L-3/T-2/WRE **Date: 12/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **WRE 303** (Hydrology)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Define the components of 'initial Loss; in hydrologic cycle. **(5)**

(b) Ordinates of 4-hr UH for a catchment are given below. Derive the 3-hr UH for the same catchment. **(15)**

Time (hr)	0	4	8	12	16	20	24	28	32	36	40	44
Ordinate of UH (m^3/s)	0	20	80	120	160	130	90	50	30	15	5	0

(c) The ordinates of a storm hydrograph of a river draining a catchment area of 500 km^2 due to a 6-hr rainfall are given below. Derive the ordinates of a 6-h unit hydrograph. **(15)**

Time (hr)	0	6	12	18	24	30	36	42	48	54	60	66	72
Ordinate of UH (m^3/s)	50	150	300	250	200	150	120	100	85	75	65	55	50

Consider, end of direct runoff to be 72 hours from the start of storm event.

2. (a) Define (i) Marshes, and (ii) Soil Moisture. **(5)**

(b) The average rainfall values over a catchment in three successive 4-h intervals are known to be 5.5, 1.5 and 3.5 cm. The φ-index for the catchment is estimated to be 0.25 cm/hr. At the beginning the base flow is 10 m^3/s and it increases by 1 m^3/s every 8 hr till the end of direct runoff. Estimate the resulting flood hydrograph. Use the 4-hr unit hydrograph (UH) ordinates from the table below. **(15)**

Time (hr)	0	4	8	12	16	20	24	28	32	36	40	44
Ordinate of UH (m^3/s)	0	20	80	130	150	130	90	52	27	15	5	0

(c) The design precipitation intensity for a storm with a T-year return period with slope of 0.005 and maximum length of travel of water of 1000 m for the catchment is 3.8 in/hr. Estimate the **design return period** (T). Also estimate the **design precipitation volume** (m^3). Find out the **design peak discharge** (in m^3/s) using rational method for the catchment. The area of the catchment is 2 km^2 and runoff coefficient is 0.5. Use the IDF curves (Fig. 1) and Kirpich formula for your estimation. **(15)**

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3. (a) Explain in brief the use of Plotting Position formula in flood frequency analysis. **(5)**

(b) Annual maximum recorded floods (Q) in a river for the year 2007 - 2020 are given below. Verify whether the Gumbel extreme value distribution fit the recorded values. Estimate the flood discharge with the return periods of (i) 100 years and (ii) 500 years by graphical extrapolation (Use Semi-Log paper). Given, $y_n = 0.51$ and $s_n = 1.0095$ for N = 14. The notations have their usual meaning. **(30)**

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Q (m^3/s)	3800	2900	4800	3900	3350	6650	5400	4250	3760	4160	8890	3980	4200	5700

4. (a) Explain the importance of Infiltration Index in hydrologic calculations. **(5)**

(b) Discuss infiltration capacity regarding (i) forest soil, and (ii) water with heavy suspended particles. **(5)**

(c) Draw the groundwater table positions of various streams for dry and wet seasons and explain in brief. **(5)**

(d) Discuss why a rainfall of very long duration is necessary in estimating the magnitude of peak runoff for a catchment by Rational Method. **(5)**

(e) In a 120-min storm, the following intensities of rainfall were observed in successive 20-min intervals, 3.3, 0.6, 3.6, 9.0, 6.6 and 0.9 cm/hr. Assume φ-index value to be 1.0 cm/hr, compute: (i) total volume of runoff, (ii) total volume of infiltration, (iii) duration of rainfall excess, and (iv) runoff coefficient. The catchment area is 3 km^2. **(15)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Briefly describe the weather systems that can form precipitation. **(10)**

(b) Write down the factors to be considered while setting a rain gauge. **(5)**

(c) In a catchment ABCDE, whose shape can be approximated by a pentagon, four rain gauge stations (P, Q, R and s) are situated inside the catchment. The coordinates of the corners of the catchment that define its boundaries and the coordinates of the four rain gauge stations are given below. Also given are the annual railfall recorded by the four stations in the year 2020. Determine the average annual rainfall over the catchment in that year by the Thiessen polygon method. Given, distance are in kilometer. **(20)**

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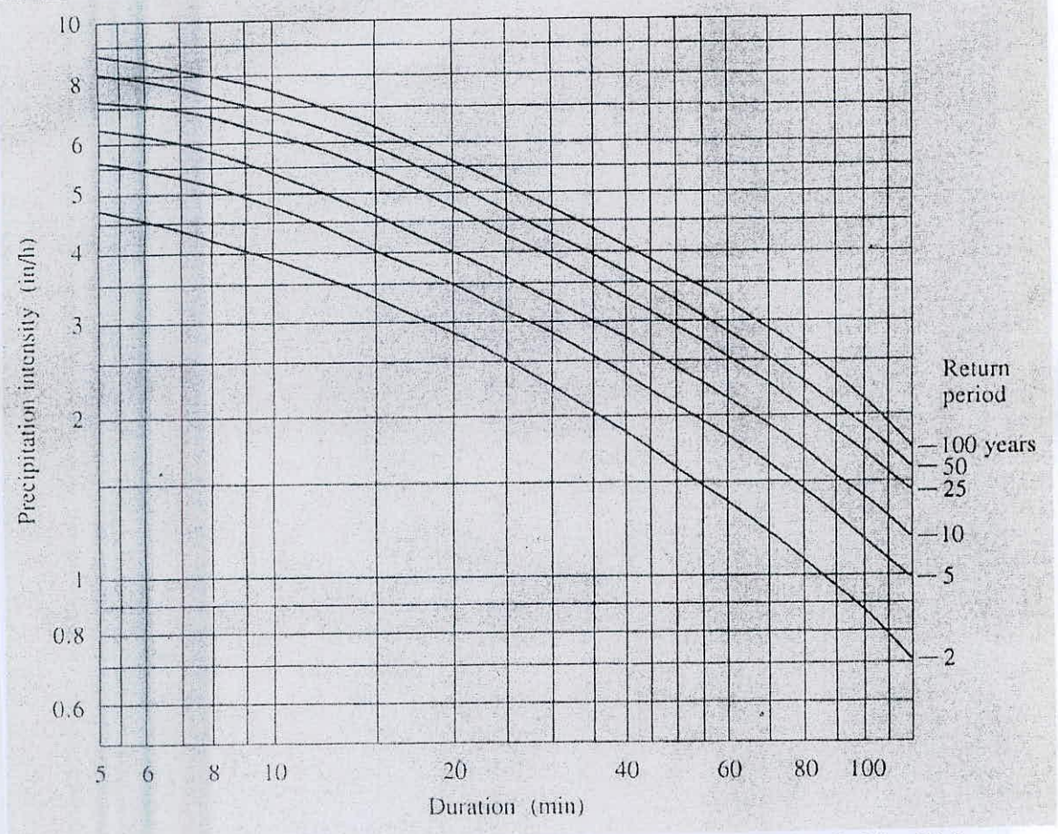

Fig. 1: Intensity-Duration-Frequency (IDF) curves for Q. No. 2(c)

TABLE 1 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

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

TABLE 2. 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 3. 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

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Contd... Q. No. 5(c)

Catchment Boundary	Corner Coordinates	A (0.0)	B (120,0)	C (120,80)	D (60,140)	E (0,80)
Rain gauge Station	Station Coordinates	P (40,20)	Q (80,20)	R (80, 60)	S (40, 80)	
	Annual Rainfall (cm)	120	110	100	125	

6. (a) Briefly describe the analytical methods of evaporation estimation. **(10)**

Compute Potential Evapotranspiration from the following information.

Latitude = 28°N, Elevation = 230 m (above sea level), Mean monthly temperature = 32.0°C, mean relative humidity = 70%, Mean observed sunshine = 11 hr, Wind velocity at 2 m height = 85 km/day. Also estimate daily evaporation from a lake situated in that place. **(25)**

Use Table 1, 2, and 3 for other information. Given

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

7. (a) Explain the procedure of measuring (i) stage by float gauge recorder, (ii) velocity by vertical axis current meter and (iii) discharge by area velocity method. **(15)**

(b) The stage-discharge data of a river are given below. Establish a stage-discharge relationship to predict the stage for a known discharge. Assume the stage value for zero discharge as 20.5 m. Determine **(20)**

(i) the stage of the river corresponding to a discharge of 2000 m^3/s.

(ii) the correlation coefficient of the relationship established above.

Stage (m)	Discharge (m^3/s)	Stage (m)	Discharge (m^3/s)
21.95	100	24.05	780
22.45	220	24.55	1010
22.80	295	24.85	1220
23.00	400	25.40	1300
23.40	490	25.15	1420
23.75	500	25.55	1550
23.65	640	25.90	1760

8. (a) Write down the differences between (i) Hydraulic routing and hydrologic routing. What are the criteria to select any method for flow routing? **(10)**

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Contd... Q. No. 8

(b) A reservoir has the following storage, elevation and outflow relationships. **(15)**

Elevation (m)	100.00	100.50	101.00	101.50	102.00	102.50	102.75	103.00
Storage ($10^6 m^3$)	3.350	3.472	3.380	4.383	4.882	5.370	5.527	5.856
Outflow (m^3/s)	0	10	25	40	75	100	120	130

When the reservoir elevation is at 100.50m, the following flood hydrograph entered the reservoir. Route the flood using Modified Pul's method and determine the maximum reservoir elevation, peak outflow, and attenuation of the flood peak.

Time (h)	0	6	12	18	24	30	36	42	48
Inflow (m^3/s)	10	20	50	80	70	55	35	25	15

(c) The storage in the reach of stream has been studied. The value of the Muskingum weighting factor is 0.25 and storage time constant is 8 hours. If the inflow hydrograph to the reach is as given below, compute the outflow hydrograph. Assume the initial outflow from the reach is 10.0 m^3/s. **(10)**

Time (h)	0	4	8	12	16	20	24	28
Inflow (m^3/s)	10	16	35	30	22	15	10	5

L-3/T-2/WRE **Date: 05/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 323** (Design of Concrete Structures I)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Assume reasonable values for missing data, If any

1. (a) What are the basic differences between Ultimate Strength Design (USD) and Working Stress Design (WSD) method? **(8)**

(b) A schematic floor plan of a residential building is shown in Figure 1. The slab is 6 in. thick and floor to floor height is 10 ft. Preliminary sizing of a typical floor indicates that the beam cross section will be 20 in. deep by 12 in. wide and the column cross section will be 14 in. by 14 in. In addition to the live load the floor supports floor finish and partition wall weighing 25 psf and 90 psf respectively. The thickness of partition wall directly resting on beam is 5 in. **(27)**

Calculate the factored load:

(i) acting on the slab between lines A-B

(ii) applied to the exterior beam on line 3 between lines B-C and

(iii) transferred to column B3.

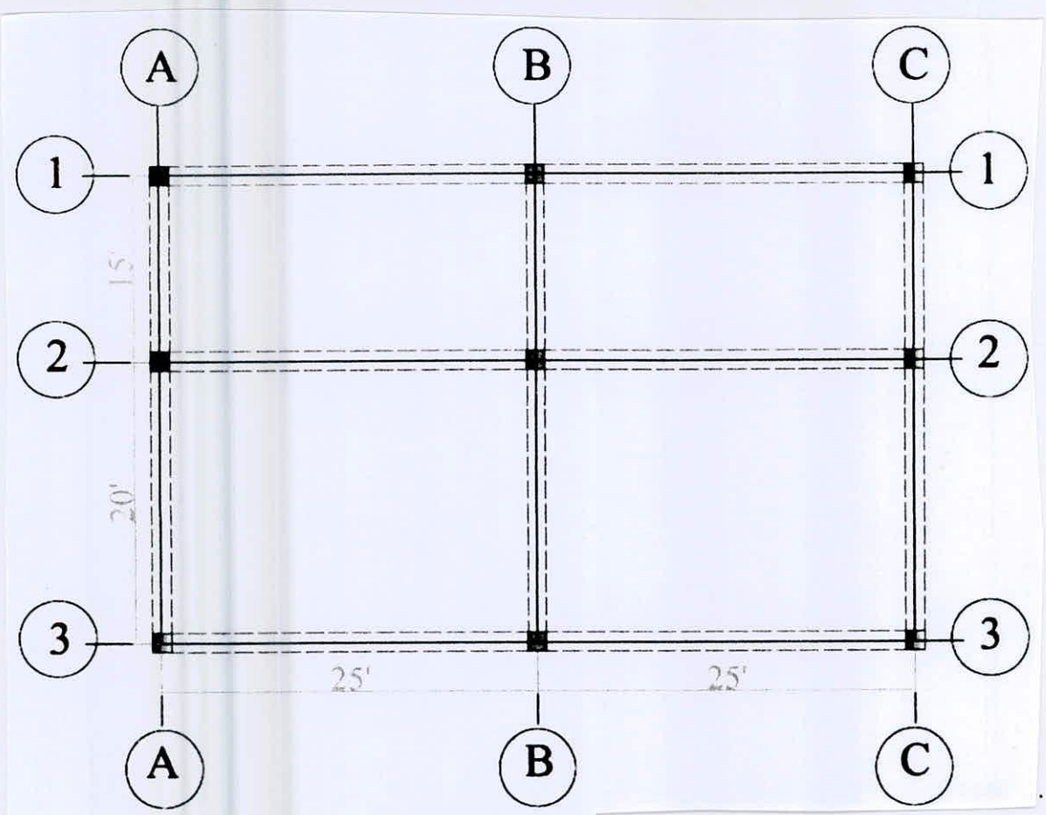

Figure 1

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2. (a) Write down the fundamental assumptions for reinforced concrete behavior. **(7)**

(b) What is the difference between underreinforced and overreinforced beam? Which one is preferable and why? **(8)**

(c) Find the concrete cross section and the steel area required for a cantilever rectangular beam with a span of 12 ft that is to carry a computed dead load of 1.2 kips/ft and a service live load of 2.1 kips/ft. Material strengths are $f'_c = 5$ ksi and $f_y = 60$ ksi. **(20)**

3. (a) Show the requirements for concrete cover in beams and slabs not exposed to weather or in contact with ground with neat sketches. **(6)**

(b) What are the minimum thicknesses of nonprestressed beams unless deflections are computed according to ACI code? **(4)**

(c) A simply supported rectangular beam that must carry a service live load of 2.74 kips/ft and calculated dead load of 1.50 kips/ft on a 20ft simple span is limited in cross section for architectural reasons to 10 in. width and 20 in. total depth. If $f_y = 60$ ksi and $f'_c = 4$ksi, design the flexural reinforcement for this member using compression steel if necessary. **(25)**

4. (a) The isolated T beam shown in Figure 2 is composed of a flange 28 in. wide and 6 in deep cast monolithically with a web of 10 in. width that extends 24 in. below the bottom surface of the flange to produce a beam of 30 in. total depth. Tensile reinforcement consists of six No. 10 (No. 32) bars placed in two horizontal rows separated by 1 in. clear spacing. The centroid of the bar group is 26 in. from the top of the beam. The concrete has a strength of 4000 psi, and the yield strength of the steel is 50,000 psi. What is the design moment capacity of the beam? **(15)**

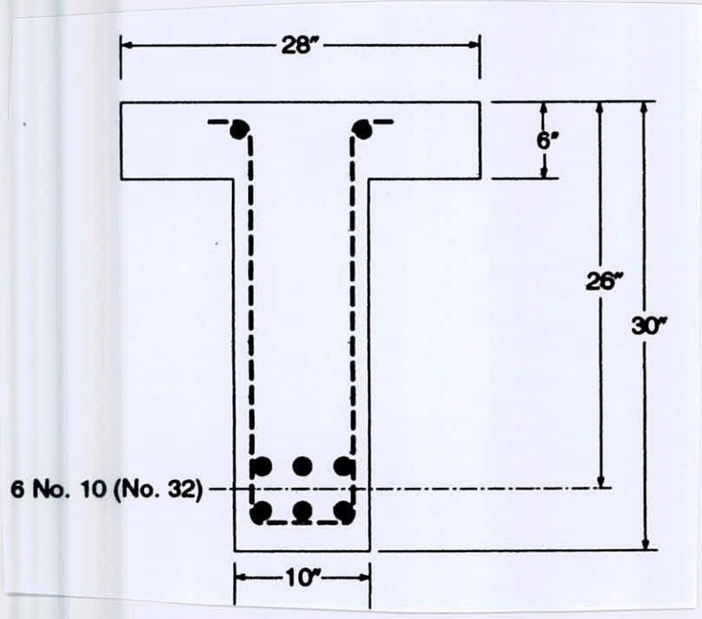

Figure 2

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(b) A floor system, shown in Figure 3, consists of a 5 in. concrete slab supported by continuous T beam with a clear span of 20 ft, 36 in. on centres. Web dimensions, as determined by negative-moment requirements at the supports, are b_w = 10 in. and d = 22 in. What tensile steel area is required at midspan to resist a factored moment of 8800 in-kips if f'_c = 3 ksi and f_y =60 ksi? **(20)**

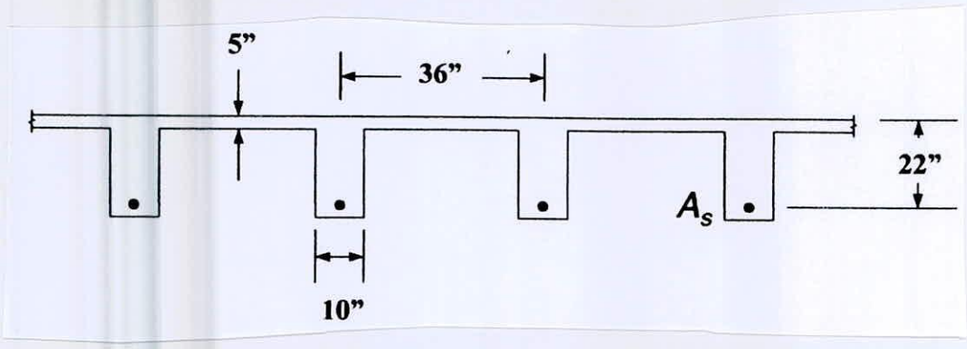

Figure 3

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Design the shear reinforcement for the beam shown in Fig. 4. All loads are factored. Calculate with 3 sets of spacings. Width of the beam is 12" and effective depth is 24". *Given:* $f'_c = 3.5$ *ksi and* $f_y = 60$ *ksi.* (25)

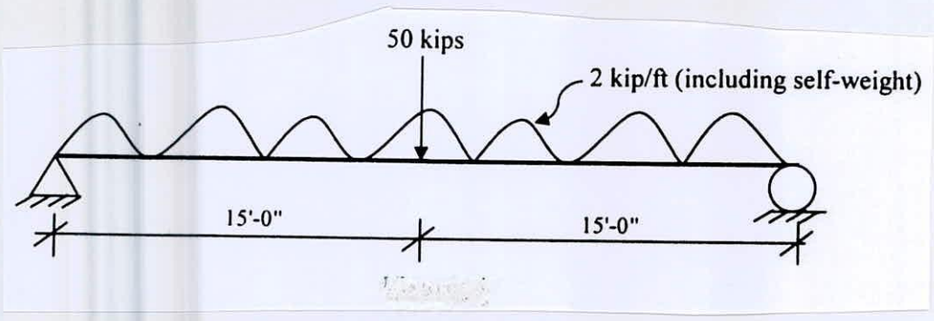

Figure: 4

(b) Diagrammatically show locations of critical section for shear design of i) beam supported by columns ii) end supported beam iii) beam supported by grider of similar depth iv) beam supported by monolithic vertical element, and v) beam loaded near the bottom. **(10)**

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6. (a) Cross Section of a rectangular RCC beam at a beam-column joint in a IMRF building is shown in Fig. 5. Based on ETABS analysis, the negative reinforcement (top bars) required at the end of the beam is 2.86 in^2. Determine the development length l_d at which the negative bars can be cut off. Use simplified equations of Table 1. *Given: clear cover = 1.5", for normal weight concrete,* $f_c' = 3$ *ksi and* $f_y = 60$ *ksi.* **(25)**

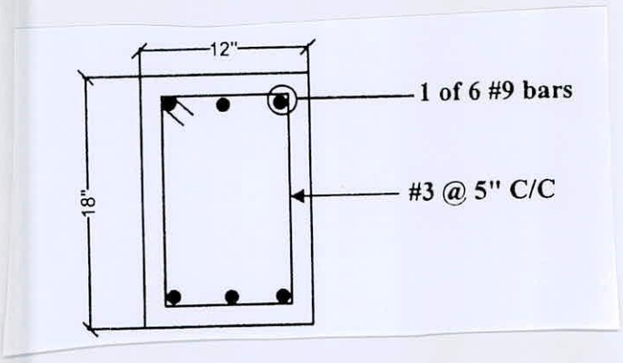

Figure: 5

If the negative rebars at that joint are to be extended into the column and terminated in a standard 90° hook. keeping 2" clear to the outside face of the column find the minimum length of embedment of the hook, l_{dh} past column face. The column width in the direction of beam width is 20".

(b) Show with neat sketches the bar details for development of standard hooks. **(10)**

7. (a) A 6.5" thick one-way slab is supported on brick walls as shown in Fig. 6. The slab is subjected to FF load = 20 psf, permanent partition wall, PW = 50 psf and live load, LL = 60 psf in addition to self-wight. The live load can occupy any portion or any position on the slab. Design the slab and show all reinforcement detailing in a neat sketch. *Given:* $f_c' = 3$ *ksi and* $f_y = 60$ *ksi.* **(25)**

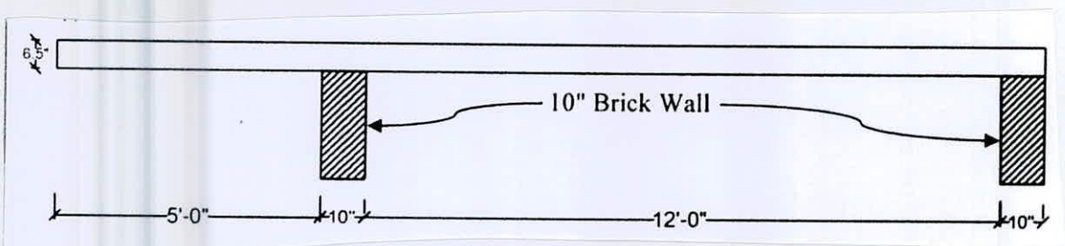

Figure: 6

(b) Why temperature and shrinkage reinforcements are required in one-way slab? What are the ACI/BNBC recommended ratios for such steel? **(10)**

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8. (a) Design the slab system shown in Fig. 7. The slab is to carry a service live load of 60 psf; as for dead load, assume floor finish load to be 25 psf and permanent partition wall load to be 60 psf in additional to self-weight of slab. *Given:* $f_c' = 3$ *ksi and* $f_y = 60$ *ksi.* Use Moment Coefficient Method. Assume beams are stiff (α_m is greater than 2.0). Show all reinforcements is sketches. **(27)**

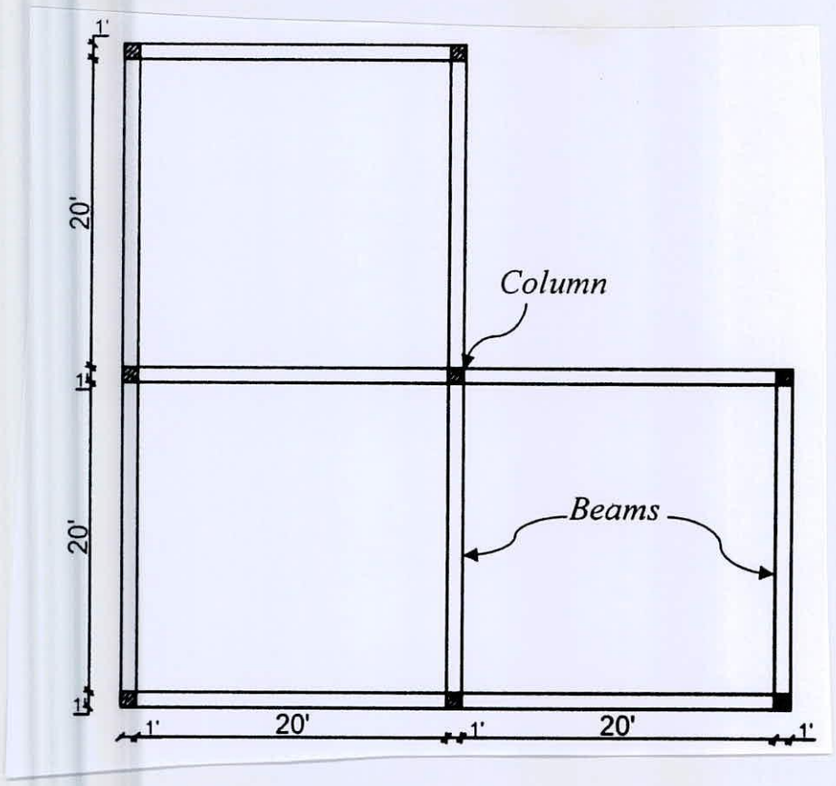

Figure: 7

(b) Describe with neat sketches four RC floor systems commonly used in Bangladesh. **(8)**

Table 1:

Simplified tension development length in bar diameters according to the ACI Code

	No. 6 (No. 19) and Smaller Bars and Deformed Wires†	No. 7 (No. 22) and Larger Bars
Clear spacing of bars or wires being developed or spliced $\geq d_b$, clear cover $\geq d_b$, and stirrups or ties throughout ℓ_d not less than the Code minimum	$\ell_d = \left(\frac{f_y \psi_t \psi_e}{25\lambda\sqrt{f'_c}}\right) d_b$	$\ell_d = \left(\frac{f_y \psi_t \psi_e}{20\lambda\sqrt{f'_c}}\right) d_b$
Clear spacing of bars or wires being developed or spliced $\geq 2d_b$, and clear cover $\geq d_b$	Same as above	Same as above
Other cases	$\ell_d = \left(\frac{3f_y \psi_t \psi_e}{50\lambda\sqrt{f'_c}}\right) d_b$	$\ell_d = \left(\frac{3f_y \psi_t \psi_e}{40\lambda\sqrt{f'_c}}\right) d_b$

Table 2: Coefficients for negative moments in slabs

$M_{a,neg} = C_{a,neg} w l_a^2$ where w = total uniform dead plus live load
$M_{b,neg} = C_{b,neg} w l_b^2$

Ratio $m = \frac{l_a}{l_b}$	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
	□	□	□	□	□	□	□	□	□
1.00 $C_{a,neg}$		0.045	0.076	0.050	0.075	0.071	0.071	0.033	0.061
1.00 $C_{b,neg}$		0.045		0.050				0.061	0.033
0.95 $C_{a,neg}$		0.050	0.072	0.055	0.079	0.075	0.067	0.038	0.065
0.95 $C_{b,neg}$		0.041		0.045				0.056	0.029
0.90 $C_{a,neg}$		0.055	0.070	0.060	0.080	0.079	0.062	0.043	0.068
0.90 $C_{b,neg}$		0.037		0.040				0.052	0.025
0.85 $C_{a,neg}$		0.060	0.065	0.066	0.082	0.083	0.057	0.049	0.072
0.85 $C_{b,neg}$		0.031		0.034				0.046	0.021
0.80 $C_{a,neg}$		0.065	0.061	0.071	0.083	0.086	0.051	0.055	0.075
0.80 $C_{b,neg}$		0.027		0.029				0.041	0.017
0.75 $C_{a,neg}$		0.069	0.056	0.076	0.085	0.088	0.044	0.061	0.078
0.75 $C_{b,neg}$		0.022		0.024				0.036	0.014
0.70 $C_{a,neg}$		0.074	0.050	0.081	0.086	0.091	0.038	0.068	0.081
0.70 $C_{b,neg}$		0.017		0.019				0.029	0.011
0.65 $C_{a,neg}$		0.077	0.043	0.085	0.087	0.093	0.031	0.074	0.083
0.65 $C_{b,neg}$		0.014		0.015				0.024	0.008
0.60 $C_{a,neg}$		0.081	0.035	0.089	0.088	0.095	0.024	0.080	0.085
0.60 $C_{b,neg}$		0.010		0.011				0.018	0.006
0.55 $C_{a,neg}$		0.084	0.028	0.092	0.089	0.096	0.019	0.085	0.086
0.55 $C_{b,neg}$		0.007		0.008				0.014	0.005
0.50 $C_{a,neg}$		0.086	0.022	0.094	0.090	0.097	0.014	0.089	0.088
0.50 $C_{b,neg}$		0.006		0.006				0.010	0.003

Table 3: Coefficients for dead load positive moments in slabs

$M_{a,pos,dl} = C_{a,dl} w l_a^2$
$M_{b,pos,dl} = C_{b,dl} w l_b^2$
where w = total uniform dead load

Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,dl}$	0.036	0.018	0.018	0.027	0.027	0.033	0.027	0.020	0.023
	$C_{b,dl}$	0.036	0.018	0.027	0.027	0.018	0.027	0.033	0.023	0.020
0.95	$C_{a,dl}$	0.040	0.020	0.021	0.030	0.028	0.036	0.031	0.022	0.024
	$C_{b,dl}$	0.033	0.016	0.025	0.024	0.015	0.024	0.031	0.021	0.017
0.90	$C_{a,dl}$	0.045	0.022	0.025	0.033	0.029	0.039	0.035	0.025	0.026
	$C_{b,dl}$	0.029	0.014	0.024	0.022	0.013	0.021	0.028	0.019	0.015
0.85	$C_{a,dl}$	0.050	0.024	0.029	0.036	0.031	0.042	0.040	0.029	0.028
	$C_{b,dl}$	0.026	0.012	0.022	0.019	0.011	0.017	0.025	0.017	0.013
0.80	$C_{a,dl}$	0.056	0.026	0.034	0.039	0.032	0.045	0.045	0.032	0.029
	$C_{b,dl}$	0.023	0.011	0.020	0.016	0.009	0.015	0.022	0.015	0.010
0.75	$C_{a,dl}$	0.061	0.028	0.040	0.043	0.033	0.048	0.051	0.036	0.031
	$C_{b,dl}$	0.019	0.009	0.018	0.013	0.007	0.012	0.020	0.013	0.007
0.70	$C_{a,dl}$	0.068	0.030	0.046	0.046	0.035	0.051	0.058	0.040	0.033
	$C_{b,dl}$	0.016	0.007	0.016	0.011	0.005	0.009	0.017	0.011	0.006
0.65	$C_{a,dl}$	0.074	0.032	0.054	0.050	0.036	0.054	0.065	0.044	0.034
	$C_{b,dl}$	0.013	0.006	0.014	0.009	0.004	0.007	0.014	0.009	0.005
0.60	$C_{a,dl}$	0.081	0.034	0.062	0.053	0.037	0.056	0.073	0.048	0.036
	$C_{b,dl}$	0.010	0.004	0.011	0.007	0.003	0.006	0.012	0.007	0.004
0.55	$C_{a,dl}$	0.088	0.035	0.071	0.056	0.038	0.058	0.081	0.052	0.037
	$C_{b,dl}$	0.008	0.003	0.009	0.005	0.002	0.004	0.009	0.005	0.003
0.50	$C_{a,dl}$	0.095	0.037	0.080	0.059	0.039	0.061	0.089	0.056	0.038
	$C_{b,dl}$	0.006	0.002	0.007	0.004	0.001	0.003	0.007	0.004	0.002

Table 4: Coefficients for live load positive moments in slabs

$M_{a,pos,ll} = C_{a,ll} w l_a^2$
$M_{b,pos,ll} = C_{b,ll} w l_b^2$
where w = total uniform live load

Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,ll}$	0.036	0.027	0.027	0.032	0.032	0.035	0.032	0.028	0.030
	$C_{b,ll}$	0.036	0.027	0.032	0.032	0.027	0.032	0.035	0.030	0.028
0.95	$C_{a,ll}$	0.040	0.030	0.031	0.035	0.034	0.038	0.036	0.031	0.032
	$C_{b,ll}$	0.033	0.025	0.029	0.029	0.024	0.029	0.032	0.027	0.025
0.90	$C_{a,ll}$	0.045	0.034	0.035	0.039	0.037	0.042	0.040	0.035	0.036
	$C_{b,ll}$	0.029	0.022	0.027	0.026	0.021	0.025	0.029	0.024	0.022
0.85	$C_{a,ll}$	0.050	0.037	0.040	0.043	0.041	0.046	0.045	0.040	0.039
	$C_{b,ll}$	0.026	0.019	0.024	0.023	0.019	0.022	0.026	0.022	0.020
0.80	$C_{a,ll}$	0.056	0.041	0.045	0.048	0.044	0.051	0.051	0.044	0.042
	$C_{b,ll}$	0.023	0.017	0.022	0.020	0.016	0.019	0.023	0.019	0.017
0.75	$C_{a,ll}$	0.061	0.045	0.051	0.052	0.047	0.055	0.056	0.049	0.046
	$C_{b,ll}$	0.019	0.014	0.019	0.016	0.013	0.016	0.020	0.016	0.013
0.70	$C_{a,ll}$	0.068	0.049	0.057	0.057	0.051	0.060	0.063	0.054	0.050
	$C_{b,ll}$	0.016	0.012	0.016	0.014	0.011	0.013	0.017	0.014	0.011
0.65	$C_{a,ll}$	0.074	0.053	0.064	0.062	0.055	0.064	0.070	0.059	0.054
	$C_{b,ll}$	0.013	0.010	0.014	0.011	0.009	0.010	0.014	0.011	0.009
0.60	$C_{a,ll}$	0.081	0.058	0.071	0.067	0.059	0.068	0.077	0.065	0.059
	$C_{b,ll}$	0.010	0.007	0.011	0.009	0.007	0.008	0.011	0.009	0.007
0.55	$C_{a,ll}$	0.088	0.062	0.080	0.072	0.063	0.073	0.085	0.070	0.063
	$C_{b,ll}$	0.008	0.006	0.009	0.007	0.005	0.006	0.009	0.007	0.006
0.50	$C_{a,ll}$	0.095	0.066	0.088	0.077	0.067	0.078	0.092	0.076	0.067
	$C_{b,ll}$	0.006	0.004	0.007	0.005	0.004	0.005	0.007	0.005	0.004

L-3/T-2/WRE **Date: 29/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 371** (Environmental Engineering)

Full Marks: 280 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Assume any reasonable value (if needed)

1. (a) The following air quality data have been recorded at the CAMS in an industrial town on March 10, 2023) in the Salt Lake City of USA.

PM- 10 = 53.5 $\mu g/m^3$ (24-hr);

PM- 2.5 = 38.4 $\mu g/m^3$ (24-hr);

NO_2 = 0.62 ppm (annual)

O_3 = 0.32 ppm (1-hr)

CO = 2.55 ppm (8-hr)

Calculate & report the AQI for that day.

(Necessary tables are attached with the question) **(18)**

(b) Differentiate between - SSF and RSF. **(8)**

(c) Write short notes on the following water quality parameters: **(9)**

i) Acidity in water and

ii) Taste and odor.

(d) What are the factors to be considered while selecting location of an intake? Draw the neat diagram of – protected intake, unprotected intake and floating intake. **($11\frac{2}{3}$)**

2. (a) A part of water distribution layout of a small industrial village is shown below. Water being supplied from an overhead tank (tank height above ground is 95 ft). Length of the supply pipes are shown below. Determine the missing pipe sizes and do necessary checks and corrections if needed. Note that the terminal pressure head required at any farthest end of supply is 30 psi. Assume flow velocity, V = 3 fps and density of water = 62.5 lb/ft^3. **(18)**

Contd P/2

CE 371/WRE

Contd... Q. No. 2

(b) Draw a flow diagram and show possible options of treatment units to treat water from a groundwater source. Lab analysis shows presence of iron, arsenic and hardness above corresponding ECR'97 standards for drinking. Note that there is moderate amount of organic substances present in water. **(10)**

(c) Define short lived climate pollutants (SLCPs). Describe how carbon monoxide effect the oxygen carrying capacity of blood. **(5+5=10)**

(d) How is the water bearing ground formation categorized depending on water transmitting and water storage capacity? **($8\frac{2}{3}$)**

3. (a) The past population data of a city for last four decades is given below. Estimate the population of the city for year 2025 and 2035 using geometric progression method. **(16)**

Year	1985	1995	2005	2015
Population (millions)	6.5	9.8	13.9	17.2

(b) Discuss effects of noise on human health. **(10)**

(c) What are the benefits of using submersible pump? Name different types of positive displacement pumps used in water works. **(5+8=13)**

(d) Describe the reverse osmosis process of water treatment. **($7\frac{2}{3}$)**

4. (a) An 8-inch diameter tubewell is installed to supply water to a 10-storied student residence tower of a college. The depth of water below the piezometric level is 92 ft and it falls 8 ft in the tubewell while pumping. Assume, Coefficient of permeability of the aquifer is 0.485 L/s/m^2 and the radius of the circle of influence is 145 ft. Calculate the yield of the tubewell. Again, if the tower height up to roof top is 102 ft above ground level and the rooftop tank inlet is 15 ft above the roof surface, calculate the pump capacity. Consider, the piezometric water table is 100 ft below the ground level. Given, flow velocity through pipe = 3 fps and total frictional head loss (H_f) = 38 ft. Also consider pump efficiency E = 70%. **(10+8=18)**

(b) Write down advantages and disadvantages of Ring system and Grid iron system of water distribution. What are the problems associated with direct pumping system of water distribution? **(10+5=15)**

(c) Write in short the impacts of radioactive pollutants on the human and environment. Define relationship between TKN and NBOD. **($8+5\frac{2}{3}=13\frac{2}{3}$)**

Contd P/3

CE 371/WRE

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define BOD and COD. Draw qualitative BOD curves for different temperatures. **(15)**

(b) Discuss the role of Fungi in industrial wastewater treatment. Mention the advantages and disadvantages of using Fungi in wastewater treatment. **(11 2/3)**

(c) Show that the ratio of BOD_5 at $20^{\circ C}$ and $BOD_{2.5}$ at $35^{\circ C}$ is unity. (Assume thermal coefficient, $\theta = 1.047$) **(20)**

6. (a) Distinguish between the followings- **(26 2/3)**

(i) "Catabolism" and "Anabolism".

(ii) "Primary clarifier" and "Secondary clarifier".

(iii) "Recirculation of Activated sludge" and "recirculation of trickling Filter".

(iv) "Activated sludge process" and "Aerated Lagoon process".

(v) "Aerobic treatment processes" and "Anaerobic treatment processes".

(b) Draw the flow diagrams of the following treatment processes - **(20)**

(i) Waste stabilization pond.

(ii) Aerated lagoon.

(iii) Activated sludge process.

(iv) Trickling Filter process.

7. (a) Why Faecal coliform removal in Pagla waste stabilization pond system is more than Dashankandi STP (Activate sludge process)? **(5)**

(b) How odour can be controlled in an Anaerobic pond? **(6 2/3)**

(c) Discuss briefly a conventional simplepit latrine with advantages and disadvantages. **(15)**

(d) Discuss the various important processes that take place in a septic tank. Design a septic tank for 30 users. The average wastewater flow rate is 180 litres/capital/day, Desludging interval is 10 years. (Assume any data required). **(20)**

8. (a) Discuss briefly the functional elements of a solid waste management. **(14 2/3)**

(b) Draw a typical sectional view of a sanitary landfill. **(12)**

(c) The quantity of flow of a 450 mm pipe flowing full is 0.135 m^3/s and the slope of the pipe is 0.001. Determine the velocity of flow and n value. When the depth of flow is $\frac{3}{4}$ th of the full flow, determine the velocity and quantity of flow for the mentioned pipe. **(20)**

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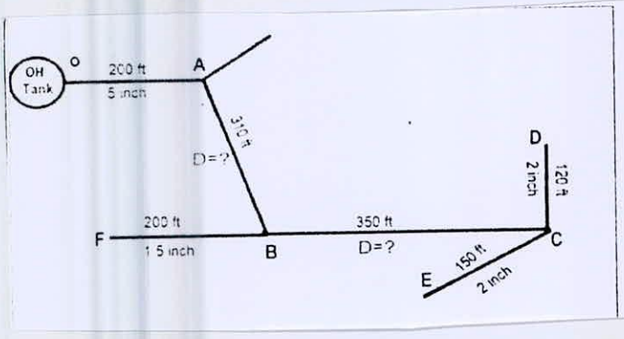
(4)



Consumption point	Water Demand (lpd)
F	55000
E	125000
D	230000

Tables for Question- 1(a)

Table -1: Air Pollutant Breakpoint concentrations

Breakpoints								
O_3 (ppm) 8-hr	O_3 (ppm) 1-hr(i)	$PM_{2.5}$ ($\mu g/m^3$) 24-hr	PM_{10} ($\mu g/m^3$) 24-hr	CO (ppm) 8-hr	SO_2 (ppm) 24-hr	NO_2 (ppm) Annual	AQI	Category
0.000-0.064	—	0.0-15.4	0-54	0.0-4.4	0.000-0.034	0.000.0.053	0-50	Good
0.065-0.084	—	15.5-40.4	55-154	4.5-9.4	0.035-0. 144	0.054-0.100	51-100	Moderate
0.085-0.104	0.125-0.164	40.5-65.4	155-254	0.5-12.4	0.145-0.224	0.101-0.360	101-150	Unhealthy for Sensitive Groups
0.105-0.124	0.165-0.204	65.5-150.4	255-354	12.5-15.4	0.225-0.304	0.361-0.649	151 -200	Unhealthy
0.125-0.374	0.205-0.404	150.5-250.4	355-424	15.5-0.4	0.305-0.604	0.65-1.24	201-300	Very Unhealthy
--	0.405-0.504	250.5-350.4	425-504	30.5-40.4	0.605-0.804	1.25-1.64	301-400	Hazardous
--	0.505-0.604	350.5-500.4	505-604	40.5-50.4	0.805-1.004	1.65-2.04	401-500	Hazardous

Table-2: Pollutant specific sensitive groups

When pollutant has an index value > 100	Report these sensitive groups
Ozone	Children and the people with asthma are the groups most at risk
PM-2.5	People with respiratory or heart disease, the elderly and children are the groups most at risk
PM-10	People with respiratory disease are the group most at risk
CO	People with heart disease are the group most at risk
SO_2	People with asthma are the group most at risk

L-3/T-2/WRE **Date: 30/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 391** (Transportation Engineering)

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Assume reasonable values for any missing data.

1. (a) With neat sketches demonstrate the conflict point at a 3-legged intersection. Draw and explain the possible "**trumpet**" configuration for the following intersection shown in Figure 1. **(3+13⅔=16⅔)**

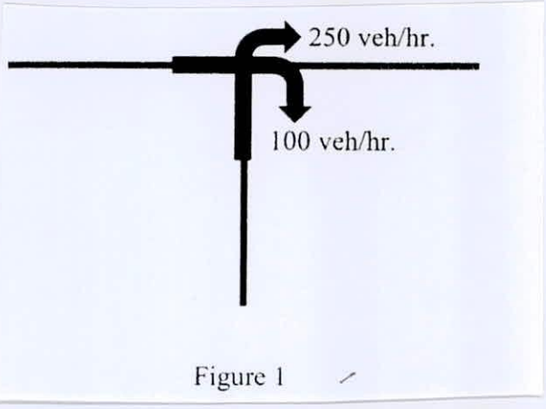


Figure 1

(b) Describe the four methods by which super-elevation can be attained on a curved section of roadway. **(8)**

(c) Write down the advantages and disadvantages of Water Transport System. What are the criteria to ensure an efficient Water Transport System? Briefly explain the general considerations in designing water terminals. **(10)**

(d) Four vehicles are found to be travelling at constant speeds between section "A" and "B" (450 m apart) at a particular instant in time. An observer at point "A" found the four vehicles passing point "A" during a period of 20 seconds. The speeds of the vehicles are measured as 43, 49, 61 and 56 km/hr. respectively. Calculate the flow, density, time mean speed and space mean speed of the vehicles. **(12)**

2. (a) Describe NEMA phasing with necessary diagrams. Design a two-phase signal of an isolated cross-junction for the following data. Also draw the phase and cycle time bar diagram and find all red time. **(16⅔)**

Contd P/2

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Contd.... for Q. No. 2(a)

	N	S	E	W
Flow (PCU/hr)	726	478	943	761
Saturation Flow (PCU/hr)	2250	2125	2600	2375

	N-S	E-W
Inter-green periods (sec)	3	5
Initial and final lost time (sec)	3	2

(b) Briefly explain the sequential improvement of at-grade intersection control. List the warrants for traffic signals. **(10)**

(c) Write short notes on the followings: **(8)**

(i) VKT (ii) 30^{th} highest Hourly Volume (iii) Fatality (iv) Headway

(d) The acceleration of a vehicle is specified as: **(12)**

$$\frac{du}{dt} = 1 - 0.06u$$

Where, u is the velocity in m/s. If the vehicle is travelling at 80 kmph, determine the velocity after 7 seconds of acceleration and distance traveled during that time.

3. (a) Briefly explain the different types of vehicle characteristics considered in geometric design of roadways. **(9)**

(b) The owner of a parking garage located in a CBD has observed that 25% of those wishing to park are turned back every day during the open hours of 6 a.m. to 9 p.m. because of lack of parking spaces. An analysis of data collected at the garage indicates that 70% of those who park are commuters, with an average parking duration of 8 hr., and the remaining are shoppers, whose average parking duration is 3 hr. If 40% of those who cannot park are commuters and the rest are shoppers, and a total of 300 vehicles currently park daily in the garage, determine the number of additional space required to meet the excess demand. Assume parking efficiency is 0.92. **(13)**

(c) Draw and explain a collision diagram with necessary notations. **(12)**

(d) An urban arterial street segment 0.25-mile-long has an average annual daily traffic (AADT) of 17,500 veh/day. In a two-year period, there have been eight crashes resulting in death and/or injuries and twelve involving property damage only. The statewide average crash experience for similar types of roadways in 350 per 100 mvm for a two-year period of which 100 involved death and/or injury and 250 caused property damage only. Is the 0.25-mile-long street segment hazardous? In identifying hazardous locations, consider that a single death/injury crash is equivalent to three property damage crashes. Use a 95% confidence level. **(12⅔)**

Contd P/3

CE 391

4. (a) List and explain different methods of travel time studies. **(10)**

(b) Briefly explain the properties of vertical curve with necessary diagrams and notations. **(10)**

(c) Using the capacity restrained assignment technique, assign the vehicle trips shown in Table 1 to the network shown in Figure 2 by **five steps**. You need to complete the **first two steps** only. To summarize your results, list all link in the network and their corresponding traffic volume. Assume, link capacity = 300 veh/hr. **(26⅔)**

Table 1: OD Trip

From/To	Trips Between Zones			
	1	**2**	**3**	**4**
1	0	250	400	450
2	650	0	525	135
3	225	185	0	285
4	250	195	335	0

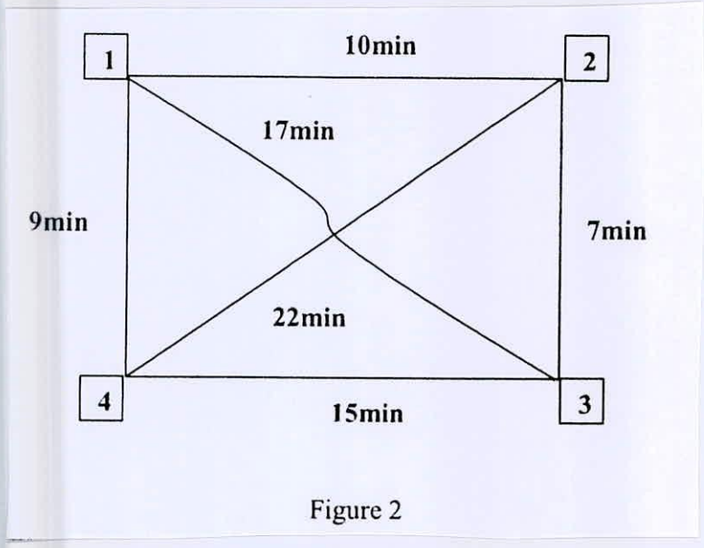


Figure 2

Figure 2

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Describe the load transfer mechanism of rigid pavement and two-dimensional layered elastic model of pavement design. Draw a typical cross-section of **(10+9=19)**

(i) Flexible Pavement

(ii) Rigid Pavement

(iii) Railway Permanent Way

Contd P/4

CE 391

Contd.... for Q. No. 5(a)

(b) What are the steps of flexible pavement design as per the Asphalt Institute method? What is ESAL? With help of general equation, describe the process of determining ESAL from AADT and other traffic flow parameters. **(5+6⅔=11⅔)**

(c) Describe contact pressure and wheel load. With the help of figures, explain different axle configurations and truck configurations. **(6+10=16)**

6. (a) What is asphalt concrete? Briefly describe the classification systems of Bitumen. What aggregate tests are needed to be performed before pavement construction? **(3+6+4⅔=13⅔)**

(b) Explain the stress distribution on different flexible and rigid pavement layers with necessary figures. Explain function of different joints used in rigid pavement. **(9+9=18)**

(c) Design a rigid pavement using the **ASSHTO** Method for the following design criteria: **(15)**

Effective modulus of subgrade reaction, $k = 80$ lb/in^3

Concrete elastic modulus, $E_c = 7 \times 10^6$ lb/in^2

Mean concrete modulus of rupture, $S'_c = 850$ psi

Load transfer coefficient, $J = 4.0$

Drainage coefficient, $C_d = 1.1$

Present serviceability index, $P_i = 4.6$

Final serviceability index, $P_t = 2.8$

Reliability, $R = 90\%$

Overall standard deviation, $So = 0.35$

ESAL $= 10 \times 10^6$

(**Necessary Design Chart is attached at the end of the question. The Design Chart must be attached with the answer script**)

7. (a) What are the elements of airport lighting? Describe airport beacon and approach lighting as per ICAO guidelines. **(6⅔+6=12⅔)**

(b) Draw layout of Flag Station, Crossing Station, Junction Station and Terminal Station with proper labeling. What do you understand by the depth of the ballast cushion? Explain with necessary figures. **(12+9=21)**

(c) What factors affect the selection of railway alignment? Describe the gauge of the railway with necessary figure. Also, state the problems associated with the non-uniformity of gauge. **(5+4+4=13)**

Contd P/5

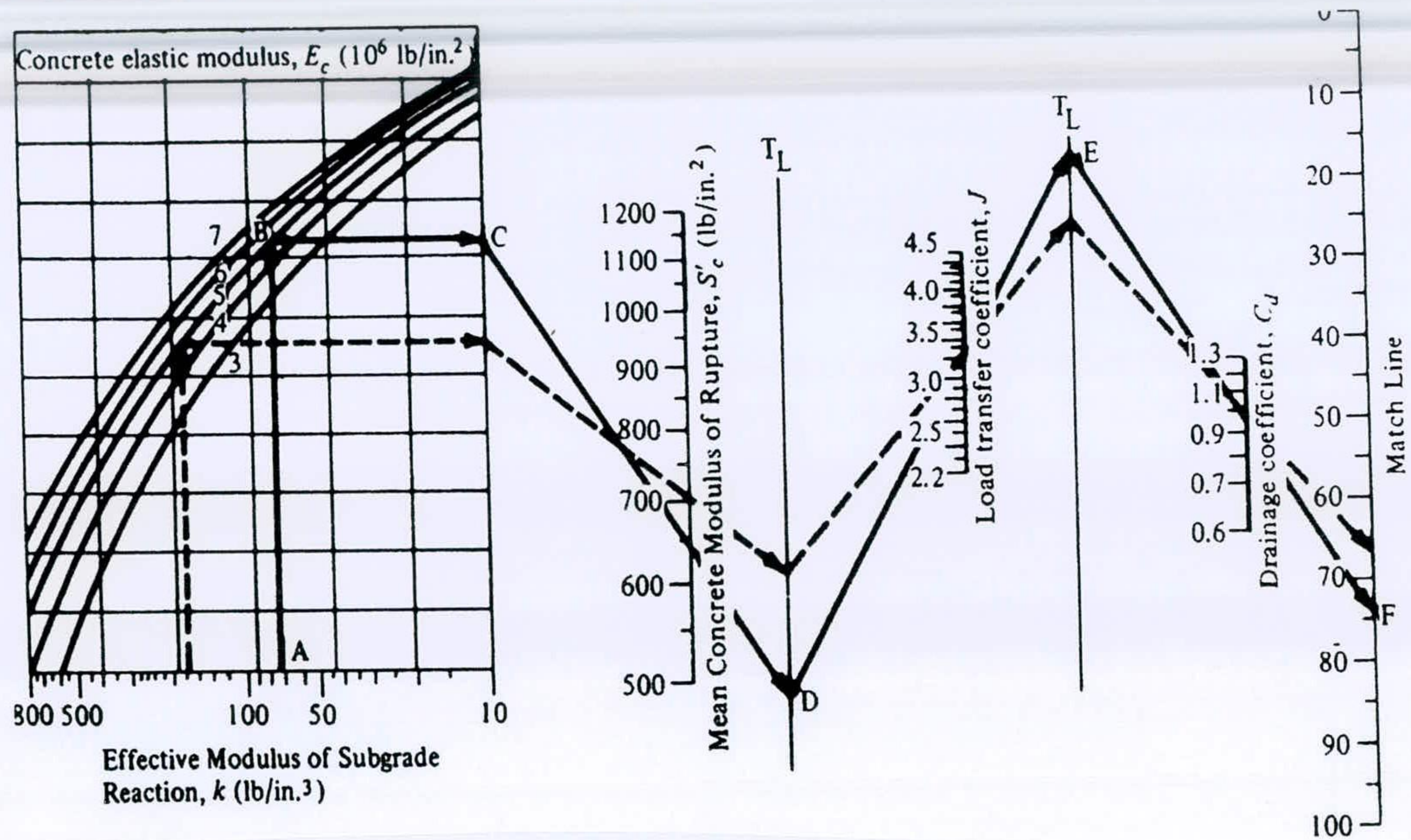
CE 391

8. (a) Compute the steepest gradient that a train of 20 wagons with a locomotive can travel with the following data: **(10⅔)**

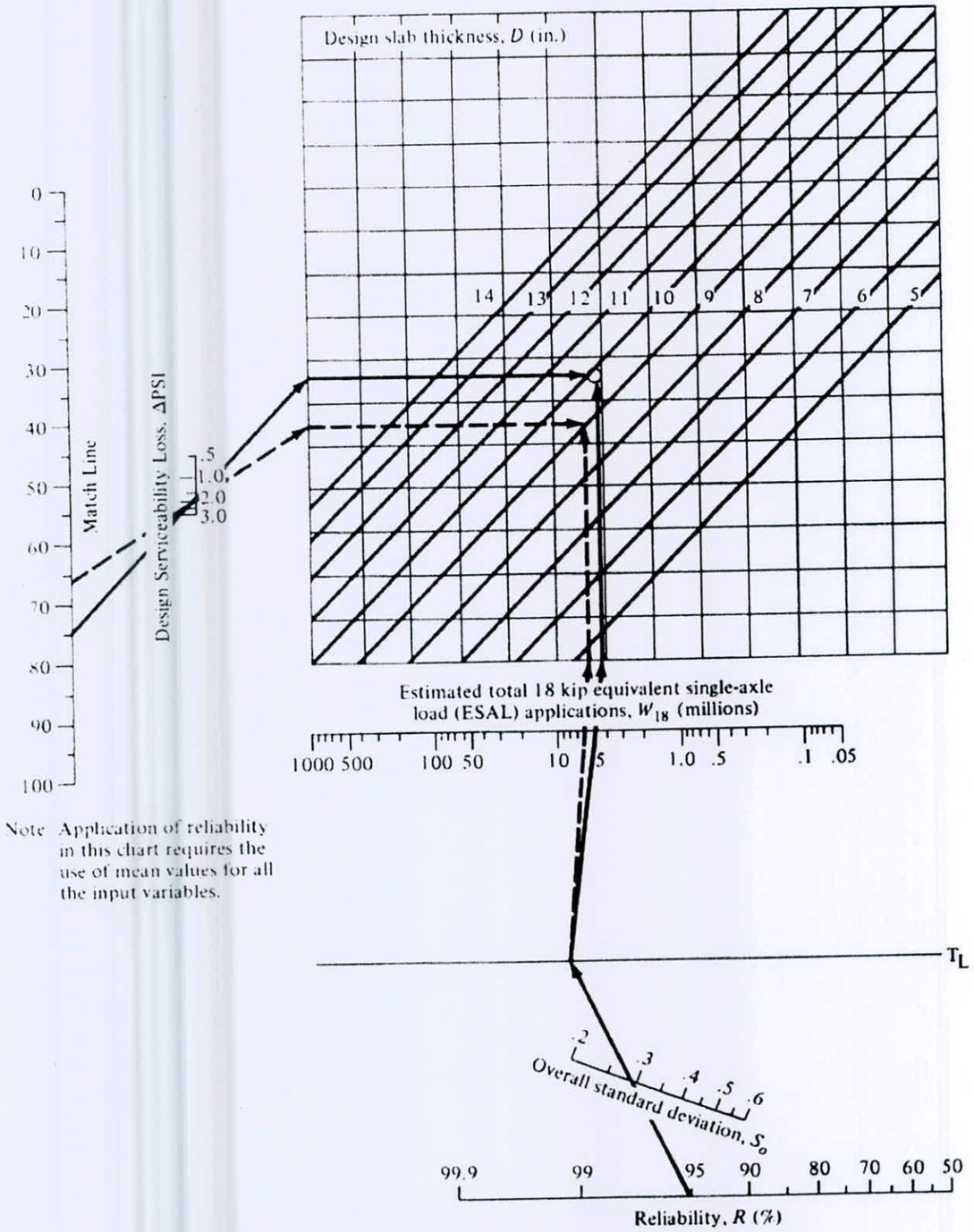
Weight of each wagon = 20 tons
Weight of locomotive = 150 tons
Tractive effort of locomotive = 15 tons
Rolling resistance of locomotive = 3 kg/ton
Rolling resistance of wagon = 2.5 kg/ton
Speed of the train = 60 Kmph

(b) Give a brief description of airport shoulder marking with relevant figures. What do you understand by Hub and Spoke route planning and No-frills airlines? **(10+6=16)**

(c) Draw a plan view of the left-hand railway turnout with all necessary parts. Describe the operation of lower quadrant semaphore signal with figure. What do you understand by Critical and Non-critical area in an airport? **(10+6+4=20)**



Design Chart for AASHTO Pavement Design (Segment-1)
For question 6(c)



Note: Application of reliability in this chart requires the use of mean values for all the input variables.

Design Chart for AASHTO Pavement Design (Segment-2)
For question 6(c)