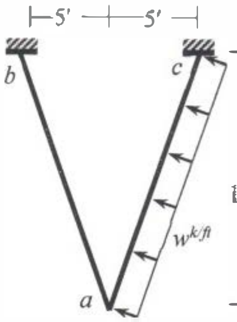


Fig.1

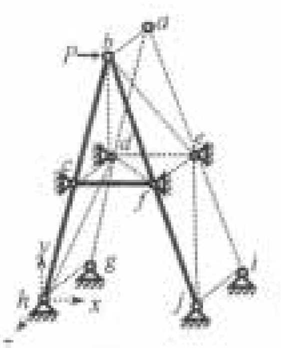


Fig.2

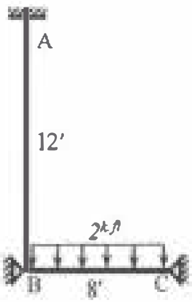


Fig.3

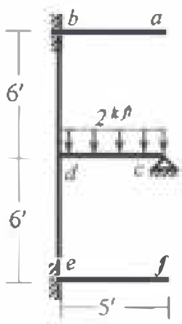


Fig.4

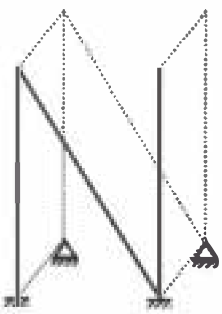


Fig.5

4. Use the stiffness method (neglect axial deformation) to calculate the rotation at joint ***B*** and ***C*** of the frame loaded as shown in ***Fig.3***, if the hinge support at ***C*** is replaced by a circular foundation of radius 3.5 ft on the surface of subsoil (half-space) with shear wave velocity(v_s) equal to 1200 ft/sec
[Given: $EI = 80 \times 10^3$ *k-ft*^{2}. *Unit weight of soil = 120 pcf, Poisson's ratio = 0.25*]

5. Use Stiffness Method considering flexural deformations only to calculate the unknown rotations at joint ***c*** and ***d*** of the frame ***abcdef*** loaded as shown in ***Fig.4***
[Given: $EI = 60 \times 10^3$ *k-ft*^{2}].

6. Determine the degree of kinematic indeterminacy (**doki**) and show the corresponding deflections and rotations of the 2D frame (***Fig.4***) and 3D frame (***Fig.5***), for the following cases (i) Not considering boundary conditions, (ii) Considering boundary conditions, (iii) Neglecting axial deformations.

7. Use Energy method to calculate the plastic moment (M_p) needed to prevent the development of plastic hinge mechanism loaded frame ***ABCD*** as shown in ***Fig.6*** considering beam mechanism for ***AB***, ***BC*** and sidesway mechanism for column ***BD***.

8. Use Stiffness Method (neglecting axial deformations) to calculate the value of ***F*** required to cause buckling of the frame ***abcdef*** loaded as shown in ***Fig.7***
[Given: $EI = 30 \times 10^3$ k-ft^2].

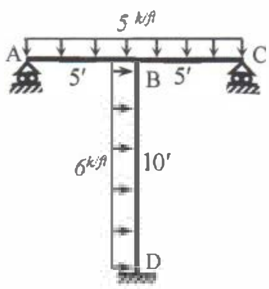


Fig.6

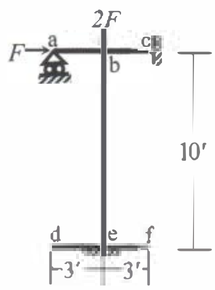


Fig.7

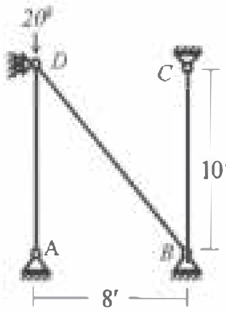


Fig.8

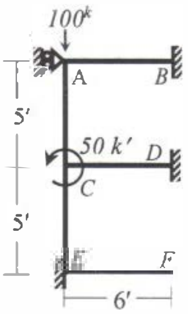


Fig.9

9. Identify zero-force members of the 2D truss ***ABCD*** loaded as shown in ***Fig.8.***
Determine the displacements of joint ***D*** considering the settlement of support ***B*** is 0.10 ft. Also calculate member forces. [Given: $EA/L = 1000$ k/ft].

10. Use Stiffness Method considering flexural deformations and geometric nonlinearity to calculate unknown rotations at A and ***C*** of the frame ***ABCDEF*** loaded as shown in ***Fig.9***
[Given: $EI = 30 \times 10^3$ k-ft^2].

List of Useful Formulae for CE 411

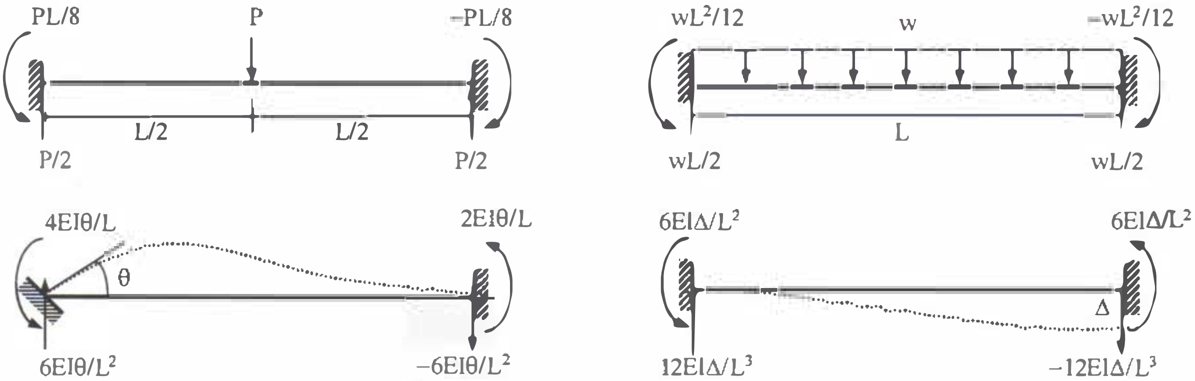
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

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

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 $T_1 = GJ/L$
* 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 2018
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II — Course Code: CE 441
Time: 3 hours — Full Marks: 100

Answer the following questions.

1. (a) Recommend a type of sampler that can be used for sampling sand. 1
   With these samples, which laboratory tests can be carried out? 2

   (b) During soil exploration, standard penetration tests were carried out at a test site. Given that $\gamma_{sat} = 18.5$ kN/m^3. Water table is at the ground level.
   Calculate $(N_1)_{60}$ at depths of 5 m, if $N_{60} = 12$.

   (c) Compare the advantage of cone penetration test over vane shear test. 2

2. (a) Calculate the settlement of the rectangular footing (dimension 2 m x 3 m) in the soil profile shown in Figure 1, due to primary consolidation settlement of the soft clay layer. Use 2:1 pressure distribution. The depth of foundation is 2 m. 10

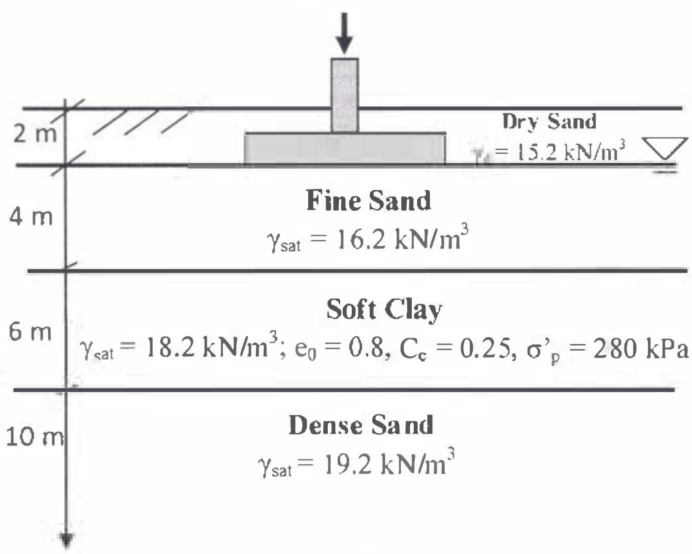


Figure 1

2. (b) Calculate the settlement of a group of 9 piles in the soil profile shown in Figure 1, due to primary consolidation settlement of the soft clay layer. 10
   Given that
   Pile length = 10 m,
   Pile diameter = 0.75 m, and c/c spacing = 3D.

3. The arrangement of 12 piles (in a group) and the soil profile are shown in Figure 2. Center-to-center pile spacing is 0.9 m.

(a) Calculate the capacity of an individual pile. Given that $\alpha = 0.5$, $K_s = 0.8\ K_0$, $\delta/\varphi = 0.8$. 10

(b) The group of vertical piles are subjected to an eccentric force Q, magnitude of 2600kN. Q is located 0.2 m from the x-axis and 0.15 m from the z-axis. Determine the maximum and the minimum forces on the piles. 10

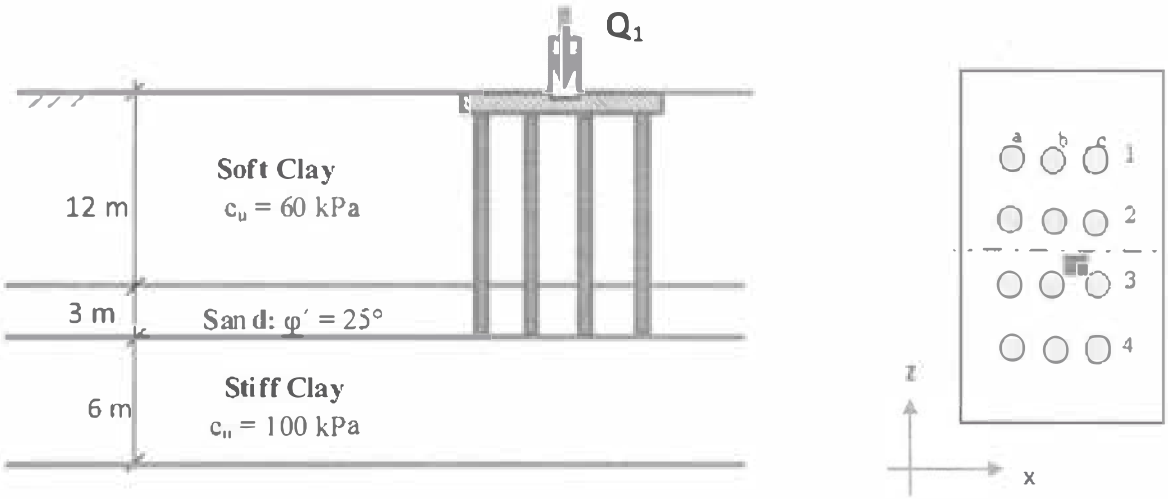


Figure 2

4. According to the soil exploration report, the upper loose sand layer is found homogeneous and overlying medium dense sand. The ground water table is located at EGL.

Estimate the net allowable bearing capacity of a 2 m wide strip footing, placed at a depth 1.5 m below the ground level. Given that **Z** = 2 m. 10

Provide a factor of safety equal 2.

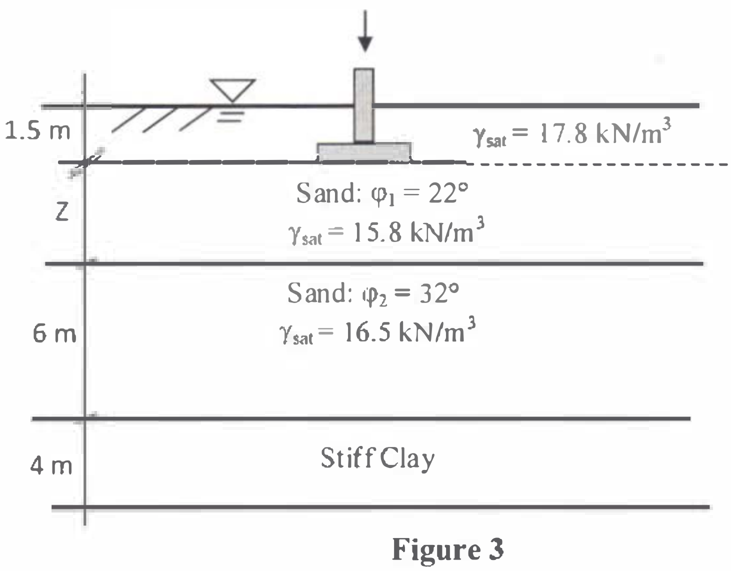


Figure 3

5. (a) Design a rectangular shallow foundation (placed at a depth 1.5 m below the ground level) to support 400 kN load for the following soil data. Provide a factor of safety equal 3. According to the soil exploration report, the upper layer is found homogeneous and extends up to 8 m below the ground level. The ground water table is located at GL. Use Meyerhof's theory of bearing capacity. Assume that L = 2B. 15

The data of this soil layer is as follows:

Given data: γ_{sat} = 18.2 kN/m^3; c = 10 kPa; φ = 35°

(b) Determine the depth of a partially compensated mat foundation with a dimension of 25 m x 18 m. The mat will be constructed on a deep bed of saturated clay with c_u = 65 kPa and γ_{sat} = 16.5 kN/m^3. Assume a reasonable factor of safety. 5

6. Determine the factor of safety for the trial slip surface (Figure 4) applying ordinary method of slices for the given data. 25
The α angles, width of the slices, pore-water pressure and weight of the slices are given in Table 1.

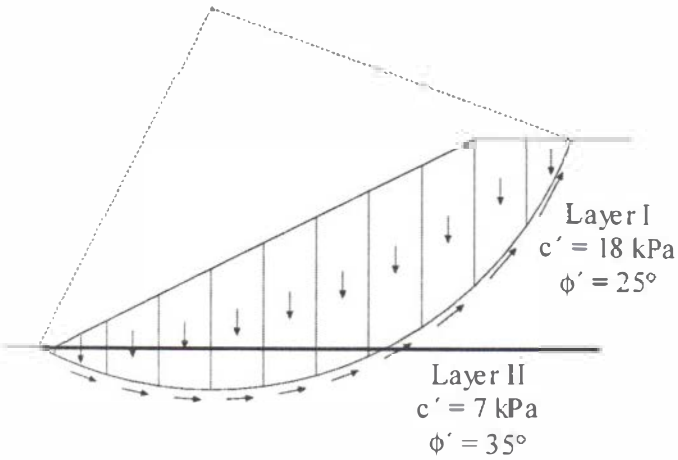


Figure 4

Table 1

Slice No.	α (°)	b (m)	u (kPa)	W (kN/m)
1	-18	2.5	5	68
2	-10	2.5	10	160
3	0	2.5	14	204
4	15	2.5	12	221
5	21	2.5	12	238
6	27	2.5	10	229
7	33	2.5	7	221
8	48	2.5	6	221
9	53	2.5	5	204
10	65	1.6	0	108

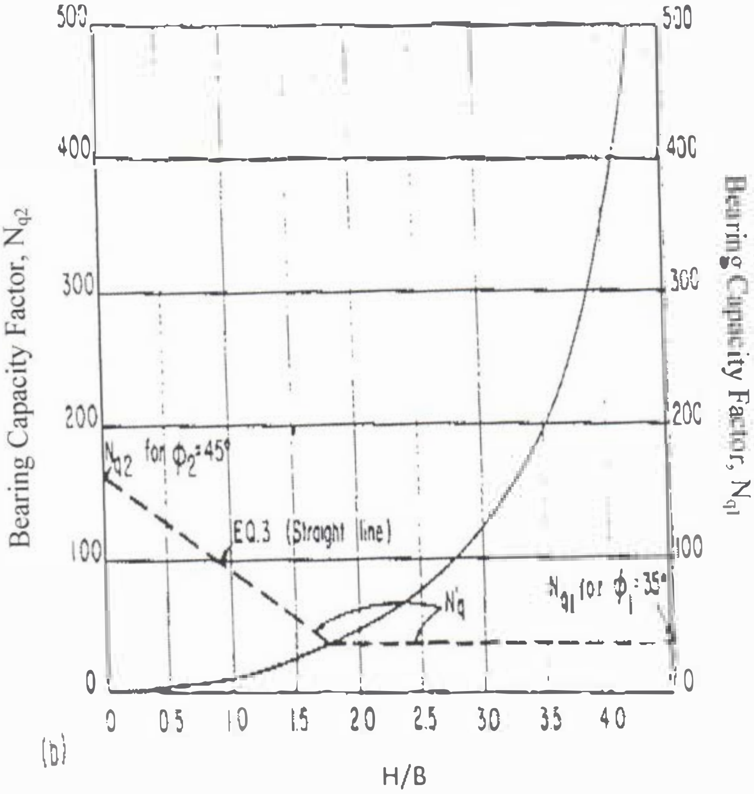
Table: Shape, Depth and Inclination Factors

Factor	Condition	Equation
Shape	φ = 0°	$F_{cs} = 1 + 0.2\left(\frac{B}{L}\right)$ $F_{qs} = F_{\gamma s} = 1$
	φ ≥ 10°	$F_{cs} = 1 + 0.2\left(\frac{B}{L}\right)\tan^2(45^\circ + \frac{\varphi}{2})$ $F_{qs} = F_{\gamma s} = 1 + 0.1\left(\frac{B}{L}\right)\tan^2(45^\circ + \frac{\varphi}{2})$
Depth	φ = 0°	$F_{cd} = 1 + 0.2\left(\frac{D_f}{B}\right)$ $F_{qd} = F_{\gamma d} = 1$
	φ ≥ 10°	$F_{cd} = 1 + 0.2\left(\frac{D_f}{B}\right).\tan(45^\circ + \frac{\varphi}{2})$ $F_{qd} = F_{\gamma d} = 1 + 0.1\left(\frac{D_f}{B}\right).\tan(45^\circ + \frac{\varphi}{2})$
Inclination	Any φ	$F_{ci} = F_{qi} = (1 - \frac{\alpha^\circ}{90^\circ})^2$
	$\varphi > 0^\circ$	$F_{\gamma i} = (1 - \frac{\alpha}{\varphi^\circ})^2$
	$\varphi = 0^\circ$	$F_{\gamma i} = 0$

Ordinary Slice Method

$$F_s = \frac{\sum[c'\Delta L_n + (W_n \cos\alpha_n - u_n \Delta L_n)\tan\varphi']}{W_n \sin\alpha_n}$$

Design Charts for N_q' and N_γ' (applicable to weak sand over strong sand)



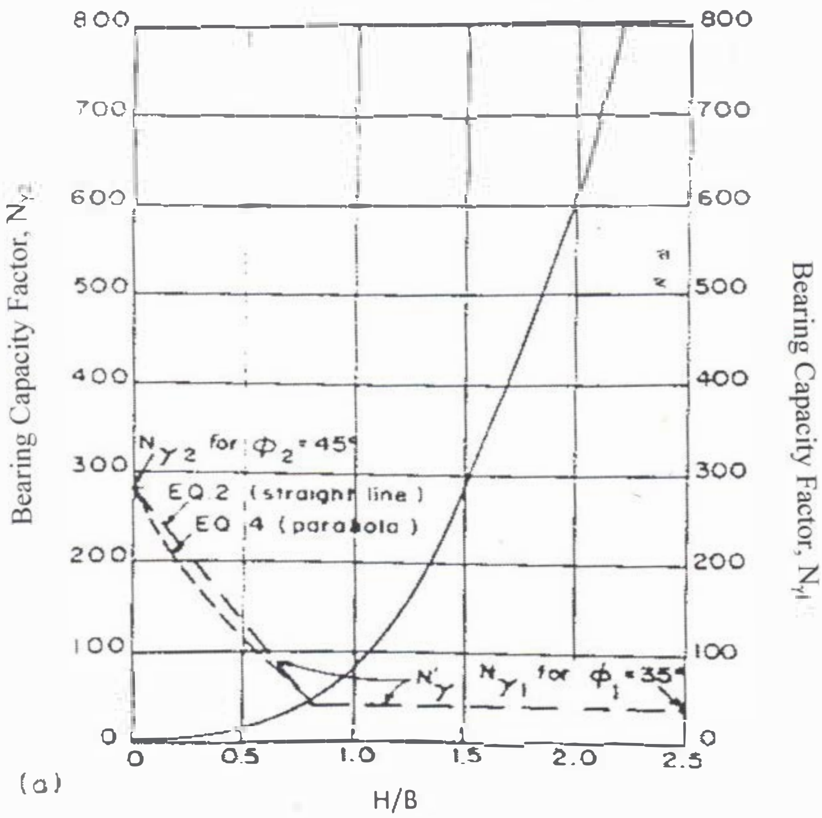
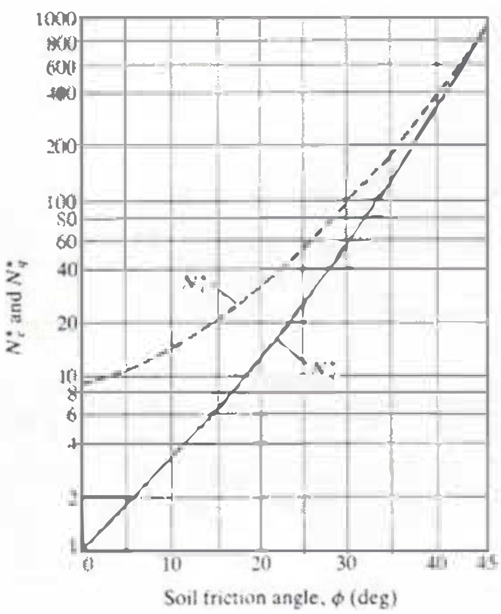


Table: Bearing Capacity Factors (Meyerhof's Chart)

ϕ	N_c	N_q	N_γ (Meyerhof)	ϕ	N_c	N_q	N_γ (Meyerhof)	ϕ	N_c	N_q	N_γ (Meyerhof)
0°	5.10	1.00	0.00	17°	12.34	4.77	1.66	34°	42.16	29.44	31.15
1°	5.38	1.09	0.00	18°	13.10	5.26	2.00	35°	46.12	33.30	37.15
2°	5.63	1.20	0.01	19°	13.93	5.80	2.40	36°	50.59	37.75	44.43
3°	5.90	1.31	0.02	20°	14.83	6.40	2.87	37°	55.63	42.92	53.27
4°	6.19	1.43	0.04	21°	15.81	7.07	3.42	38°	61.35	48.93	64.07
5°	6.49	1.57	0.07	22°	16.88	7.82	4.07	39°	67.87	55.96	77.33
6°	6.81	1.72	0.11	23°	18.05	8.66	4.82	40°	75.31	64.20	93.69
7°	7.16	1.88	0.15	24°	19.32	9.60	5.72	41°	83.86	73.90	113.99
8°	7.53	2.06	0.21	25°	20.72	10.66	6.77	42°	93.71	85.37	139.32
9°	7.92	2.25	0.28	26°	22.25	11.85	8.00	43°	105.11	99.01	171.14
10°	8.34	2.47	0.37	27°	23.94	13.20	9.46	44°	118.37	115.31	211.41
11°	8.80	2.71	0.47	28°	25.80	14.72	11.19	45°	133.87	134.87	262.74
12°	9.28	2.97	0.60	29°	27.86	16.44	13.24	46°	152.10	158.50	328.73
13°	9.81	3.26	0.74	30°	30.14	18.40	15.67	47°	173.64	187.21	414.33
14°	10.37	3.59	0.92	31°	32.67	20.63	18.56	48°	199.26	222.30	526.46
15°	10.98	3.94	1.13	32°	35.49	23.18	22.02	49°	229.93	265.50	674.92
16°	11.63	4.34	1.37	33°	38.64	26.09	26.17				

Design chart: Nc* and Nq* vs ϕ



University of Asia Pacific

Department of Civil Engineering

Final Examination Spring 2017

Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II — Course Code: CE 451

Time: 3 hour — Full Marks: 100

There are Six questions. Answer any **Five**.

[Assume Reasonable Values for Any Missing Data]

1. (a) Figure 1 is a pavement system with the resilient moduli, layer coefficients, and drainage coefficients as shown. If predicted ESAL= 18.6×10^6, R = *95%*, S_0 = *0.35*, and PSI = *2.1*, **calculate thicknesses D1, D2, and D3**. (10)

E_1 = 400,000 psi	a_1 = 0.42		D_1
E_2 = 30,000 psi	a_2 = 0.14	m_2 = 1.2	D_2
E_3 = 11,000 psi	a_3 = 0.08	m_3 = 1.2	D_3

M_R = 5,700 psi

Figure 1

(b) What are the desirable properties of soil? 5

(c) You are a pavement engineer after lab examination, calculation and analysis you found that Group index value of your soil sample is *-20*, give comment on your soil sample. 5

2. (a) What is the **classification and group index** of soil sample (AASHTHO Method) with *84%* passing No.10 sieve, *58%* passing No. 40 sieve, and *8%* passing No. 200 sieve? The sample is non-plastic. Also comment whether that can be used as subbase or base course. (10)

(b) **Design size and spacing of** dowel bars at an expansion joint of concrete pavement of thickness *20* cm. Given the radius of relative stiffness of *90* cm. Design wheel load *4000* kg. Load capacity of dowel system *40* percent of design load. Joint width is *3.0* cm and the permissible stress in shear, bending and bearing stress in dowel bars are *1000*, *1500* and *100* kg/cm^2 respectively. (10)

3. (a) Clarify the importance of i) penetration test, ii) ductility test, iii) Softening point test, iv) flash and fire point test, v) loss on heating test of bitumen for pavement design and construction. (2x5=10)

(b) What are the facilities required for: i) station where lines from 3 or more direction meet, and ii) station where a railway line or one of its branches terminates. (5+5=10)

4. (a) If the sleeper density is M+7 on a broad gauge route and the length of the rail is 13 m and width of sleeper is *25.4* cm. then **calculate ballast density**. (10)

(b) Explain the importance of Westergaard's Modulus of Subgrade Reaction (k) in rigid pavement design and the state factors upon which k value depends (5)

(c) Summarize the application of Equivalent Single Axle Load. (5)

5. (a) A six-lane divided highway is to be designed to replace an existing highway. The present AADT (both directions) of *6000* vehicles is expected to grow at *5%* per annum. The percent of traffic on the design lane is *45%*. **Determine the design ESAL** if the design life is 20 years and the vehicle mix is: (10)

Passenger cars (1000 lb/axle) =*60%*
2-axle single-unit trucks (5000 lb/axle) =*30%*
3-axle single-unit trucks (7000 lb/axle) =*10%*

(b) 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 (both ways) on the existing section can be represented by *500* ESAL. It is expected that construction will be completed five years from now. If the traffic growth rate is *5%* and the effective CBR of the subgrade on the new alignment is *85*, **determine a suitable depth of the asphalt pavement** using the AASHTO method and briefly explain. Take the design life of the pavement as *20* years. The resilient modulus of the asphalt is *400,000* lb/in^2. Assume m_i for the as I and the percentage of traffic on the design lane is 45%. Assume the design serviceability loss is *2.0*, a reliability level of *90%* and a standard deviation of *2.0*. (10)

6. (a) A *15* cm layer of cement treated granular material is to be used as subbase for a rigid pavement. The monthly values for the roadbed soil resilient modulus and the subbase elastic (resilient) modulus are given in Table 1. If the rock depth is located *1.5* m below the subgrade surface and the projected slab thickness is *22.5* cm, **estimate the effective modulus of subgrade reaction** using the AASHTO method. (15)

Table 1

Month	Roadbed Modulus $(kN/m^2) X10^3$	Subbase Modulus $(kN/m^2) X10^3$
January	1.38	345
Feb	1.38	345
March	17.25	103.5
April	27.60	103.5
May	27.60	103.5
June	48.3	138
July	48.3	138
August	48.3	138
September	48.3	138
October	48.3	138
November	27.6	103.5
December	1.38	345

(b) Given k=*100* pci (*19.5* MN/m^3), E_c=*10 x 10⁶* psi (*34.5* GPa), S_c=*650* psi (*4.5MPa*), J=*3.2*, C_d=*1.0*, PSI=*2*, R=99%, S_0= *0.4*, and W_{18}= *5.1 x 10⁶*, **determine thickness D (briefly explain).** (5)

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2018
Program: B.Sc. Engineering (Civil)

Course title: Irrigation and Flood Control
Time: 3 Hours

Course code: CE 461
Full marks: 100

There are TWO sections in the question paper namely "SECTION A" and "SECTION B". You have to answer from both sections according to the instruction mentioned on each section.

SECTION A
MARKS: 72

There are FIVE (5) questions. Answer question no. 01 (COMPULSORY) and any THREE (3) from the rest (18+ 3*18=72). (Assume any missing data.)

1. 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: 18
    - 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.).

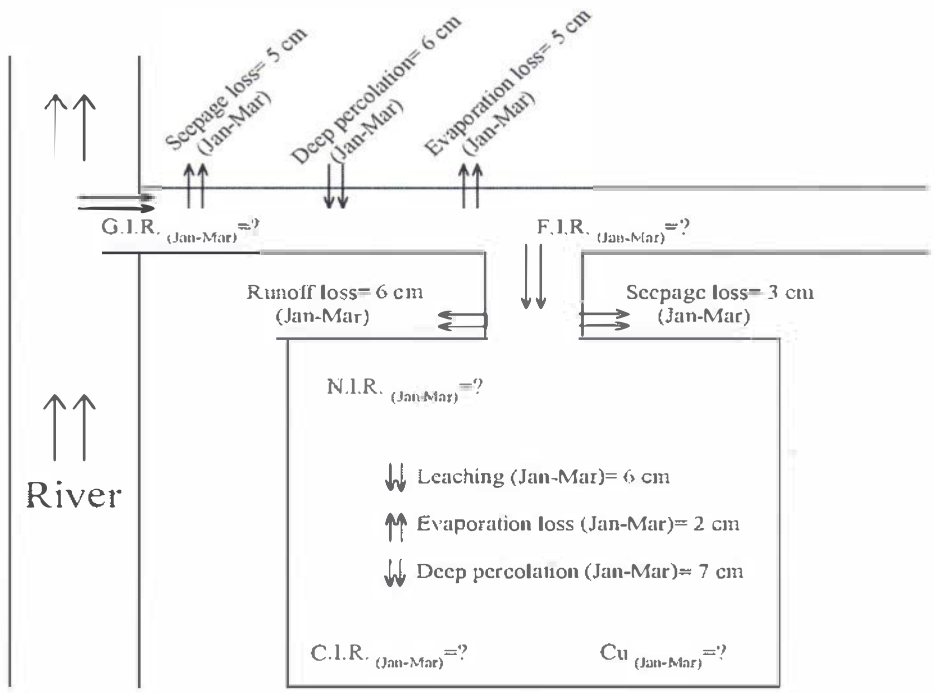


Figure 1

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	19.0	7.45	1.45	0.75
February	15.6	7.10	2.05	0.70
March	15.5	7.20	2.30	0.65

2. a) Explain irrigation and its necessity in Bangladesh. 2 + 4
   b) Do you agree that *furrow irrigation method* is more appropriate than *sprinkler irrigation method*? Justify your answer. 8
   c) In a rural village of Bangladesh, the farmers together decided to install a centrifugal pump to supply irrigation water to the agricultural fields at a rate of 149 liters/second through an existing earthen canal network. Calculate the brake horse power of the pump from the following data: 4
   - Suction head = 5 m
   - Delivery head = 2 m
   - Coefficient of friction = 0.01
   - Efficiency of pump = 70%
   - Diameter of pipe = 18 cm

3. a) Explain the following with neat sketch: i) Super passage ii) Level crossing. 4
   b) An irrigation project is located in an area formed by alluvial soil. The responsible engineering department is planning to construct a new irrigation canal to provide sufficient water in the agricultural plots located in the project area. The engineering department decided to construct an unlined canal. 14

   As a newly recruited engineer, you need to design that canal having the following data (two trials are required):
   - Full supply discharge = 7 m^3/sec
   - Rugosity coefficient (n) = 0.0224
   - Critical velocity ratio (C.V.R) (m) = 1
   - Bed slope = 1 in 5000

   Assume other reasonable data for the design.

4. a) Explain the following: i) Berms ii) Spoil Banks 4

b) By analyzing the data and information provided in **figure 2**, find out the following: 14

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

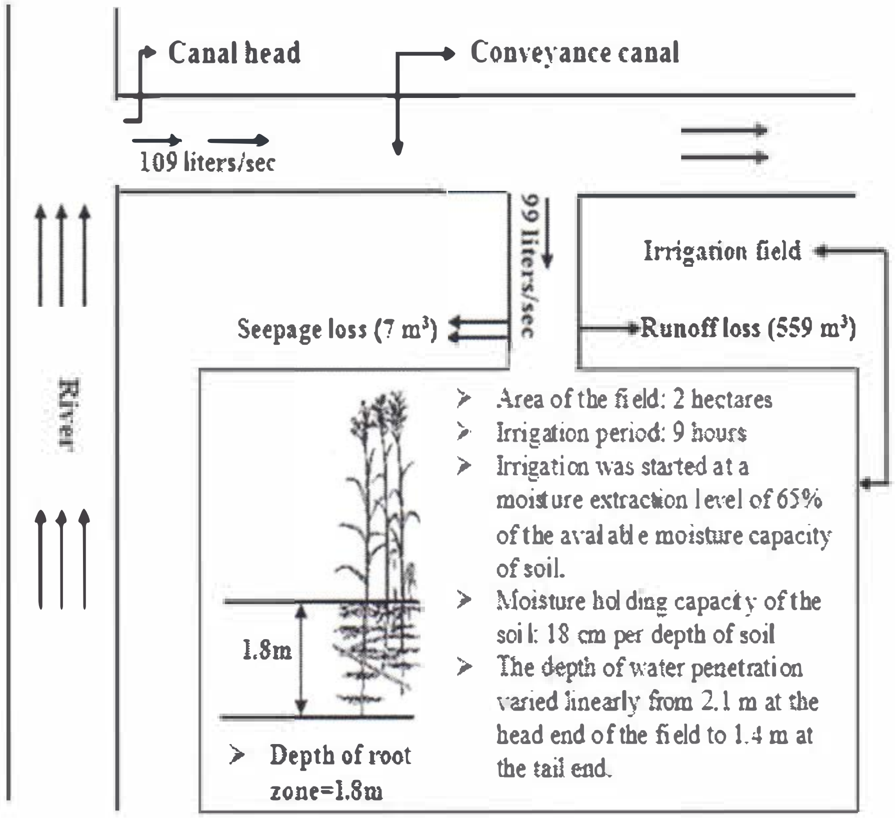


Figure 2

5. a) What is meant by C2-S2 water? Discuss its usefulness for irrigating fine textured soil. 2+2

b) Find out the following by analyzing the data and information provided in **figure 3** below: 14

- Discharge required at the head of the distributary canal (Q);
- Discharge required at the potato field (Q_1);
- Discharge required at the wheat field (Q_2);
- Discharge required at rice field (Q_3).

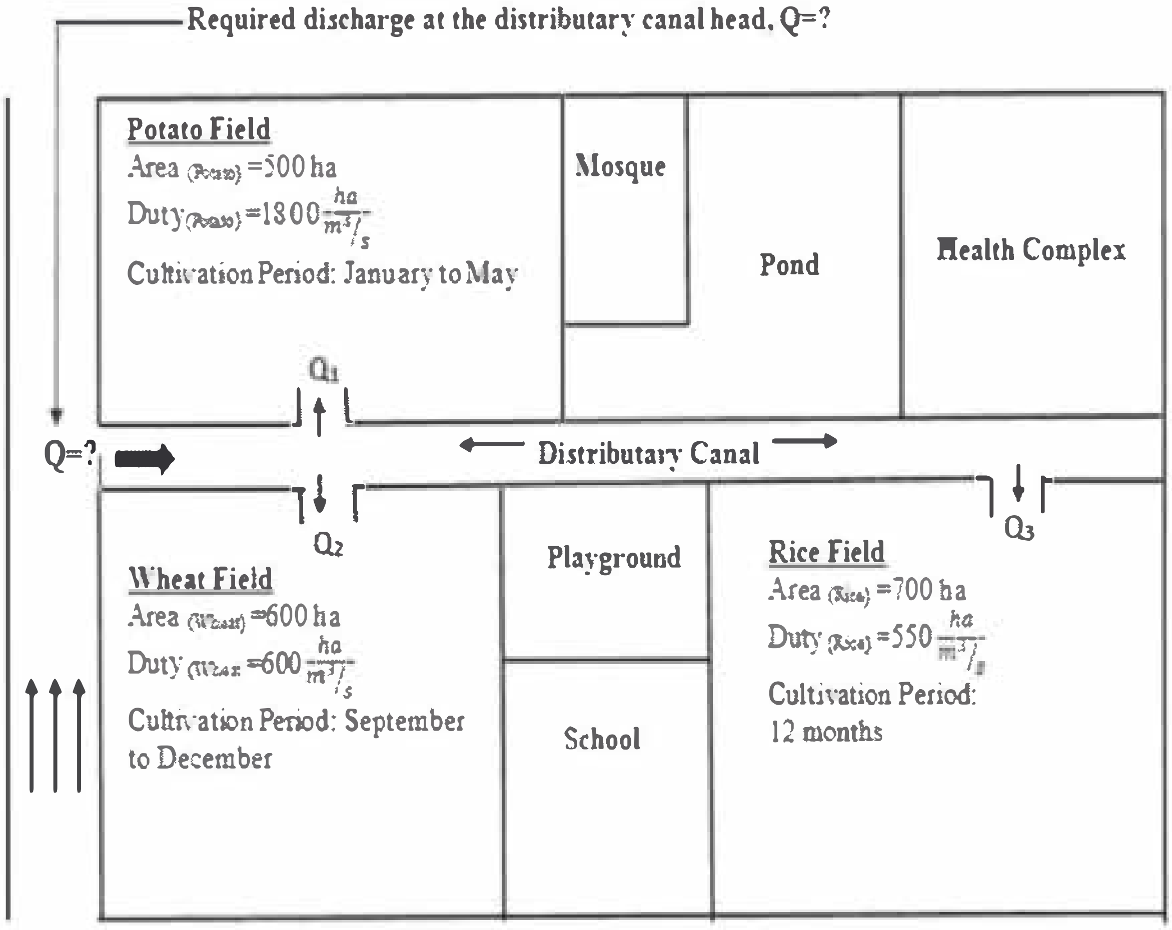

Required discharge at the distributary canal head, Q=?
Potato Field
Area (Potato) =500 ha
Duty (Potato) =1800 ha/(m³/s)
Cultivation Period: January to May
Mosque
Pond
Health Complex
Q1
Q=?
Distributary Canal
Q2
Q3
Playground
Wheat Field
Area (Wheat) =600 ha
Duty (Wheat) =600 ha/(m³/s)
Cultivation Period: September to December
School
Rice Field
Area (Rice) =700 ha
Duty (Rice) =550 ha/(m³/s)
Cultivation Period: 12 months

Figure 3

SECTION B
MARKS: 28

There are THREE (3) questions. Answer <u>question no. 06 (COMPULSORY)</u> and any ONE (1) from the rest (16+12=28). (Assume any missing data.)

6. a) Summarize delta formation process and how delta formation process relates to flood. 6
   b) **Figure 4** shows an area located in eastern part of Dhaka city that is regularly affected by waterlogging. Based on the land use pattern shown in figure, identify four reasons of waterlogging in this area **with justification.** 2+8

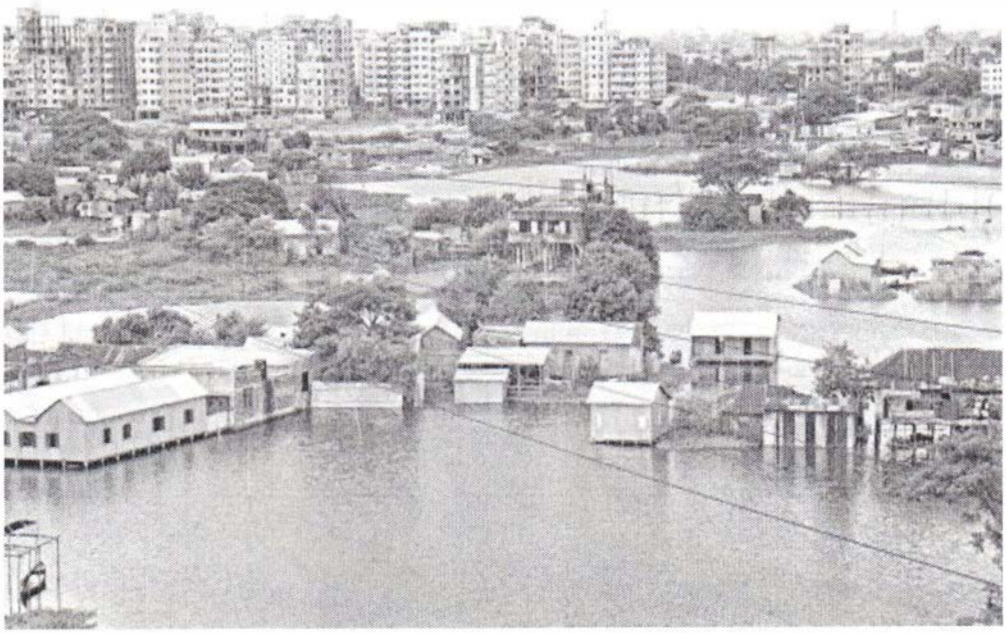


Figure 4 *(Source*: Prothom Alo, 10 August 2016)

7. a) Select three structural and three non-structural measures of flood management in Bangladesh that are most important in your opinion. Justify your answer. 6
   b) Explain different components of flood risk management. 6

8. a) Explain the procedures for determining the required discharge capacity and number of spillways. 6
   b) Explain the following (any two): 3+3
      i. Integrated water resources management
      ii. Changing paradigms of flood management
      iii. River training works