3-2

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2019
Program: B.Sc in Civil Engineering

Course Title: Principles of Management   Course Code: IMG 301   Credit: 2

Time: 2 Hours   Full Marks: 50

(Answer all the questions)

1.	(a)	Differentiate between programmed and nonprogrammed decisions.	(3.5)
	(b)	Explain different types of decision makes with examples.	(6)
	(c)	Explain decision making matrix.	(3)
2.	(a)	Explain five alternatives to job specialization.	(5)
	(b)	Explain the steps in the delegation process.	(3.5)
	(c)	Explain the factors influencing the span of management.	(4)
3.	(a)	Explain six traits that differentiate leaders from non-leaders.	(6)
	(b)	Explain the continuum of leader behavior.	(6.5)
4.		Explain the two-factor motivational theory.	(12.5)

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: B.Sc. Engineering (Civil)

Course Title: Design of Concrete Structures II | Course Code: CE317
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 150

Assume reasonable values for any missing data. Symbols used have their usual meanings.
[Use $f_c' = 30\ N/mm^2$ and $f_y = 420\ N/mm^2$ for all design]

QUESTION 1 [30 MARKS]

a. The **corner panel (A)** of beam supported reinforced concrete slab of an office building as shown in **Figure 1** is to be designed. The slab is subjected to 7.2 kN/m^2 dead load (including self-weight, random wall and finishes) and 2.4 kN/m^2 live load. The thickness of slab could be assumed as 125 mm. Apply design concept to obtain reinforcements for bending moments at mid-span and support of short span of slab panel "A". The co-efficient of moments are listed in **Table 1**. [15]

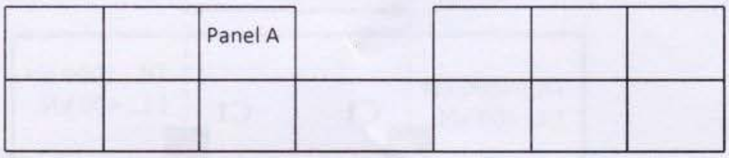


Figure 1(a). Floor slab

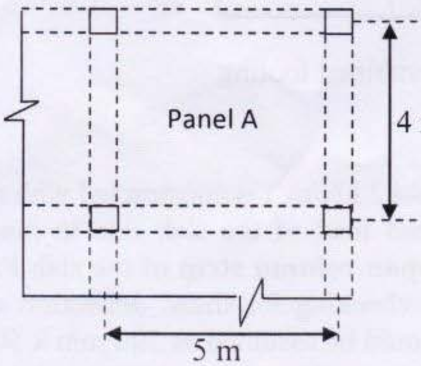


Figure 1(b). Details of corner slab

Table 1: Moment coefficients of corner slab (short span)

Span Ratio	Positive Moment		Negative Moment
	Live load	Dead Load	
0.8	0.048	0.039	0.071

b. *"Eccentric tendon is economical choice for post-tensioned pre-stressing system".* Justify the statement through analysis of the girder shown in **Figure 2**. The girder of 10 meter span is carrying 15 kN/m live load and 30 kN/m dead load (including self-weight of beam). The section of the rectangular beam is 250 mm x 800 mm. The eccentricity of the tendon is 250 mm below the centre at mid span of the beam. [15]

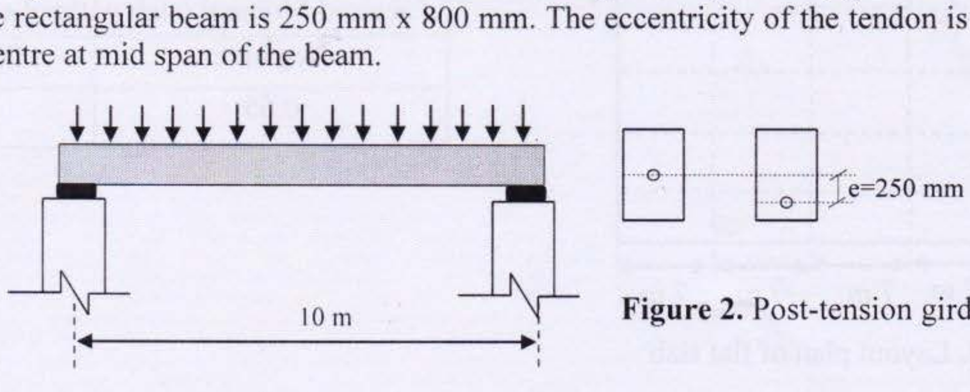


Figure 2. Post-tension girder

QUESTION 2 [30 MARKS]

a. A reinforced concrete column is required to design for 2000 kN dead load and 700 kN live load. Apply design concept to obtain size and reinforcements of the column as tied and spiral columns and show reinforcement details. The minimum steel ratio (As/Ag) 0.01 could be used to design the spiral and tied columns. Assume required data to design the columns. [15]

b. Two tied columns of **Question 2(a)** are supported by combined footing as shown in **Figure 3**. The bearing capacity of soil is 170 kN/m^2. Apply the concept to design the footing for **long span only**. The depth (h) of footing and size of each column could be assumed as 500 mm and 500 mm x 50 mm respectively. Assume required data to design the footing. [15]

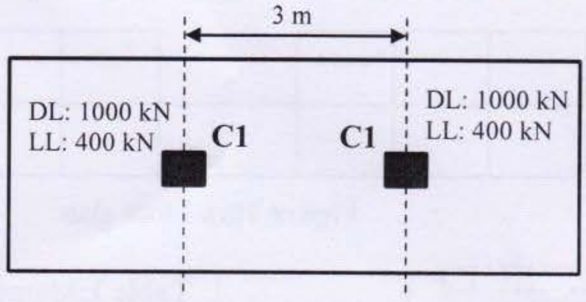


Figure 3. Layout plan of combined footing

QUESTION 3 [30 MARKS]

a. The floor of 6 storeyed residential building (live load 2 kN/m^2) is constructed with reinforced concrete flat slab as shown in **Figure 4**. The dead load of the slab due to random wall (excluding self-weight) is 2 kN/m^2. Design **long span column strip** of the slab **Panel A (7 m x 6 m)** of the floor as shown in **Figure 4** with checking for shear, deflection and crack. Assume required data to design. The column size could be assumed as 500 mm x 500 mm. [15]

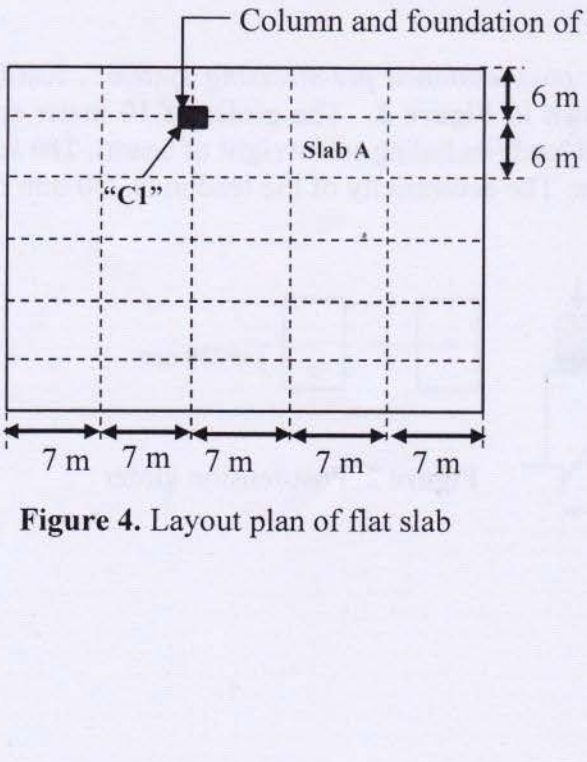


Figure 4. Layout plan of flat slab

Table 2: Distribution of total factored static moment (M_0) for flat slab of interior span

Factored Moment (slab without edge beam)	
Negative	Positive
0.65	0.35

b. The interior column **C1 (Figure 4)** of 6 storeyed residential building stated in **Question 3(a)** is required to design as **tied column** for axial load and 300 kN.m uniaxial bending moment. The smaller dimension of column is 300 mm. Design the first floor column of "C1"with economical design and show reinforcements details. Use **column design chart** as shown in attachment to design the column. [15]

QUESTION 4 [30 MARKS]

a. Design the isolated base of the column **"C1"** of **Question 3(b)** as shown in **Figure 4.** Provide optimal depth of base considering all critical parameters. The safe bearing capacity of soil is 170 kN/m^2. [15]

b. A reinforced concrete cantilever retaining wall of hilly area as shown in **Figure 5** is subjected to lateral load due to soil and pore water pressure. Design the wall for bending moment and check for shear. The density of soil and water is 1800 kg/m^3 and 1000 kg/m^3 respectively, coefficient of active soil pressure is 0.33. Because of pore water, 30% water pressure could be used to analyze the wall. Assume required data to design. [15]

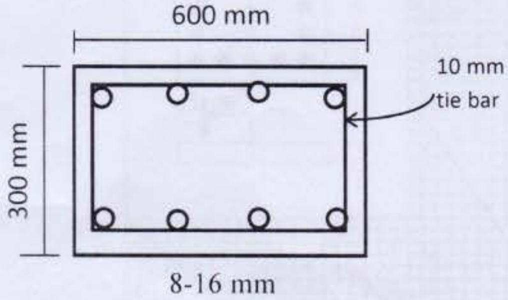


Figure 6. Sections of column

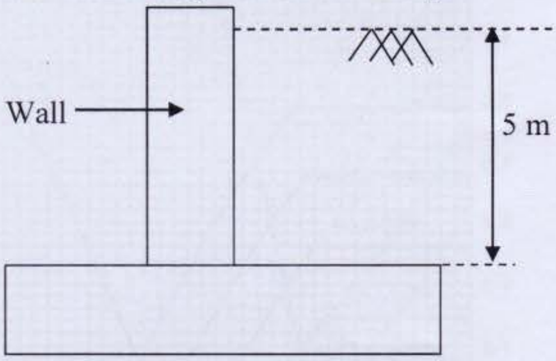


Figure 5. Retaining wall

QUESTION 5 [30 MARKS]

a. As design checker, evaluate and justify whether the reinforced concrete column as shown in **Figure 6** could sustain 2500 kN axial load and 250 kN.m bending moment at balanced failure condition in shorter direction of the column. If not, propose optimal solution by increasing number or size of bars to resist the load and moment. Assume required information for analysis of the column. [15]

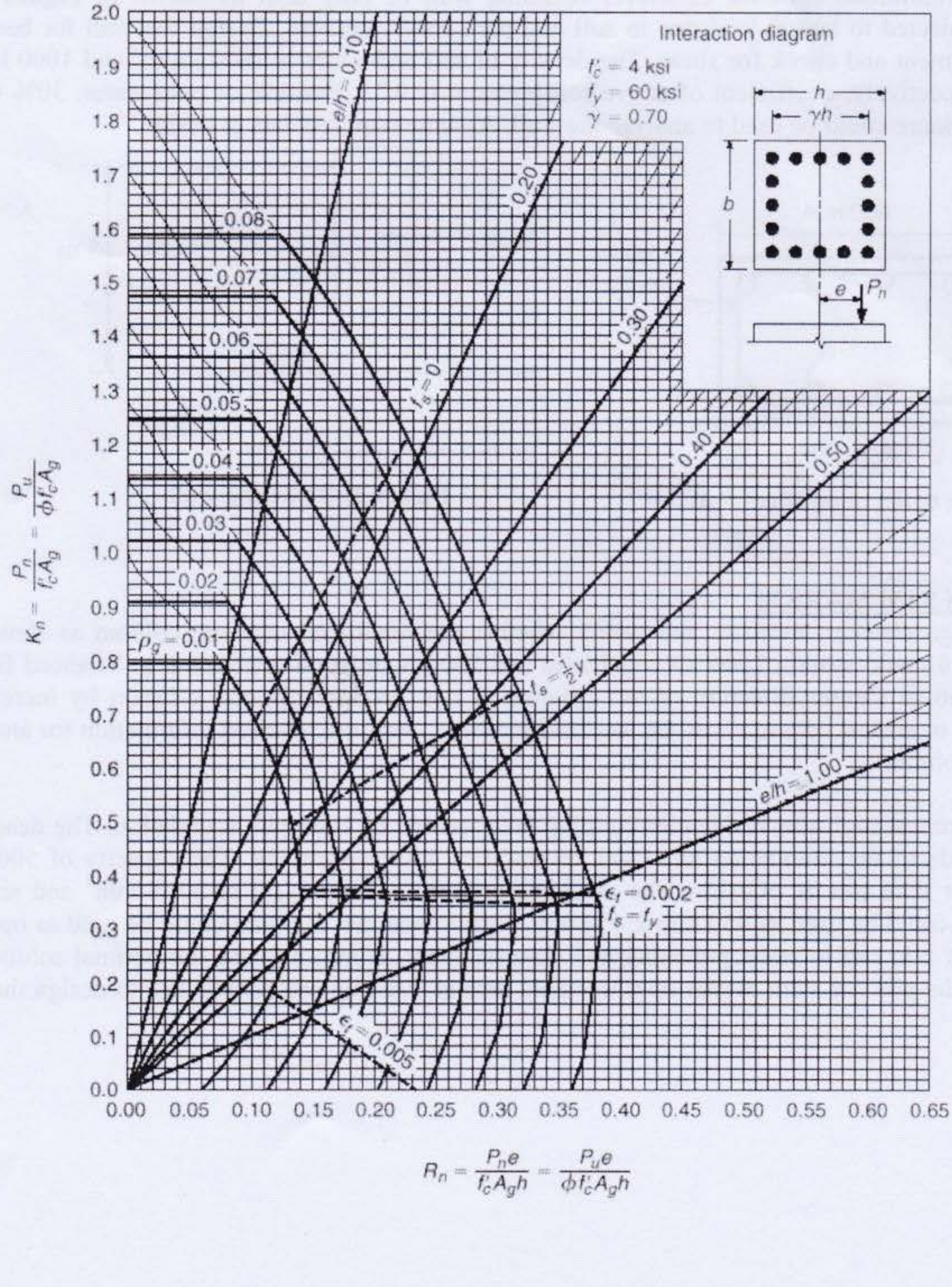
b. A column of high rise residential building is supported by bore pile foundation. The dead and live loads of the foundation are 1800 kN and 600 kN respectively. The capacity of 500 mm diameter bore pile is 600 kN. The available concrete strength (f_c') is 20 N/mm^2 and size of column could be used as 450 mm x 450 mm. Justify whether, 600 mm could be used as optimal depth of pile cap to resist punching and flexural shear. If not, propose the optimal solution to design the pile cap with proper reinforcement details. Assume reasonable data to design the pile cap. [15]

APPENDIX

Direct Design Method:

Minimum thickness of Flat Slab

Exterior Panels without Edge Beams	Exterior Panels with Edge Beams	Interior Panels
$L_n/33$	$L_n/36$	$L_n/36$



University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering II — Course Code: CE 333
Time: 3 hours — Credit Hour: 3.00 — Full Marks: 150

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

1. (a) What is the main difference between ROEC and VIP latrines? **[5]**
   (b) Why an aerated grit chamber is used in large treatment plants? **[5]**
   (c) A clarifier is designed to have a surface overflow rate of 35.0 m^3/m^2.d. Compute overall removal efficiencies with settling analyses data, illustrated in following table. The water temperature is 15°C, and particle specific gravity is 1.20. At 15°C the kinematic viscosity of water, μ is 0.00113kg/(s.m) and specific gravity of water ρ is 0.9990. **[20]**

Particle size mm	Weight fraction <size, %
0.10	10
0.08	25
0.07	45
0.06	78
0.05	87
0.04	95
0.02	99
0.01	100

Use the following equation if required: $V_a = \dfrac{g(\rho_s - \rho)d^2}{18\mu}$

2. (a) Why aeration tank is used in a secondary treatment process? **[7.5]**
   (b) Explain the operational principles of sequential batch reactors. **[7.5]**
   (c) Why oxygen demand is lower at the effluent end of a plug flow basin? **[7.5]**
   (d) Why a trickling filter or RBC reactor is followed by a secondary clarifier? **[7.5]**

3. (a) Write short notes on: (i) three sludge nitrogen removal; (ii) modified Bardenpho phosphorus removal processes. **[7.5]**
   (b) "Denitrification can be achieved in secondary clarifiers of a tertiary treatment process"-justify the statement. **[7.5]**
   (c) What are the main principles of CETP process? **[7.5]**
   (d) What are the advantages of two pipe building drainage systems when compared with one pipe network? **[7.5]**

4. Design two stage trickling filters using NRC formula from the following dataset: [30]

- Water temperature= 30°C
- Incoming wastewater= 4000 m^3/d
- Influent BOD=350 mg/L
- Estimated effluent BOD=15 mg/L
- Depth of each filter=2 m
- Recirculation for filter 1 and 2 ($r_1=r_2$) =1.5
- Assume both filters will have equal BOD removal efficacy

Use the following equations: $E_1 + E_2(1 - E_1) = E$ $\quad F = \dfrac{1+r}{(1+0.1r)^2}$

$$E_1 = \frac{100}{1+0.532\sqrt{\dfrac{W}{VF}}} \qquad E_2 = \frac{100}{1+\dfrac{0.532}{1-E_1}\sqrt{\dfrac{W'}{VF}}}$$

5. (a) Explain how simultaneous nitrification, denitrification and phosphorus removal can be achieved employing two stage vertical flow wetlands. [7.5]
   (b) What is the role of plants in constructed wetland systems? [7.5]
   (c) "In a stabilization pond series, anaerobic pond is not required for the treatment of high strength wastewater"-is the statement true or false? Justify your answer. [7.5]
   (d) How sludge dewatering occurs in sludge drying beds? [7.5]

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering II | Course Code: CE 313
Time: 3 hour | Credit Hour : 3.0 | Full Marks: 100

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

PART-A

1. Using Virtual Work Method, calculate the vertical deflection of joint E of the truss shown in ***Fig. 1*** [Given: E=200000 MPa and A= 400 mm^2 for all members]. **[12]**

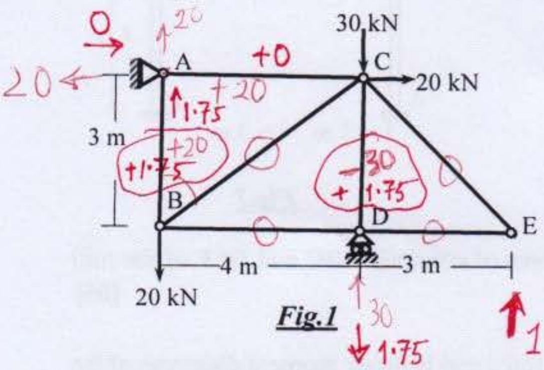


Fig.1

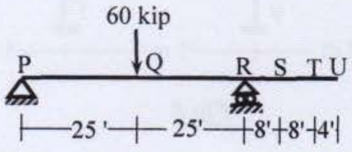


Fig.2

2. Calculate the vertical deflection at **T** and rotation at **S** of the beam shown in ***Fig.2*** [Given: EI=Constant]. **[12]**

3. Using Force Method determine the bar forces of the truss shown in ***Fig.3*** [Given: EA=Constant]. **[12]**

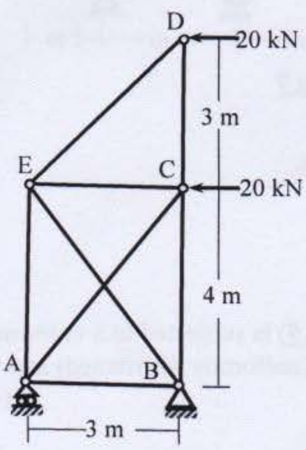


Fig.3

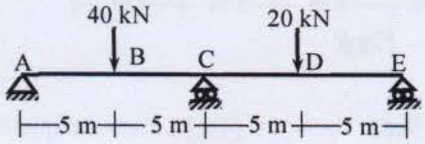


Fig.4

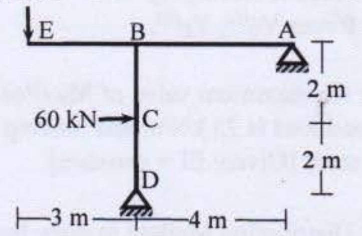


Fig.5

4. Using Force Method, calculate the support reactions of the beam shown in ***Fig.4*** **[14]**

OR

Using Force Method, draw the bending moment diagram of the frame shown in ***Fig.5*** [Given: EI=Constant].

PART-B

5. Use Cantilever Method to draw the axial force, shear force and bending moment diagrams of the frame **GHIJKL** shown in ***Fig.6***. **[10]**

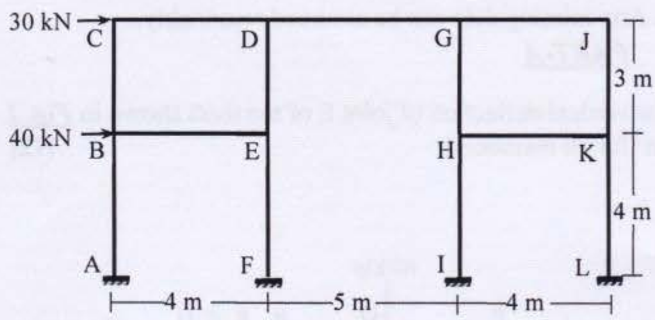


Fig.6

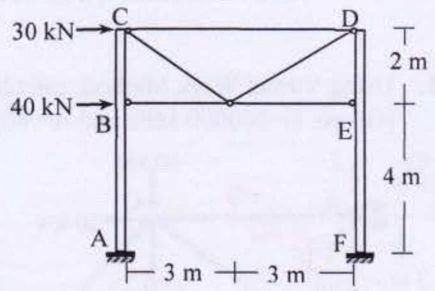


Fig.7

6. Use Portal Method to draw the bending moment diagrams of columns ABC and DEF of the mill bent shown in ***Fig.7***. **[05]**

7. Use the Moment Distribution Method to draw the shear force and bending moment diagrams of the beam shown in ***Fig.8***
[Given:E=200 GPa , I = 90×10^6 mm^4]. **[10]**

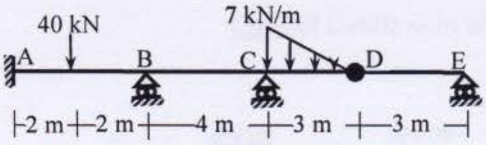


Fig.8

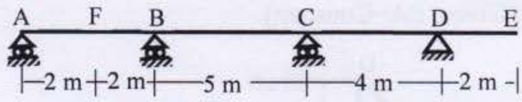


Fig.9

8. (i) For the beam shown in ***Fig.9***, draw the qualitative influence lines,
   (a) Bending moments M_C, M_F
   (b) Support reactions R_C, R_D and
   (c) Shear forces $V_D^{(L)}$, $V_C^{(R)}$.

(ii) Calculate the maximum value of $\mathbf{M_F}$ (Positive), if the beam (***Fig.9***) is subjected to a uniformly distributed dead load is 25 kN/m and moving live loads of 20 kN/m (uniformly distributed) and 40 kN (concentrated) [Given: EI = constant]. **[15]**

9. Use Moment Distribution Method to draw bending moment diagram of the frame shown in ***Fig.10***
[Given=200 GPa , I_{AB} = 120×10^6 mm^4 and $I_{BC/CD}$ = 90×10^6 mm^4]. **[10]**

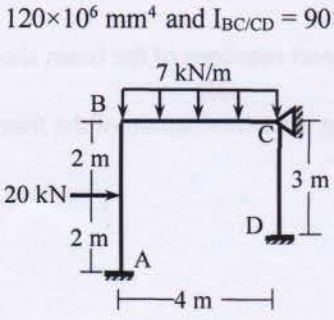
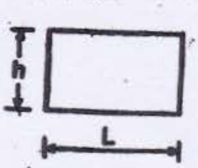
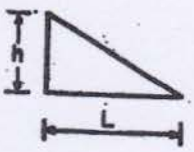
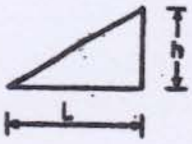
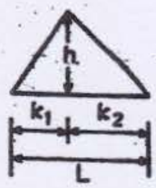
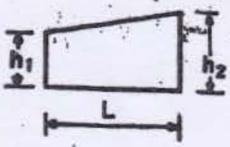
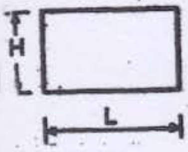
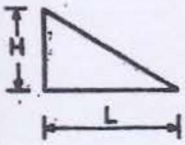
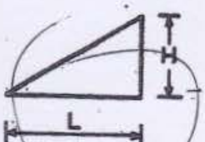
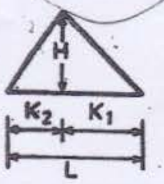
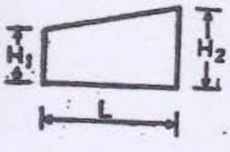
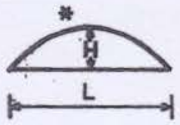
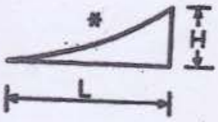
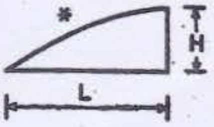


Fig.10

PRODUCT INTEGRALS $\int_0^L m_0 m_1 \, dx$

m_i-diagram (m_1) / M-diagram or m_k-diagram (m_0)	 (1)	 (2)	 (3)	 (4)	 (5)
	hHL	$\frac{1}{2}hHL$	$\frac{1}{2}hHL$	$\frac{1}{2}hHL$	$\frac{HL}{2}(h_1 + h_2)$
	$\frac{1}{2}hHL$	$\frac{1}{3}hHL$	$\frac{1}{6}hHL$	$\frac{hH(L + k_2)}{6}$	$\frac{HL}{6}(2h_1 + h_2)$
	$\frac{1}{2}hHL$	$\frac{1}{6}hHL$	$\frac{1}{3}hHL$	$\frac{hH(L + k_1)}{6}$	$\frac{HL}{6}(h_1 + 2h_2)$
	$\frac{1}{2}hHL$	$\frac{hH(L + K_2)}{6}$	$\frac{hH(L + K_1)}{6}$	$k_1 < K_1$: $\frac{hHL}{6k_2K_1}(L^2 - k_1^2 - K_2^2)$; $k_1 > K_1$: $\frac{hHL}{6k_1K_2}(L^2 - k_2^2 - K_1^2)$	$\frac{H}{6}\left[h_1(L + K_2) + h_2(L + K_1)\right]$
	$\frac{hL}{2}(H_1 + H_2)$	$\frac{hL}{6}(2H_1 + H_2)$	$\frac{hL}{6}(H_1 + 2H_2)$	$\frac{h}{6}[H_1(L + k_2) + H_2(L + k_1)]$	$\frac{L}{6}(2h_1H_1 + 2h_2H_2 + h_1H_2 + h_2H_1)$
	$\frac{2}{3}hHL$	$\frac{1}{3}hHL$	$\frac{1}{3}hHL$	$\frac{Hh}{3L}(L^2 + k_1k_2)$	$\frac{1}{3}HL(h_1 + h_2)$
	$\frac{1}{3}hHL$	$\frac{1}{12}hHL$	$\frac{1}{4}hHL$	$\frac{hH}{12L}(L^2 + k_1L + k_1^2)$	$\frac{HL}{12}(h_1 + 3h_2)$
	$\frac{2}{3}hHL$	$\frac{1}{4}hHL$	$\frac{5}{12}hHL$	$\frac{hH}{12L}(5L^2 - k_2L - k_2^2)$	$\frac{HL}{12}(3h_1 + 5h_2)$

*Second degree parabola.

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019

Course: CE 363 — Course Title: Engineering Hydrology
Full Marks: 150 — Time: 3 Hours

Assume any reasonable value, if not given.

Sec-A is compulsory, answer any FOUR from the other FIVE in Sec-B (50+25*4=150).

Sec-A

1(a). Evaluate average rainfall for the catchment area shown in Figure-1 using Thiessen polygon method. Ordinates of four rain gauge stations are A (4,13), B (7,5), C (8,10), D (2,8) and rainfall recorded in those stations are A (21cm), B (19cm), C (25cm), D (15cm). Solve this problem using the sheet having Figure-1 and attach it with the answer script. (15)

1(b). The ordinates of a storm hydrograph of the canal draining the catchment area shown in Figure-1 due to an 8-hour isolated storm are given bellow. Find the ordinates of the 8-hour unit hydrograph for the catchment. (15)

Time from start (Hour)	0	8	16	24	32	40	48
Discharge (m^3/s)	4	4	12	35	48	41	34

Time from start (Hour)	56	64	72	80	88	96	104
Discharge (m^3/s)	28	24	17	11	7	6	5

1(c). Water body shown in Figure-1 has the following elevation, storage and discharge relationship.

Elevation (m)	90.5	91.0	91.5	92.0	92.5	93.0	93.5	94.0
Storage (m^3)	3.36	3.50	3.93	4.36	4.90	5.33	5.55	5.87
Discharge (m^3/s)	0	12	23	48	75	105	120	125

When the elevation was 91m, the following flood entered in the water body. Route the flood and determine the outflow hydrograph. (20)

Time (Hour)	0	8	16	24	32	40	48	56	64	72
Discharge (m^3/s)	14	22	28	73	56	35	55	20	13	10

Sec-B

2(a). Distinguish between: (4+4)

I. Potential evapotranspiration and Actual evapotranspiration;

II. Field capacity and Permanent wilting point.

2(b). Calculate the potential evapotranspiration from the catchment shown in Figure-1 in the month of February by penman's formula. (17)

Latitude	: 23.81^0 N
Elevation	: 4 m (above sea level)
Mean monthly temperature	: 17^0C
Mean relative humidity	: 73%
Mean observed sunshine hours	: 8 hours
Wind velocity at 2m height	: 120 km/day
Nature of surface cover	: Bare land and water body

3(a). Simulate different types of streams based on flood hydrograph. (9)

3(b). The ordinates of a 6-hour unit hydrograph of a catchment are given below.

Time (Hour)	0	6	12	18	24	30	36	42	48	54	60	66
6h UH(m^3/s) ordinates	0	45	110	135	170	155	120	100	75	50	32	15

Find the 6-hour flood hydrograph in the catchment for the storm given below. The storm loss rate is estimated 0.2 cm/h. The base flow is 12 m^3/s and increased by 3.0 m^3/s for every 12 hours till the end of the direct runoff hydrograph. (16)

Time from start of storm (Hour)	0	6	12	18
Accumulated Rainfall (cm)	0	3	10	16

4(a) What is attenuation and time lag? How to choose Δt? (4+3=7)

4(b). Following inflow and outflow hydrographs were observed in the canal shown in Figure-1. Find the values of K and x applicable to this reach for use in the Muskingum equation. (18)

Time (Hour)	0	4	8	12	16	20	24	28	32	36	40	44	48
Inflow (m^3/s)	3	15	28	45	50	42	37	26	22	15	12	10	7
Outflow (m^3/s)	3	8	15	22	35	48	49	36	30	22	17	13	8

5(a). Determine the ordinates of 9-hour unit hydrograph using method of superposition from the 3-hour unit hydrograph given below. (10)

Time (Hour)	0	3	6	9	12	15	18	21	24	27	30	33	36	39
3h UH ordinates (m^3/s)	0	10	25	40	65	75	60	48	35	26	14	8	3	0

5(b). Determine the ordinates of 4-hour unit hydrograph using S-curve method from the 8-hour unit hydrograph given below. (15)

Time (Hour)	0	8	16	24	32	40	48	56	64	72	80	88	96
8h UH ordinates (m^3/s)	0	40	100	160	220	250	190	170	120	75	40	15	0

6(a). Flood frequency computations by using Gumbel's method for the canal shown in Figure-1 had the following results.

Return period (years)	100	200
Peak flood (m^3/s)	3435	3748

Predict the flood magnitude in this canal with a return period of 400 years. Also estimate the 90% confidence limits for these estimates if the probable error is 75. (13)

6(b). The data concerning to a stream-gauging operation at section AA' of the canal shown in Figure-1. Determine the discharge in the stream with the following data. (12)

Distance from the left (m)	0	3	8	12	17	23	28	33	35
Depth (m)	0	2	3.5	4.1	4.9	4.3	3.8	2.3	0
Velocity at 0.2m depth (m^3/s)	0	0.2	0.33	0.39	0.35	0.32	0.24	0.15	0
Velocity at 0.6m depth (m^3/s)	0	0.18	0.3	0.35	0.33	0.27	0.22	0.13	0

You may use the followings

$$H_n = H_a(1-r)\left(a + b\frac{n}{N}\right) - \sigma T_a^4\left(0.56 - 0.092\sqrt{e_a}\right)\left(0.10 + 0.90\frac{n}{N}\right)$$

$$E_a = 0.35\left(1 + \frac{u_2}{160}\right)\left(e_w - e_a\right)$$

c in per cent	50	68	80	90	95	99
$f(c)$	0.674	1.00	1.282	1.645	1.96	2.58

Usual ranges of values of r are given below:

Surface	range of r values
Close ground crops	0.15 - 0.25
Bare lands	0.05 - 0.45
Water surface	0.05
Snow	0.45 - 0.95

SATURATION VAPOUR PRESSURE OF WATER

Temperature (°C)	Saturation vapour pressure e_w (mm of Hg)	A (mm/°C)
0	4.58	0.30
5.0	6.54	0.45
7.5	7.78	0.54
10.0	9.21	0.60
12.5	10.87	0.71
15.0	12.79	0.80
17.5	15.00	0.95
20.0	17.54	1.05
22.5	20.44	1.24
25.0	23.76	1.40
27.5	27.54	1.61
30.0	31.82	1.85
32.5	36.68	2.07
35.0	42.81	2.35
37.5	48.36	2.62
40.0	55.32	2.95
45.0	71.20	3.66

$e_w = 4.584 \exp\left(\frac{17.27\,t}{237.3 + t}\right)$ mm of Hg, where t = temperature in °C

TABLE MEAN MONTHLY SOLAR RADIATION AT TOP OF ATMOSPHERE, H_a IN mm OF EVAPORABLE WATER/DAY

North latitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0°	14.5	15.0	15.2	14.7	13.9	13.4	13.5	14.2	14.9	15.0	14.6	14.3
10°	12.8	13.9	14.8	15.2	15.0	14.8	14.8	15.0	14.9	14.1	13.1	12.4
20°	10.8	12.3	13.9	15.2	15.7	15.8	15.7	15.3	14.4	12.9	11.2	10.3
30°	8.5	10.5	12.7	14.8	16.0	16.5	16.2	15.3	13.5	11.3	9.1	7.9
40°	6.0	8.3	11.0	13.9	15.9	16.7	16.3	14.8	12.2	9.3	6.7	5.4
50°	3.6	5.9	9.1	12.7	15.4	16.7	16.1	13.9	10.5	7.1	4.3	3.0

TABLE MEAN MONTHLY VALUES OF POSSIBLE SUNSHINE HOURS, N

North latitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0°	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
10°	11.6	11.8	12.1	12.4	12.6	12.7	12.6	12.4	12.9	11.9	11.7	11.5
20°	11.1	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
30°	10.4	11.1	12.0	12.9	13.7	14.1	13.9	13.2	12.4	11.5	10.6	10.2
40°	9.6	10.7	11.9	13.2	14.4	15.0	14.7	13.8	12.5	11.2	10.0	9.4
50°	8.6	10.1	11.8	13.8	15.4	16.4	16.0	14.5	12.7	10.8	9.1	8.1

Attach this page with the answer script

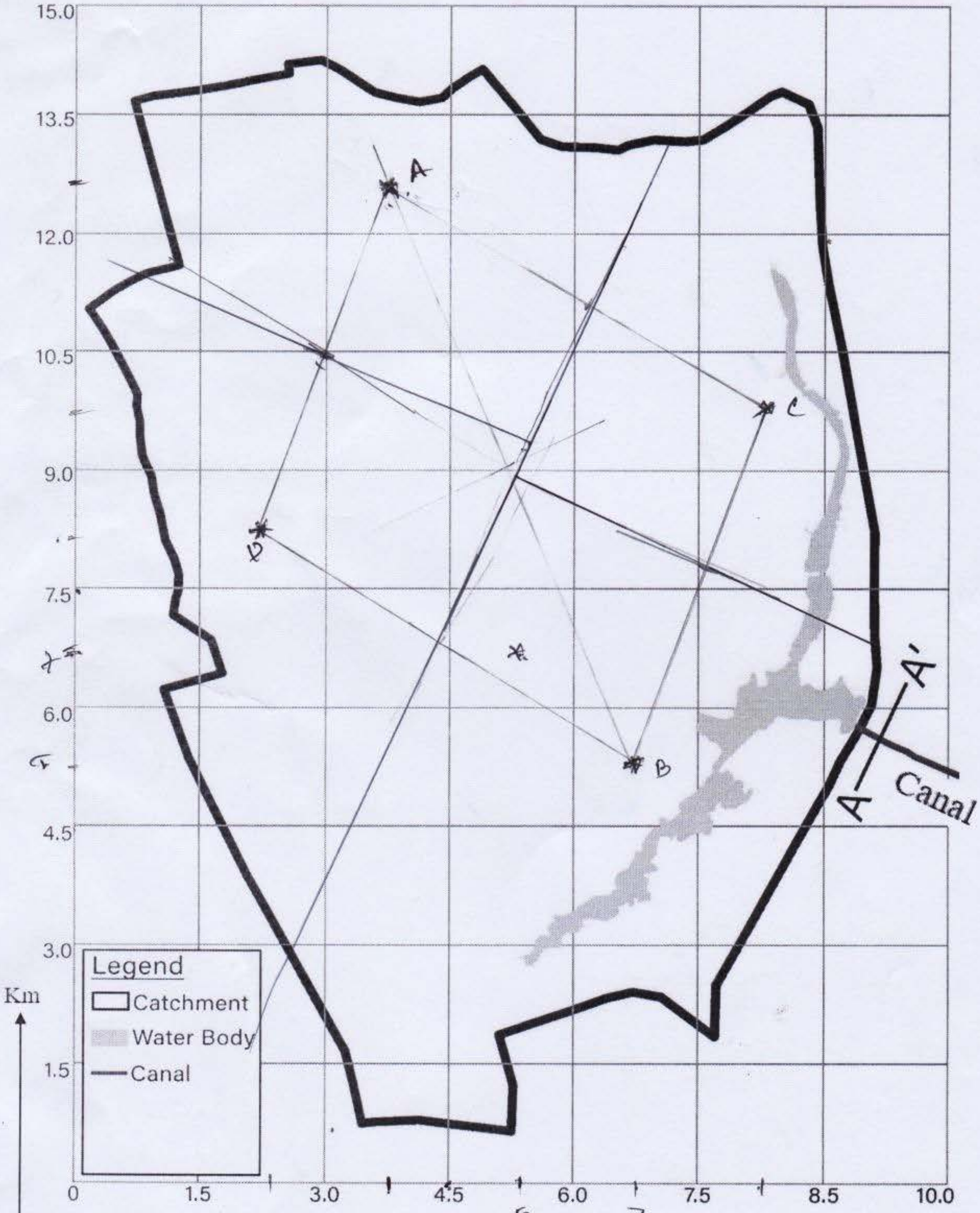


Figure-1

University of Asia pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering I (Transport and Traffic Design)		Course Code: CE 351
Time: 3 hours	Credit Hour: 3.00	Full Marks: 150

There are **five** questions. Answer **all** of them.

1. a) A driver perceived a pedestrian 180 ft ahead of him while driving at a speed 60 mph. Evaluate whether the driver can avoid accident or not if deceleration rate is 10.5 ft/sec^2. If not determine the driver's PR (perception reaction) time. 12

Or

b) A vehicle initially traveling at 55 km/h skids to a stop on a 6% downgrade, where the pavement surface provides a coefficient of friction equal to 0.3. How far does the vehicle travel before coming to a stop?

c) Design the offsets at certain interval for a transition curve which is to be used to join the ends of a 5.5^0 circular curve with the straight. The length of transition curve is 550 m. Draw the transition curve. 10

d) Summarize the factors to evaluate the effectiveness of traffic calming devices. 8

2. a) Briefly explain the impacts of transportation sector in Environmental and Cultural developments of Bangladesh. 16

b) An accident supervisor presumed that a bus collided with a tree at a speed of 18 km/hr. determined by her estimation of damage. Examining the accident location she identified skid marks of 30 m on the concrete pavement (f=0.345) and 25 m on the mud shoulder (f=0.425). There is +4% grade. Determine the speed of the vehicle at the commencement of skid marks. 14

3. a) 50 vehicles traversing a section of a major arterial road with spot speeds as below: 25
53, 75, 40, 33, 62, 65, 72, 47, 45, 68, 49, 76, 55, 79, 56, 42, 85, 44, 53, 87, 66, 36, 68, 67, 73, 69, 78, 57, 47, 65, 39, 55, 37, 39, 32, 56, 44, 74, 54, 49, 56, 51, 35, 55, 67, 63, 48, 77, 42, 83.
Determine the, average speed, safe speed, design speed and lower limit of speed. Consider pace as **10-19, 20-29** and so on.

b) List the factors that affect the choice of a particular type of mode. 5

4. a) Determine the minimum length of vertical curve that must be provided to connect a +6% grade with -2% grade on á highway with a design speed 60 mi/hr. Driver reaction time is the AASHTO standard 2.5 sec for simple highway stopping reactions. Assume height of driver's eye to be 3.5ft, object height to be 1.5 ft. 15

b) A large grain elevator is sited 50 ft from the centerline of a two-lane highway, which has 11 feet wide lanes. The elevator is located on the inside of a horizontal curve with a radius 650feet. Assume that the elevator is the only sight restriction on the curve, estimate the minimum sight distance along the curve. 15

5. a) An urban primary road with 55 ft pavement width having a reflectance of 12% carries a maximum of 1360 vph at night-time. Design the lighting system considering Tungsten source with mounting height of 20 ft and a maintenance factor of 0.768. Draw the 18

lighting layout.

b) Briefly explain 'Stopping Sight Distance' and 'Passing Sight Distance' in the context of highway design. 12

Necessary equations:

$$S < L: \quad L = \frac{AS^2}{100(\sqrt{2h_1} + \sqrt{2h_2})^2}$$

$$S > L: \quad L = 2S - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A}$$

$$S < L: \quad L = \frac{AS^2}{200[2.0 + S(\tan 1^\circ)]}$$

$$S > L: \quad L = 2S - \frac{200[2.0 + S(\tan 1^\circ)]}{A}$$

Table for Question 5 a)

TABLE 1 RECOMMENDED AVERAGE ILLUMINATION (LUMENS/FT^2)

Pedestrian traffic[1]	Vehicular traffic[2] (vph)			
	Very light (<150 vph)	Light (150 – 500 vph)	Medium (500 – 1,200 vph)	Heavy (>1,200 vph)
Heavy	-	0.8	1.0	1.2
Medium	-	0.6	0.8	1.0
Light	0.2	0.4	0.6	0.8

Notes: (1) Heavy: As on main business street
Medium: As on secondary business streets
Light: As on local streets
(2) Night hour flow in both directions

TABLE 2 ADJUSTMENT FACTORS FOR RECOMMENDED AVERAGE ILLUMINATION VALUES

Surface Reflectance	Adjustment Factors
3 % or less	1.5
10%	1.0
20% or more	0.75

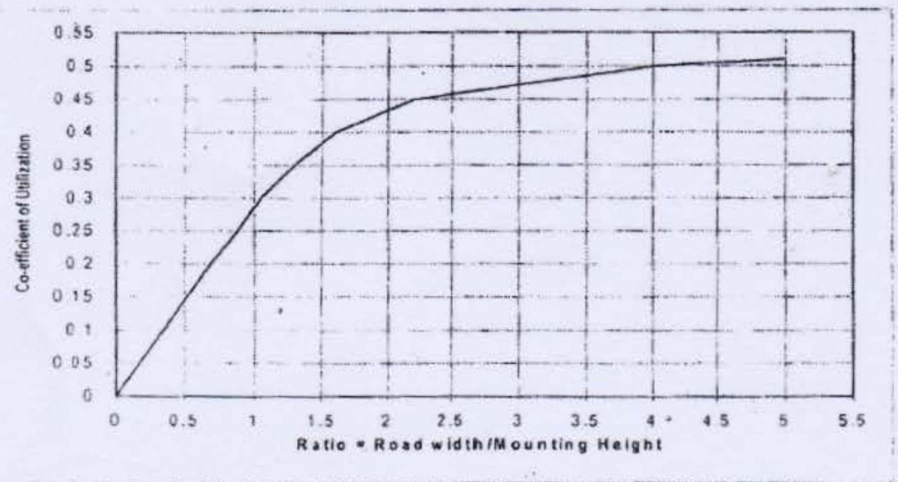
TABLE 3 LIGHTING SOURCE CHARACTERISTICS

Source Types	Expected Life (hrs)	Lighting Efficiency (Lumens/Watt)	Wattage (Watt)
Tungsten	1000	8 – 14	Up to 1000
Fluorescent	6000	50 – 75	Up to 250
Sodium	6000	100 – 120	Up to 160
Mercury	7500	20 – 60	Up to 400

TABLE 4 RECOMMENDED ARRANGEMENT OF STREET LIGHTING

Type of Arrangement	Pavement Width
One side	Width <= 30ft
Both sides – Staggered	30ft > Width <= 60ft
Both sides – Opposite	Width > 60ft

FIGURE 1 CO-EFFICIENT OF UTILIZATION CURVES (FOR LIGHT DISTRIBUTION TYPE III)



Note: Due to poor maintenance, the actual co-efficient of utilization is reduced by a factor usually 0.8 (i.e. taken as 80%).