University of Asia Pacific
Department of Civil Engineering
Mid Term Examination Spring 2018
Program: B. Sc. in Civil Engineering

Course Title: Project Planning & Management Course Code: CE 401
Time: 1 Hour Full Marks: 60

[Assume Reasonable Values for Any Missing Data]

SECTION – A

There are **TWO** questions in this section. Answer any **ONE**.

1. **(a)** What challenges are being faced by the construction industry nowadays? **(7 ½)**

(b) Write down the negative sides of project management and mention the different categories of construction projects with examples. **(7 ½)**

(c) In separate graphs show (i) the rate of work in a project life cycle (ii) level of effort required in different stages of the project and (iii) effect of risk in estimating project cost. **(7 ½)**

(d) Mention the characteristics of a project and the forces that foster project management. **(7 ½)**

2. **(a)** 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? **(7 ½)**

(b) List the 'Think Twice' contract clauses. **(7 ½)**

(c) Write short notes on (i) Open Tendering Method and (ii) Limited Tendering Method **(7 ½)**

(d) Show different phases of project management and list the key participants of a project. **(7 ½)**

SECTION – B

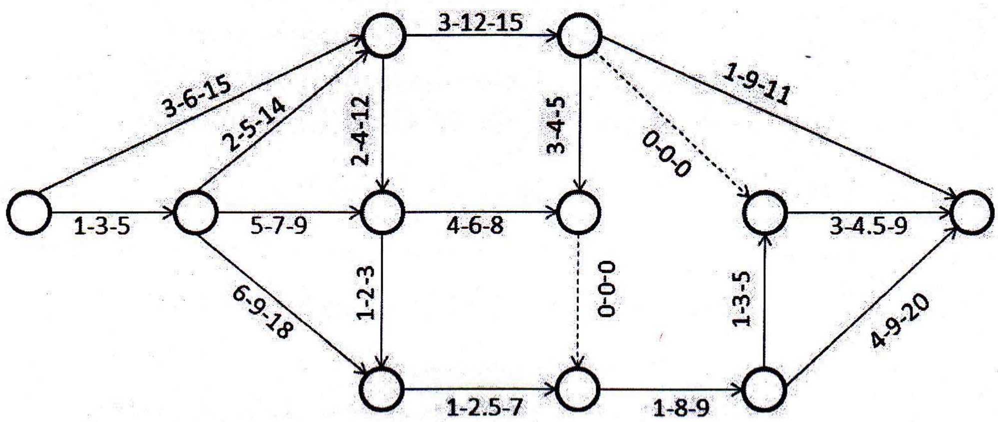
There are **TWO** questions in this section. Answer any **ONE**.

3. **(a)** The figure below shows the network of a construction project, with the three time estimates of each activity marked. Determine: **(20)**

i. Critical path and its standard deviation

ii. Probability of completion of project in 38 weeks

iii. Time duration that will provide 95% probability of its completion in time



(b) Describe different methods of demand forecasting. **(5)**

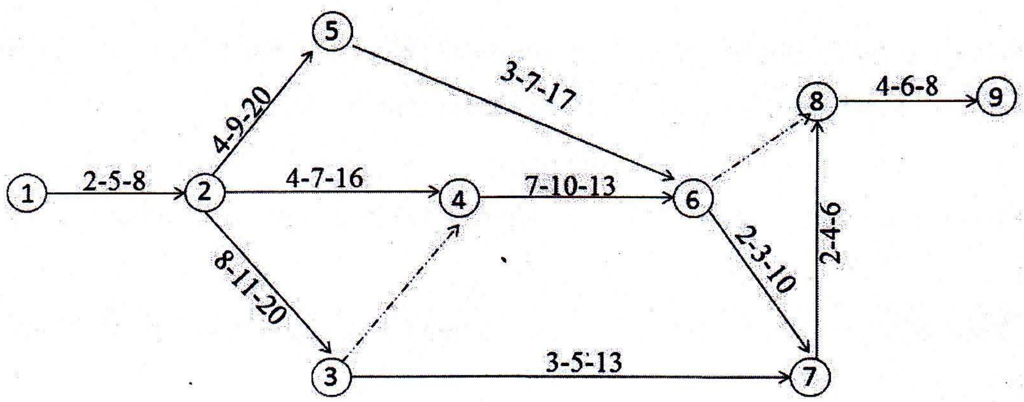
(c) What are the differences between diversification and divestment projects? **(5)**

4. (a) The figure below shows the network of a construction project. **(20)**

i. Determine critical path based on activity expected time

ii. Determine critical path based on event times

iii.Identify variances for each activity



(b) Describe the uncertainties in demand forecasting. **(5)**

(c) Describe the limitations of Gantt Chart. **(5)**

Standard Normal Probabilities

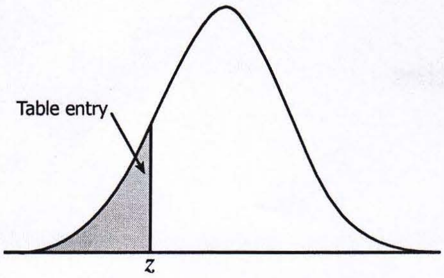


Table entry for z is the area under the standard normal curve to the left of z.

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

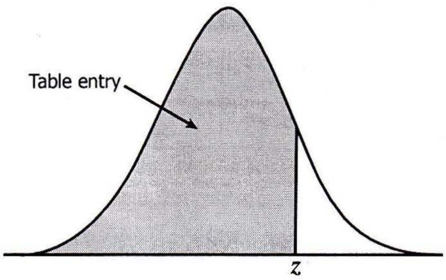


Table entry for z is the area under the standard normal curve to the left of z.

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
Midterm Examination Spring 2018
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering III		Course Code: CE 411
Time: 1 hour	Credit Hour : 3.0	Full Marks: 4 x 10

ANSWER ALL QUESTIONS. *The figures are not drawn to scale.* Any missing data can be assumed reasonably.

1. Ignore zero-force members of the space truss ***abcdefghi*** as shown in ***Fig.1*** and apply boundary conditions to formulate stiffness matrix, force vector and load vector [Given: S_x = 1200 k/ft; Nodal Coordinates (ft) are *a*(0,10,-6), *b*(0,10,0), *c*(12,10,-3), *d*(0,0,-6), *e*(0,0,0), *f*(12,0,-3), *g*(0,-10,-6), *h*(0,-10,0), *i*(12,-10,-3)].

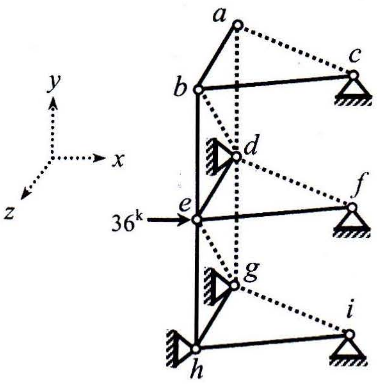


Fig.1

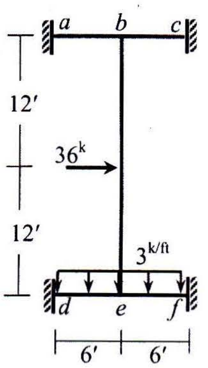


Fig.2

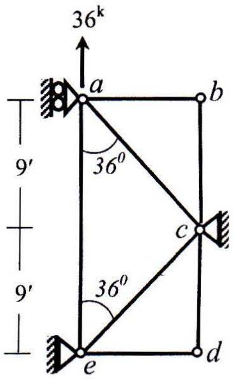


Fig.3

2. Use Stiffness Method (neglecting axial deformations) to calculate rotation of joints ***b*** and ***e*** of the frame ***abcdef*** shown in ***Fig.2*** [Given: EI = 40×10^3 k-ft^2].

3. Identify zero-force members of the truss ***abcde*** loaded as shown in ***Fig.3***. Determine the displacements of joint ***a*** [Given: EA/L = 500 k/ft].

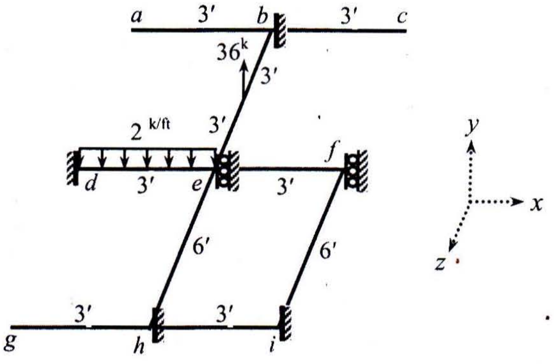


Fig.4

4. Use Stiffness Method to calculate deflections of joint ***e*** and ***f*** of the grid system ***abcdefghi*** loaded as shown in ***Fig.4*** [Given: EI = 20×10^3 k-ft^2 and GJ = 5×10^3 k-ft^2].

List of Useful Formulae for CE 411

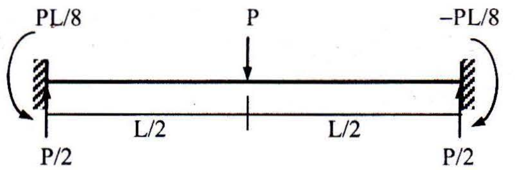
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

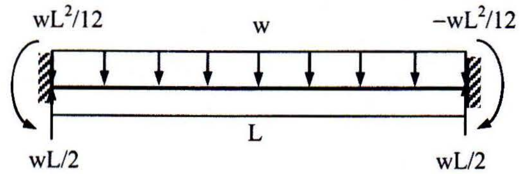
$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

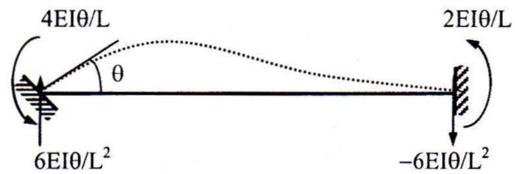
and Truss member force, $P_{AB} = S_x\,[(u_B-u_A)\,C + (v_B-v_A)\,S]$

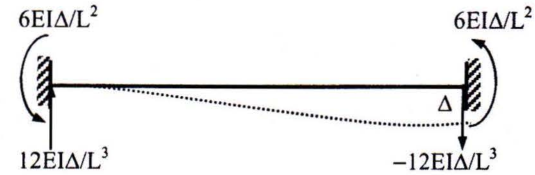
[where $C = \cos\theta$, $S = \sin\theta$]

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 $P_{AB} = S_x\,[(u_B - u_A)\,C_x + (v_B - v_A)\,C_y + (w_B - w_A)\,C_z]$

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

*The general form of the stiffness matrix for any member of a 2-dimensional frame is

$$\mathbf{K_m}^G = \begin{pmatrix} S_xC^2+S_1S^2 & (S_x-S_1)CS & -S_2S & -(S_xC^2+S_1S^2) & -(S_x-S_1)CS & -S_2S \\ (S_x-S_1)CS & S_xS^2+S_1C^2 & S_2C & -(S_x-S_1)CS & -(S_xS^2+S_1C^2) & S_2C \\ S_2S & S_2C & S_3 & S_2S & -S_2C & S_4 \\ -(S_xC^2+S_1S^2) & -(S_x-S_1)CS & S_2S & S_xC^2+S_1S^2 & (S_x-S_1)CS & S_2S \\ -(S_x-S_1)CS & -(S_xS^2+S_1C^2) & -S_2C & (S_x-S_1)CS & (S_xS^2+S_1C^2) & -S_2C \\ -S_2S & S_2C & S_4 & S_2S & -S_2C & S_3 \end{pmatrix}$$

University of Asia Pacific
Department of Civil Engineering
Mid Term Examination Spring 2018
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II | Course Code: CE 441
Time: 1 hour | Full Marks: 20

Answer all the questions. **(5 + 10 + 5 = 20)**

1. (a) In a deposit of normally consolidated dry sand, a CPT was conducted. The point resistance obtained at the depth of 9 m is 5000 kN/m^2. 2

The unit weight of the soil up to 12 m depth is given below:
Moist unit weight = 15.5 kN/m^3
Saturated Unit Weight = 18.5 kN/m^3

Water table is observed at the depth of 4.5 m.

Estimate relative density and effective angle of internal friction.

(b) Calculate the corrected undrained shear strength of the clay soil based on the vane shear test conducted in a saturated clay. 2

Vane Dimensions: Height = 101.6 mm, Diameter = 55 mm
Given that maximum torque applied was 0.45 N-m.
Soil properties: LL = 48%, PL = 29%

(c) At depth 18 m, N_{60} was calculated 15. Calculate $(N_1)_{60}$. 1

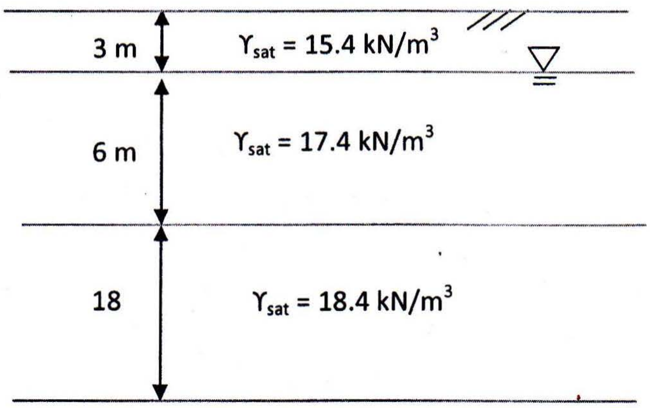


Figure 1

2. Calculate the following:

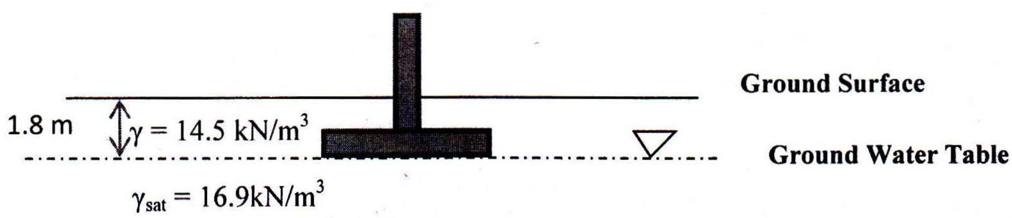
(a) the net allowable load if factor of safety of the rectangular footing (Figure 2) is 2, when the load is concentric but inclined 5° with the vertical. Given that the soil is homogeneous clay having cohesion of 28 kPa. 3

(b) the net ultimate bearing capacity of the footing (Figure 2), if eccentricity along footing length is 0.38 m and the load is vertical. Given that the soil is homogeneous sand having φ' of 32°. 3

(c) the ultimate (gross) bearing capacity of footing in medium dense sand overlying dense sand. 4

φ'of medium dense sand = 25°
φ'of dense sand = 45°
Water table is at the ground level.
The dimension of rectangular footing: 3 m x 4 m, and the depth of foundation is 2 m.

The upper layer extends upto 6.5 m below the ground level.



[Footing Dimension: 3 m x4m]

Figure 2

3. Sketch the failure surface and soil profile according to the data presented in the following table. 1

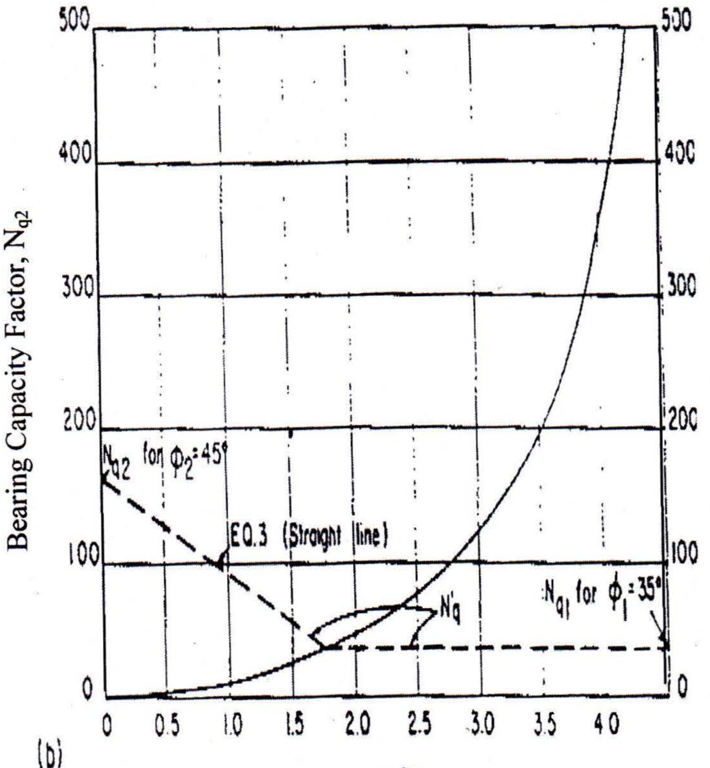
Calculate the factor of safety for slope stability applying Ordinary Method of Slices. 4

Slice No.	α (°)	b (m)	u (kPa)	W (kN/m)	c' (kPa)	φ′ (°)
1	51	2	0	66	0	30
2	36	2	10	146	0	30
3	28	1.3	17	108	0	30
4	24	0.7	18	55	1	22
5	15	2	18	140	1	22
6	2	2	14	100	1	22
7	-5	2	6	48	1	22
8	-20	2.5	0	25	1	22

Table: Shape, Depth and Inclination Factors

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

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



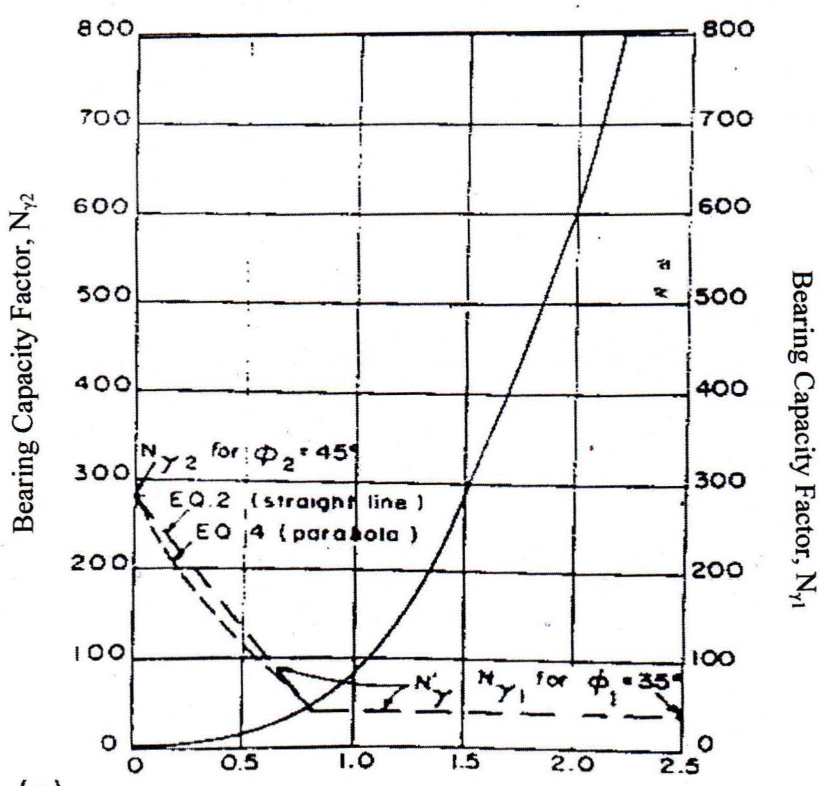


Table: Bearing Capacity Factors (Meyerhof's Chart)

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				

Correlations

$$D_r(\%) = 68\left[\log\left(\frac{q_c}{\sqrt{P_a\sigma'_0}}\right) - 1\right]$$

$$\varphi' = tan^{-1}\,[0.1 + 0.38\log\left(\frac{q_c}{\sigma'_0}\right)]$$

$$\varphi' = tan^{-1}\,[\frac{N_{60}}{12.2 + 20.3\,(\frac{\sigma'_0}{P_a})}]^{0.34}$$

$$\varphi' = \sqrt{20(N_1)_{60}} + 20$$

$$K = (\frac{\pi}{10^6})(\frac{D^2H}{2})(1 + \frac{D}{3H})$$

$$FS = \frac{\sum c'l + (Wcos\alpha - ul)tan\varphi'}{Wsin\alpha}$$

University of Asia Pacific
Department of Civil Engineering
Mid Term Examination Spring 2018
Program: B. Sc. Engineering (Civil)

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

Time: 1 hour — Full Marks: 30

[Assume Reasonable Values for Any Missing Data]

PART – A

There are **Three** questions in this section. Answer any **Two**. 5x (2) =10

1. Explain the load distribution pattern of flexible pavement.
2. Explain the advantages of cutback bitumen over bitumen emulsion.
3. Summarize the significance of penetration test and softening point test of bitumen?

PART – B

Answer the **following** question. 20x (1) =20

4. The aggregate mix used for the design of an asphalt mixture consists of *42%* coarse aggregates, *51%* fine aggregates, and *7%* mineral fillers. If the respective bulk specific gravities of these materials are *2.60, 2.71*, and *2.69*, determine the **optimum asphalt content** as a **percentage of the total mix** where results obtained using the Marshall method are shown in the following:

Percent Asphalt	Weight of Specimen (g)		Stability (lb)	Flow (0.01 in)	Maximum Specific Gravity of Paving Mixture
	In Air	In Water			
5.5	1325.3	785.6	1796	13	2.54
6.0	1330.1	793.3	1836	14	2.56
6.5	1336.2	800.8	1861	16	2.58
7.0	1342.0	804.5	1818	20	2.56
7.5	1347.5	805.1	1701	25	2.54

Also find out the **properties of the paving mixture** containing the optimum asphalt content.

Required Formula:

$$G_{mb} = \frac{W_a}{W_a - W_w} \qquad P_a = 100\frac{G_{mm} - G_{mb}}{G_{mm}}$$

$$G_{sb} = \frac{P_{ca} + P_{fa} + P_{mf}}{\frac{P_{ca}}{G_{bca}} + \frac{P_{fa}}{G_{bfa}} + \frac{P_{mf}}{G_{bmf}}} \qquad G_{se} = \frac{100 - P_b}{(100/G_{mm}) - (P_b/G_b)}$$

University of Asia Pacific
Department of Civil Engineering
Mid Term Examination, Spring 2018 Semester
Program: B.Sc. Engineering (Civil)

Course code: CE 461
Course title: Irrigation and Flood Control

Time: 1 hour Total marks: 40

Answer all questions

1. a) Summarize the benefits of irrigation and the harmful effects of excess irrigation. **(5)**
   b) Derive the relationship between depth of irrigation water, consumptive use of water and leaching requirement. **(4)**
   c) Summarize four factors that you should consider during planning an irrigation project that mostly rely on groundwater **(3)**
   d) Define the following: i) Weir ii) Barrage **(4)**

2. a) Explain four non-structural measures of flood control and management in Bangladesh? **(4)**
   b) Explain the following: i) Integrated Water Resources Management ii) Flood Management **(4)**

3. a) What are the classifications of irrigation water having the following characteristics: Concentration of Na, Ca and Mg are 28, 2 and 3 milli-equivalents per liter respectively, and the electrical conductivity is 350 μmhos/cm at 25° C? **(4)**
   b) What problems might arise in using this water for irrigation? **(1)**
   c) What remedies do you suggest to overcome this trouble? **(1)**

4. a) Explain *sub-surface irrigation*. **(5)**
   b) Determine the time required to irrigate a strip of land of 600 m^2 in area from a tube-well with a discharge of 0.05 m^3/second. The infiltration capacity of the soil may be taken as 1 millimeter/minute and the average depth of flow on the field as 200 millimeter. **(5)**