BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 421** (Dynamic of Structures)

Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

No.	Questions	Marks
1.	A single storey reinforced concrete (RC) building idealized as a massless frame as shown in **Fig.1 (a)** supporting a dead load of, W = 15 kip at the roof level. Each column is 12"x12" in cross-section. The beam is assumed to be rigid ($EI_b = \infty$). Assume Young's modulus of concrete, E = 3 x 10^3 ksi. The building is subjected to EL Centro ground motion. The columns are fixed at base. Determine the peak displacement of the frame. Assume 2% damping of the system. Use response spectrum graph, **Fig. 1(b)** given herewith.	20
2.	Express the periodic loading (Amplitude, P_o = 200 kip and time period T_p = 1 sec), shown in **Fig. 2(a)** as a Fourier series. Determine only the first three terms of the Fourier coefficients a_o, a_n and b_n. Hence, determine the steady state response of the system shown in **Fig. 2(b)** subjected to this periodic loading.	20
3.	(a) The SDOF system as shown in **Fig. 3** is subjected to a loading history *F(t)*. Determine the response time history of this system upto 0.5 sec by the Newmark's Beta method (constant average acceleration method) using h = Δt = 0.1 sec. Given, initial displacement, v_o = 0 and initial velocity, $\dot{v}_o$ = 0. Use equation 1 to 4 given herewith. Assume 10% critical damping of the system. $\tilde{k}_c = k + \frac{2c}{h} + \frac{4m}{h^2}$ (1) $\tilde{p}_{1c} = p_1 + c\left(\frac{2v_0}{h} + \dot{v}_0\right) + m\left(\frac{4v_0}{h^2} + \frac{4}{h}\dot{v}_0 + \ddot{v}_0\right)$ (2) $\dot{v}_1 = \frac{2}{h}(v_1 - v_0) - \dot{v}_0$ (3) $\ddot{v}_1 = \frac{1}{m}(p_1 - c\dot{v}_1 - kv_1)$ (4)	20
4.	(a) Determine the natural frequency and mode shape of the two DOF shear frame as shown in **Fig. 4**. Given: E = 30,000 ksi. For W10 × 21 section, I = 118 in^4 and for W10 × 45 section, I = 248 in^4.	20

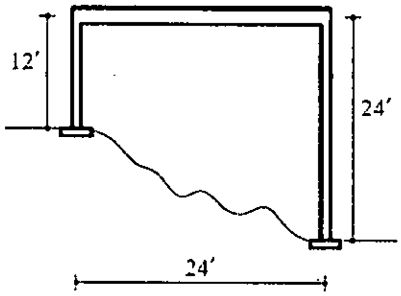


Fig. 1 (a)

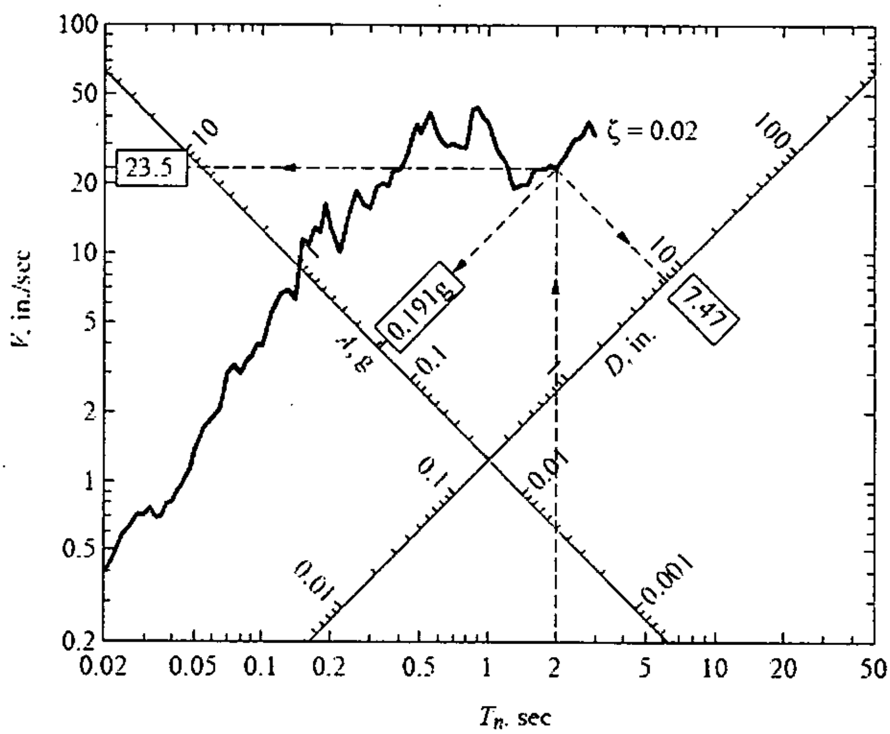


Fig. 1 (b)

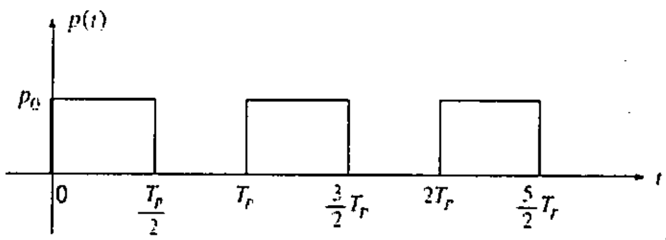


Fig. 2(a)

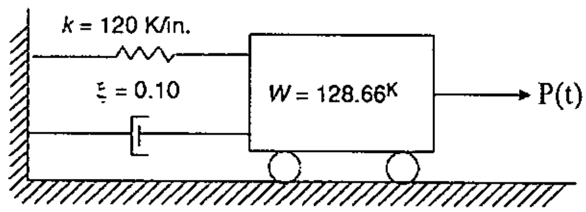


Fig. 2(b)

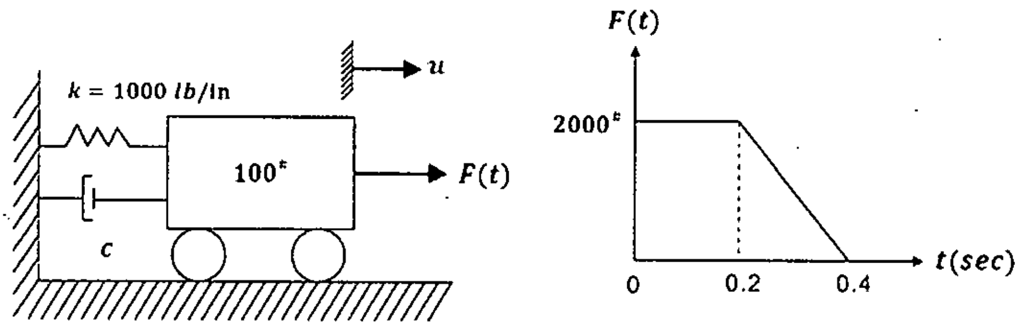


Fig. 3

SECTION-B: CE 421

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

5.	The steel frame shown in **Fig. 5** is fixed at the base and has a rigid top W that weighs 1000 lb. Experimentally, it has been found that its natural period in lateral vibration is equal to 1/10 of a second. It is required to lengthen its period by 20% by adding weight. Determine needed additional weight (neglect the weight of the columns).	20
6.	(a) The steel frame shown in **Fig. 6** supports a rotating machine that exerts a horizontal force at the girder level, F (t) = 300 sin 5.5t lb. Assuming 5% of critical damping, determine, (i) the steady-state amplitude of vibration, (ii) the maximum steady-state flexural stresses in the columns and Assume the girder is rigid. E = 30,000 ksi. Given: W8 × 24 section properties: section modulus, S = 20.8 in^3, I = 82.8 in^4. W10 × 33 section properties: S = 35.0 in^3, I = 170.0 in^4.	20
7.	(a) What are the basic differences between static and dynamic problems? (b) What is the impulse response function? Write short notes on Duhamel's integrals.	(5) (15)
8.	The frame fixed at base as shown in **Fig. 7** is subjected to a base excitation that has an acceleration amplitude of 0.2*g* and is idealized as simple harmonic motion with a frequency of 1 Hz. What is the maximum shear force at the foundation if the damping is assumed to be 2 percent critical? Assume that the girder of the frame is rigid. Given: W12 × 53 section properties: I = 425 in^4, S = 70.6 in^3, E = 30,000 ksi.	20

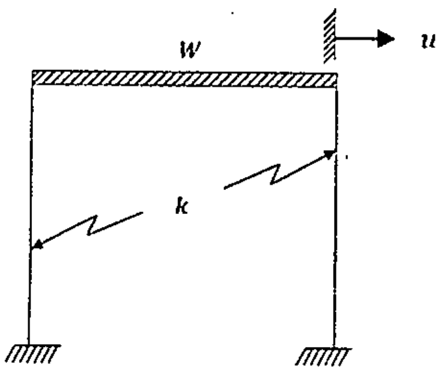


Fig. 5

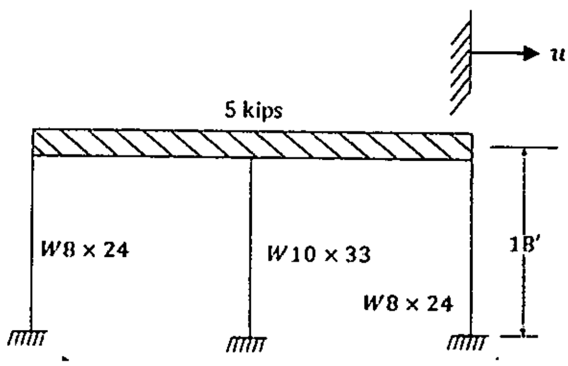


Fig. 6

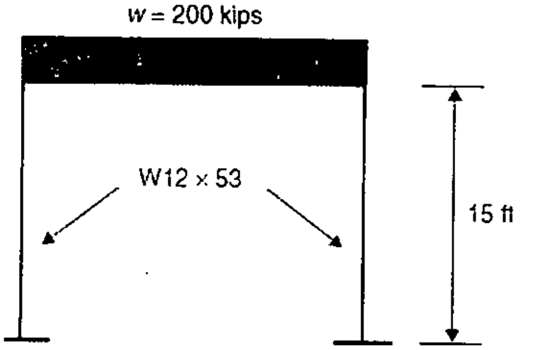


Fig. 7

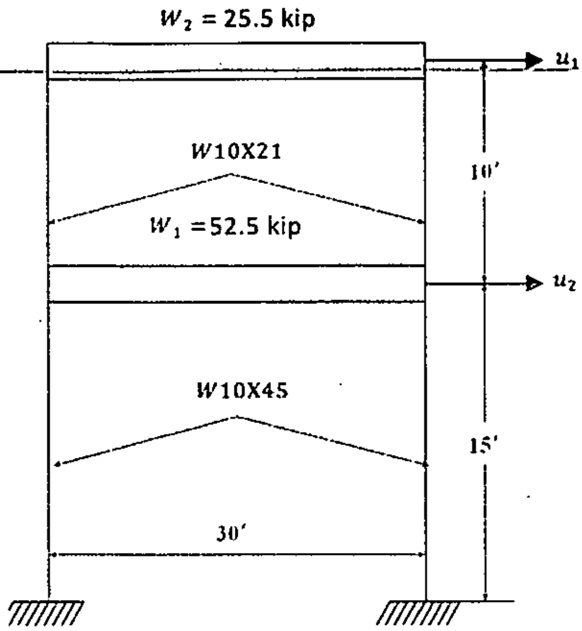


Fig. 4

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations: January-2020 Term

Sub: **CE 433** (Solid and Hazardous Waste Management)

Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Q. # 1 MARKS

a) Draw the typical flow chart showing the inter-relationship among the functional elements of the solid waste management system. How does this differ for Bangladesh? 8

b) Determine the round-trip break-even time for solid waste collection systems in which the 30-yd³ self-loading compactors used for collection are driven to the disposal site and compare that with using a transfer & transport system. Assume that the following data are applicable: 12

i) Specific weight of wastes in self-loading compactor = 600 lb/yd³
ii) Specific weight of wastes in transport trailers = 325 lb/yd³
iii) Volume of tractor-semitrailer transport unit = 105 yd³
iv) Operational cost for self-loading compactor = $40/hr
v) Operational cost for tractor-semitrailer transport unit = $60/hr
vi) Transfer station operating costs, including amortization = $3.25/ton
vii) Extra cost for unloading facilities for transport unit, compared with compactors = $0.40/ton

Q. # 2 MARKS

a) Draw and label the schematic diagrams for the HCS and Exchange Mode HCS of waste collection. In your opinion which one is advantageous and why? 8

b) Chemical composition of the waste received at Amin Bazar landfill is: 12

$$C_{760}H_{1980}O_{874.7}N_{12.7}S$$

Determine the energy content of the waste using modified Dulong Formula both considering and neglecting Sulfur. Comment on the values obtained in relation to the approximate energy value of the organic portion of the MSW Dhaka City.

Q. # 3

a) Draw the typical qualitative particle sizes of MSW received at a Secondary Transfer Station (STS) in Dhaka City along with the same qualitative curve leaving the STS and briefly explain the reasons behind the differences. 8

b) The following average speeds (y) were obtained for various round-trip distances (x) to a disposal site. Using the graphical method to find the haul speed constants a and b for the haul speed equation represented by a rectangular hyperbola; 12

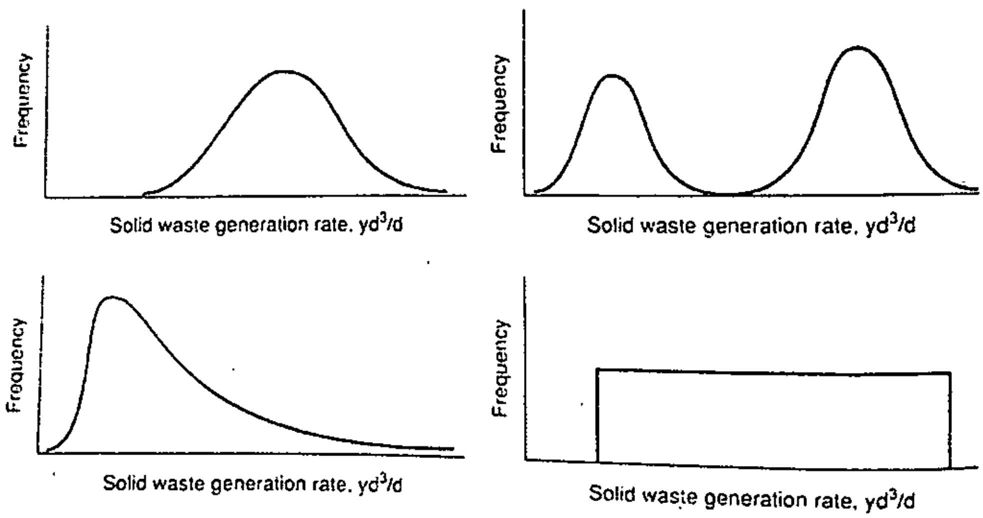
$$y = \frac{x}{a + bx}$$

Also, find the round-trip haul time for a site that is located 25 km away.

Round-trip Distance x (km)	Average Haul Speed y (kph)
3.2	27.4
8.0	45.1
12.9	51.5
19.3	57.9
25.7	64.4
32.2	67.6
40.2	72.4

Q. # 4

a) The shape of a solid waste generation frequency curve reflects the nature of the generating facility. From the following frequency curves what can be deduced from the activity and operation of the facility? 8



b) The amount of solid wastes generated per week in a large residential complex is about 600 yd^3. There are two containers, each with a capacity of 40 gal, at the rear of every house. The solid wastes are collected by a two-person crew using a 35-yd^3 manually loaded compactor truck once a week. Determine the time per trip and weekly labor requirements in person-days. The disposal site is located 15 mile away; haul constants a and b are 0.022 hr/trip and 0.022 mile/hr, respectively; the container utilization factor is 0.7; and the compaction ratio is 2. Assume that the collection is based on 8-hr day. 12

Section B: CE 433

There are FOUR questions. Answer any THREE.

1. a) List four major problems of indiscriminate dumping of solid wastes in urban areas of low-income countries. **(4)**

b) Why sanitary landfill is the only widely acceptable method of solid waste disposal currently all over the world? What precautions are required for its satisfactory performance? **(8)**

c) A solid waste has the following components and bulk densities: **(8)**

Component	% by weight	Loose bulk density (lb/ft^3)
Garden waste	30	4.75
Glass	20	18.65
Paper	25	3.75
Food waste	25	9.45

The food waste is diverted for biogas generation and the remaining waste is disposed into a sanitary landfill. The compacted waste density in the landfill is 43.2 lb/ft^3. Estimate the % volume reduction achieved during compaction of the waste.

2. a) What are the data needed to calculate the required capacity of a sanitary landfill? Explain the factors that can affect the volume requirement of a sanitary landfill. **(6)**

b) "The landfill can be considered as a natural biochemical reactor" – Explain the statement. **(6)**

c) Estimate the percolation of leachate through a landfill 13 m deep, with a 0.9 m cover of silty clay for the following data. **(8)**

Precipitation = 2450 mm/year
Runoff coefficient = 0.34
Evapo-transpiration = 770 mm/year
Silty clay field capacity = 390 mm/m
Solid waste field capacity = 310 mm/m
Assume further that the soil cover has a moisture content of 320 mm/m when applied, and that the incoming waste has a moisture content of 170mm/m.

3. a) Why leachate control is important? State how will you control leachate in a landfill? **(6)**

b) How WBM differs from HELP model in estimating the quantity of leachate generated in a landfill? **(6)**

c) The following four soils layers are lying between the base of a landfill and the underlying aquifer. How long will it take for leachate to migrate to the aquifer? Also, calculate the amount of leachate flowing down if the landfill area is 75 hectare. **(8)**

Soil Layer	Depth (m)	Porosity (%)	Permeability (m/s)
Soil A	2.0	42	2.9×10^{-9}
Soil B	2.5	44	2.2×10^{-8}
Soil C	3.0	43	3.8×10^{-7}
Soil D	3.0	44	2.5×10^{-8}

4. a) What information is essential to design a leachate treatment system? Explain how leachate recirculation is beneficial for a landfill. Name the methods of estimation of landfill gas generation. Which method do you prefer and why? Explain. **(12)**

   b) What are the characteristics of hazardous wastes? List the problems of hazardous waste management in developing countries. What are the main sources of infectious or contaminated wastes in hospitals? **(8)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 435** (Environmental Pollution Management)

Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1(a): 10

Why an averaging period is assigned with the air quality standards of air pollutant? Explain. On a particular day, air quality data recorded at a CAMS are as follows:

$PM_{2.5}$ (24-hr) = 180 microgram/m^3
PM_{10} (24-hr) = 340 microgram/m^3
CO (8-hr) = 8.90 mg/m^3
SO_2 (24-hr) = 455 microgram/m^3

Determine AQI for each parameter and report AQI for that particular day.

[Given: T = 20 °C; P = 1 atm; Table for calculating AQI provided; assume reasonable values for parameters not given]

1(b): 10

What do you understand by SLCP? What are the adverse impact of the SLCPs? Explain the effects (in terms of radiative forcing) of atmospheric aerosols (including black carbon) on global warming; distinguish between positive and negative forcing, and direct and indirect forcing.

2(a): 15

A power plant emits fine particulate matter (PM) at a rate of 38.5 g/sec through a stack that has an effective height of 65 m. Wind speed at the instrument height (10 m) is 4.6 m/sec, and the atmosphere is "slightly unstable". Calculate:

i) Ground level concentration of particulate matter (PM) 1.5 km down-wind of the power plant, along the centerline of the plume.
ii) Concentration of particulate matter (PM) 1.5 m down-wind of the power plant, at a height of 25 m above the ground and 250 m off the center-line off the center-line of the plume.
iii) If the atmospheric stability changes to "very unstable", what would be its likely effect on ground-level concentration in general; explain qualitatively (no need to show any calculation).

[Given: p = 0.25; Table for calculation of dispersion coefficient provided; assume reasonable values for parameters not given]

2(a): **5**

What do you understand by stable, unstable and neutral atmosphere? Determine the nature of atmospheric stability for each of the following situation of ambient atmosphere:

(i) $dT/dz = 0$; (ii) $dT/dz = \Gamma$; (iii) $dT/dz = -1.5\Gamma$

3(a): **13**

In the context of air quality modeling, what do you understand by a "line source". Give examples.

On a long and straight section of a highway, 475 vehicles passing a given spot per hour. Each vehicle, on an average, emits 13.5 g/km of Carbon Monoxide (CO). Wind speed is 2.5 m/sec perpendicular to the highway. Estimate CO concentrations at ground level and at the roof of a building 30 m high, located 200 m down-wind of the road. Consider atmosphere to be "neutral".

[Table for calculation of dispersion coefficient provided]

3(b): **7**

How do catalytic converters help reduce automotive emissions? Is it possible to simultaneously reduce emission of all three pollutants – CO, HC and NOx – through modification of air/fuel ratio? Explain (with an appropriate figure).

4(a): **12**

Suppose the ambient atmospheric temperature profile for a particular day is given by the following equations:

$$\Lambda = 32 - 0.005\,z \quad ; z \le 750 \text{ m}$$
$$= 28.25 + 0.015(z - 750) \quad ; z > 750 \text{ m}$$

where, z = altitude in m.

Plumes are being emitted at 35 °C from two different heights: (i) ground level (z = 0 m); and (b) top of a smoke stack with a height of 100 m. Estimate how high the plume is expected to rise in each case. Draw the shape of the plume (qualitative) emitted from the 100 m high stack along with the temperature profile of the atmosphere given by the above equations (qualitative, free hand sketch).

4(b): **8**

How do hydrocarbons affect the NO-NO_2-O_3 photochemical reaction sequence, and help produce O_3 and other secondary pollutants? Explain. Can SO_2 promote formation of photochemical smog? Explain.

Table for calculation of AQI [for Question No. 1(a)]

Breakpoints							AQI
O_3 (ppm) 8-hr	O_3(ppm) 1-hr (i)	$PM_{2.5}$ (μg/m³) 24-hr	PM_{10} (μg/m³) 24-hr	CO (ppm) 8-hr	SO_2 (ppm) 24-hr	NO_2 (ppm) Annual	
0.000-0.064	--	0.0-15.4	0-54	0.0-4.4	0.000-0.034	(ii)	0-50
0.065-0.084	--	15.5-40.4	55-154	4.5-9.4	0.035-0.144	(ii)	51-100
0.085-0.104	0.125-0.164	40.5-65.4	155-254	9.5-12.4	0.145-0.224	(ii)	101-150
0.105-0.124	0.165-0.204	65.5-150.4	255-354	12.5-15.4	0.225-0.304	(ii)	151 -200
0.125-0.374	0.205-0.404	150.5-250.4	355-424	15.5-30.4	0.305-0.604	0.65-1.24	201-300
(iii)	0.405-0.504	250.5-350.4	425-504	30.5-40.4	0.605-0.804	1.25-1.64	301-400
(iii)	0.505-0.604	350.5-500.4	505-604	40.5-50.4	0.805-1.004	1.65-2.04	401-500

(i) In some cases, in addition to calculating the 8-hr ozone index, the 1-hr ozone index may be calculated, and the maximum of the two values reported
(ii) NO_2 has no short-term air quality standard and can generate an AQI only above 200
(iii) 8-hr O_3 values do not define higher AQI values (≥301). AQI values of 301 or higher are calculated with 1-hr O_3 concentrations

Table for estimation of dispersion coefficients [for Questions 2(a) and 3(a)]

		$x \le 1$ km			$x \ge 1$ km		
Stability	a	c	d	f	c	d	f
A	213	440.8	1.941	9.27	459.7	2.094	−9.6
B	156	106.6	1.149	3.3	108.2	1.098	2.0
C	104	61.0	0.911	0	61.0	0.911	0
D	68	33.2	0.725	−1.7	44.5	0.516	−13.0
E	50.5	22.8	0.678	−1.3	55.4	0.305	−34.0
F	34	14.35	0.740	−0.35	62.6	0.180	−48.6

[a] The computed values of σ will be in meters when x is given in kilometers.

$$\sigma_y = a.x^{0.894}$$

$$\sigma_z = c.x^d + f$$

Section-B: CE 435

There are **FOUR** Questions. Answer any **THREE**

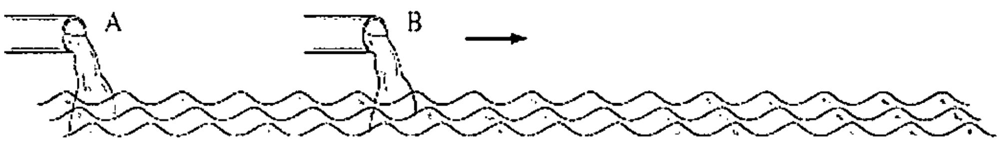
No.	Questions	Marks
5.	a) Concentrations of N and P of a water sample from an unidentified source are found to be 20 mg/L and 3 mg/L. Which of these is the limiting nutrient and why? How the eutrophication of the source water body can be controlled?	**10**
	b) Effluent from two industrial effluent treatment plant (A and B) falls into a river as shown below. Sketch the typical profile for the following. i) DO profile as a function of downstream distance ii) Sketch the BOD remaining in the river as a function of downstream distance. 	**10**
6.	The ultimate BOD of a river just below a sewage outfall is 50.0 mg/L, and the DO is at the saturation value of 10.0 mg/L. The deoxygenation rate coefficient is 0.30/day, and the reaeration rate coefficient is 0.90/day. The river is flowing at the speed of 60.0 km/day. Consider the sewage outfall as the only source of BOD on this river. i) Find the critical distance downstream at which DO is a minimum. ii) Find the minimum DO. iii) If a wastewater treatment plant is to be built, what fraction of the BOD would have to be removed from the sewage to assure a minimum of 5.0 mg/L everywhere downstream?	**20**
7.	A lake with surface area of 100×10^6 m^2 is fed by a stream having a flow rate of 20 m^3/s with 0.01 mg/L phosphorus. Effluent from a wastewater treatment plant also discharges into the lake. The effluent flow rate is 0.5 m^3/s, and its phosphorus concentration is 8 mg/L. Furthermore, agricultural runoff adds on average 0.2 g/s phosphorus into the lake. i) If the phosphorus settling rate is 10 m/yr, calculate the average phosphorus concentration in the lake. ii) Estimate the level of additional phosphorus removal required at the treatment plant to keep the concentration of phosphorus in the lake below 0.010 mg/L.	**20**
8.	Suppose a spill of trichloroethylene (TCE) distributes itself evenly throughout an aquifer 10.0 m thick, forming a rectangular plume 2,000 m long and 250 m wide. The aquifer has porosity 0.40, hydraulic gradient 0.001, and hydraulic conductivity 0.001 m/s. Using capture-zone type curves, design an extraction field to pump out the plume under the assumption that the wells are all lined up along the leading edge of the plume, with each well to be pumped at the same rate, not to exceed 0.003 m^3/s per well. i) What is the smallest number of wells that could be used to capture the whole plume? ii) What minimum pumping rate would be required for each well? iii) What would the optimal spacing be between the wells (at that minimum pumping rate)?	**20**

Table of Fourier Transforms

	$f(x)$	$\hat{f}(\omega) = \int_{-\infty}^{\infty} f(x) e^{-i\omega x}\, dx$
1.	$\dfrac{1}{x^2 + a^2} \quad (a > 0)$	$\dfrac{\pi}{a} e^{-a\lvert\omega\rvert}$
2.	$H(x)e^{-ax} \quad (\operatorname{Re} a > 0)$	$\dfrac{1}{a + i\omega}$
3.	$H(-x)e^{ax} \quad (\operatorname{Re} a > 0)$	$\dfrac{1}{a - i\omega}$
4.	$e^{-a\lvert x\rvert} \quad (a > 0)$	$\dfrac{2a}{\omega^2 + a^2}$
5.	e^{-x^2}	$\sqrt{\pi} e^{-\omega^2/4}$
6.	$\dfrac{1}{2a\sqrt{\pi}} e^{-x^2/(2a)^2} \quad (a > 0)$	$e^{-a^2\omega^2}$
7.	$\dfrac{1}{\sqrt{\lvert x\rvert}}$	$\sqrt{\dfrac{2\pi}{\lvert\omega\rvert}}$
8.	$e^{-a\lvert x\rvert/\sqrt{2}} \sin\left(\dfrac{a}{\sqrt{2}}\lvert x\rvert + \dfrac{\pi}{4}\right) \quad (a > 0)$	$\dfrac{2a^3}{\omega^4 + a^4}$
9.	$H(x + a) - H(x - a)$	$\dfrac{2 \sin \omega a}{\omega}$
10.	$\delta(x - a)$	$e^{-i\omega a}$
11.	$f(ax + b) \quad (a > 0)$	$\dfrac{1}{a} e^{ib\omega/a} \hat{f}\left(\dfrac{\omega}{a}\right)$
12.	$\dfrac{1}{a} e^{-ibx/a} f\left(\dfrac{x}{a}\right) \quad (a > 0,\ b \text{ real})$	$\hat{f}(a\omega + b)$
13.	$f(ax)\cos cx \quad (a > 0,\ c \text{ real})$	$\dfrac{1}{2a}\left[\hat{f}\left(\dfrac{\omega - c}{a}\right) + \hat{f}\left(\dfrac{\omega + c}{a}\right)\right]$
14.	$f(ax)\sin cx \quad (a > 0,\ c \text{ real})$	$\dfrac{1}{2ai}\left[\hat{f}\left(\dfrac{\omega - c}{a}\right) - \hat{f}\left(\dfrac{\omega + c}{a}\right)\right]$
15.	$f(x + c) + f(x - c) \quad (c \text{ real})$	$2\hat{f}(\omega)\cos \omega c$
16.	$f(x + c) - f(x - c) \quad (c \text{ real})$	$2i\hat{f}(\omega)\sin \omega c$
17.	$x^n f(x) \quad (n = 1, 2, \ldots)$	$i^n \dfrac{d^n}{d\omega^n} \hat{f}(\omega)$

Linearity of transform and inverse:

18.	$\alpha f(x) + \beta g(x)$	$\alpha \hat{f}(\omega) + \beta \hat{g}(\omega)$

Transform of derivative:

19.	$f^{(n)}(x)$	$(i\omega)^n \hat{f}(\omega)$

Transform of integral:

20.	$f(x) = \int_{-\infty}^{x} g(\xi)\, d\xi$, where $f(x) \to 0$ as $x \to \infty$	$\hat{f}(\omega) = \dfrac{1}{i\omega} \hat{g}(\omega)$

Fourier convolution theorem:

21.	$(f * g)(x) = \int_{-\infty}^{\infty} f(x - \xi) g(\xi)\, d\xi$	$\hat{f}(\omega)\hat{g}(\omega)$

Table of Fourier Cosine and Sine Transforms

$f(x)$	$\hat{f}_c(\omega) = \int_0^\infty f(x) \cos \omega x \, dx$
1C. e^{-ax} $(a > 0)$	$\dfrac{a}{\omega^2 + a^2}$
2C. $x^n e^{-ax}$ $(a > 0)$	$\dfrac{n! \operatorname{Re}(a + i\omega)^{n+1}}{(\omega^2 + a^2)^{n+1}}$ (Re = real part)
3C. $\dfrac{1}{x^2 + a^2}$ $(a > 0)$	$\dfrac{\pi}{2a} e^{-a\omega}$
Linearity of transform and inverse:	
4C. $\alpha f(x) + \beta g(x)$	$\alpha \hat{f}_c(\omega) + \beta \hat{g}_c(\omega)$
Transform of derivative:	
5C. $f'(x)$	$\omega \hat{f}_s(\omega) - f(0)$
6C. $f''(x)$	$-\omega^2 \hat{f}_c(\omega) - f'(0)$
Convolution theorem:	
7C. $\dfrac{1}{2} \int_0^\infty [f(\lvert x - \xi \rvert) + f(x + \xi)] g(\xi) \, d\xi$	$\hat{f}_c(\omega) \hat{g}_c(\omega)$

$f(x)$	$\hat{f}_s(\omega) = \int_0^\infty f(x) \sin \omega x \, dx$
1S. e^{-ax} $(a > 0)$	$\dfrac{\omega}{\omega^2 + a^2}$
2S. $x^n e^{-ax}$ $(a > 0)$	$\dfrac{n! \operatorname{Im}(a + i\omega)^{n+1}}{(\omega^2 + a^2)^{n+1}}$ (Im = imaginary part)
3S. $\dfrac{x}{x^2 + a^2}$ $(a > 0)$	$\dfrac{\pi}{2} e^{-a\omega}$
Linearity of transform and inverse:	
4S. $\alpha f(x) + \beta g(x)$	$\alpha \hat{f}_s(\omega) + \beta \hat{g}_s(\omega)$
Transform of derivative:	
5S. $f'(x)$	$-\omega \hat{f}_c(\omega)$
6S. $f''(x)$	$-\omega^2 \hat{f}_s(\omega) + \omega f(0)$
Convolution theorem:	
7S. $\dfrac{1}{2} \int_0^\infty [f(\lvert x - \xi \rvert) - f(x + \xi)] g(\xi) \, d\xi$	$\hat{f}_c(\omega) \hat{g}_s(\omega)$

TABLE A1 *Standard Normal Distribution Function:* $\Phi(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-y^2/2}\, dy$

x	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.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

TABLE A2 *Values of* $\chi^2_{\alpha,n}$

n	$\alpha = .995$	$\alpha = .99$	$\alpha = .975$	$\alpha = .95$	$\alpha = .05$	$\alpha = .025$	$\alpha = .01$	$\alpha = .005$
1	.0000393	.000157	.000982	.00393	3.841	5.024	6.635	7.879
2	.0100	.0201	.0506	.103	5.991	7.378	9.210	10.597
3	.0717	.115	.216	.352	7.815	9.348	11.345	12.838
4	.207	.297	.484	.711	9.488	11.143	13.277	14.860
5	.412	.554	.831	1.145	11.070	12.832	13.086	16.750
6	.676	.872	1.237	1.635	12.592	14.449	16.812	18.548
7	.989	1.239	1.690	2.167	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	21.026	23.337	26.217	28.300
13	3.565	4.107	5.009	5.892	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.484	36.415	39.364	42.980	45.558
25	10.520	11.524	13.120	14.611	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	40.113	43.194	46.963	49.645
28	12.461	13.565	15.308	16.928	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	42.557	45.772	49.588	52.336
30	13.787	14.953	16.791	18.493	43.773	46.979	50.892	53.672

Other chi-square probabilities:
$\chi^2_{.9,9} = 4.2$ $P\{\chi^2_{16} < 14.3\} = .425$ $P\{\chi^2_{11} < 17.1875\} = .8976$.

TABLE A3 *Values of* $t_{\alpha,n}$

n	$\alpha = .10$	$\alpha = .05$	$\alpha = .025$	$\alpha = .01$	$\alpha = .005$
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.474	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
∞	1.282	1.645	1.960	2.326	2.576

Other t probabilities:
$P\{T_8 < 2.541\} = .9825$ $P\{T_8 < 2.71\} = .9864$ $P\{T_{11} < .7635\} = .77$ $P\{T_{11} < .934\} = .81$ $P\{T_{11} < 1.66\} = .94$ $P\{T_{12} < 2.81\} = .984$.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 437** (Environmental-and-Sustainable Management)

Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

No.	Questions	Marks
1(a)	What kind of activities are restricted in an ecologically critical area? What is meant by 'Action taken in good faith' and 'Delegation of Power' as per Environment Conservation Act 1995? What is the difference between 'Act' and 'Rules'?	14
(b)	Explain the statement: 'The ability of the environment courts to properly function rests with the DoE'.	6
2(a)	According to the Brick Manufacturing and Kiln Establishment (Control) Act 2013, which areas are restricted for establishment of kilns? What major issues were addressed in the 2013 amendment of the Labour Act?	8
(b)	Why are the environmental quality standards (EQS) in Bangladesh less stringent compared to developed countries? What is meant by the statement 'the EQS in Bangladesh is not set for any specific period of time and there is no provision for partial compliance'?	12
3(a)	Briefly explain how environmental considerations nowadays have been integrated in the project cycle? How would you decide whether to perform EIA or IEE?	14
(b)	How can EMP be a tool for promoting accountability?	6
4(a)	How would you identify the stakeholders for public consultation? How would you plan and conduct an effective public consultation for an EIA study?	14
(b)	What were the positive effects of closure of the northern intake of Dhaleswari river for the Jamuna Multipurpose Bridge Project?	

Section-B: CE 437

There are FOUR questions. Answer any THREE

Q5.

a) "Increase of GDP does not ensure Sustainable Development" --- Explain this with examples. (10)

b) "Environmental Management is the management of human's interaction with and impacts on the environment rather than managing the environment' --- Do you agree with this statement? Justify your answer. (10)

Q6.

a) Why is 'Ecological Footprint' preferred to 'Earth's Human Carrying Capacity' in indicating Sustainability? Explain with example. (10)

b) What is BDP 2100? Do you think BDP 2100 will transform Bangladesh into a prosperous country? How? Describe. (10)

Q7.

a) Write Short Notes on i) Cleaner production ii) Externalities (8)

b) The data shown in the following Table presents the MAC of three industries for reducing pollution. Determine how much pollution each industry needs to reduce for a total emission of 16 Tonnes/week at the minimum possible total cost. (12)

Emission (Tonnes/week)	MAC (lac BDT/week)		
	Plant A	Plant B	Plant C
10	0	0	0
9	1	2	3
8	2	3	4
7	3	5	6
6	4	8	8
5	5	12	12
4	7	16	25
3	10	25	36
2	13	37	50
1	20	65	82
0	50	83	120

Q8.

a) Do you think that Bangladesh should now take a step to shift its energy use source from fossil fuel to renewable energy? Justify your answer with example. (10)

b) How can environmental economics take part in Environmental Management? Explain with example. (10)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 441** (Foundation Engineering)

Full Marks: 180 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

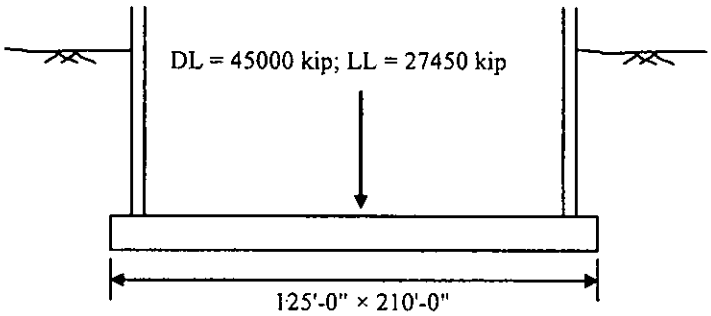
There are **FOUR** questions in this Section. Answer any **THREE**.

No.	Questions	Marks
1.	For a finite slope in c-φ soil that makes an angle β with the horizontal, show that the maximum height of slope for which critical equilibrium occurs can be obtained by (using plane failure surfaces of Culmann's Method): $$H_{cr} = \frac{4c'}{\gamma}\left[\frac{\sin\beta\cos\varphi'}{1-\cos(\beta-\varphi')}\right]$$	(30)
2. (a)	Show with neat sketches the following modes of failure of finite slope: i) Toe circle, ii) Slope circle, iii) Shallow slope circle, and iv) Base failure	**(5+10)**
2. (b)	What do you mean by '2500 aggregate SPT N values' for defining/ choosing the depth of boring required in case of bridge foundation? How do you determine the value of '2500 aggregate SPT N values'?	(15)
3. (a)	For an infinite slope in c-phi soil sand that makes an angle β with the horizontal and subjected to seepage through the soil while ground water level coincides with the ground surface, show that the value of F_s (factor of safety) is given by: $$F_s = \frac{c'}{\gamma_{sat}H\cos^2\beta\tan\beta} + \frac{\gamma'}{\gamma_{sat}}\frac{\tan\varphi'}{\tan\beta}$$ H= height of sloping ground; γ'= submerged unit weight of soil= $\gamma_{sat} - \gamma_w$	(15)
3. (b)	Define Tension pile and End bearing pile. Give relevant equations for Q_u (ultimate capacity) and Q_a (allowable capacity). Describe disturbed and undisturbed samples and their importance in soil exploration. State various factors to assess the quality of undisturbed samples.	(5+10)
4.	A concrete pile of D = 500 mm diameter was driven into sand of loose to medium density to a depth of 18 m. The following properties are known: - Average unit weight of soil along the length of the pile, γ_{wet}= 18.5 kN/m^3, average ϕ = 30°; - Average K_s = 1.0 (along the pile shaft) and $\delta = 0.8\ \phi$. - Corrected N value is 25 averaging over depth within the range between the pile tip and 2D below it. - Calculate (a) the ultimate bearing capacity of the pile, and (b) the allowable load with F_s = 2.5. Assume the water table is at great depth. Use Meyerhof's critical depth Method for estimation. Meyerhof's N_q based on ϕ and critical depth Z_c: φ (deg)-> 30, 35, 37, 38, 39, 40 N_q = 62, 135, 200, 220, 235, 250 Z_c/d= 7, 10.5, 12, 14, 15, 16	(30)

Section-B: CE 441

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

5. For the raft foundation shown below, determine the depth of foundation for full compensation. What will be the depth of foundation for a factor of safety of 3.0? If the total load is increased by 50%, what will be the factor of safety for the depth of foundation corresponding to the factor of safety of 3.0? **(30)**



Deep Soft Clay
γ = 117 pcf
Average q_u = 0.35 tsf

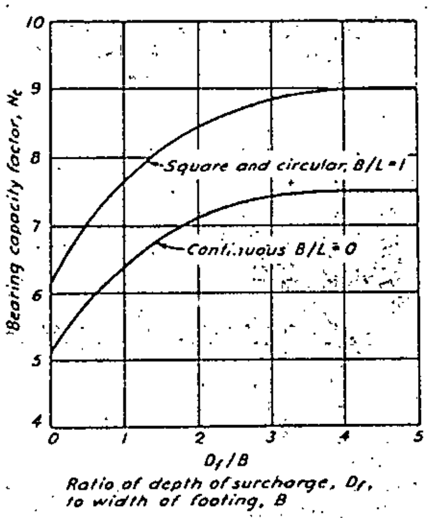


FIGURE 18.2. Bearing capacity factors for foundations on clay under $\phi = 0$ conditions (after Skempton, 1951).

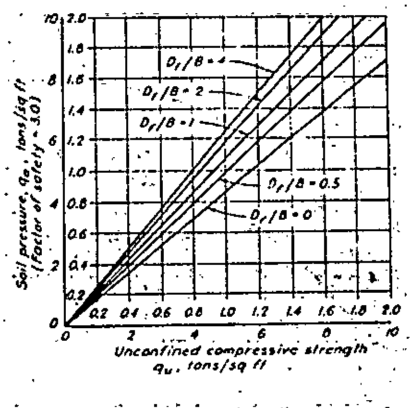


FIGURE 18.3. Net allowable soil pressure for footings on clay and plastic silt, determined for a factor of safety of 3 against bearing capacity failure ($\phi = 0$ conditions). Chart values are for continuous footings ($B/L = 0$); for rectangular footings, multiply values by $1 + 0.2\ B/L$; for square and circular footings, multiply values by 1.2.

Fig. 1 for Question No. 5

6. Calculate the total settlement of the group of piles shown in Fig. 2. Assume that the load is spread at an angle of 2 vertical to 1 horizontal. **(30)**

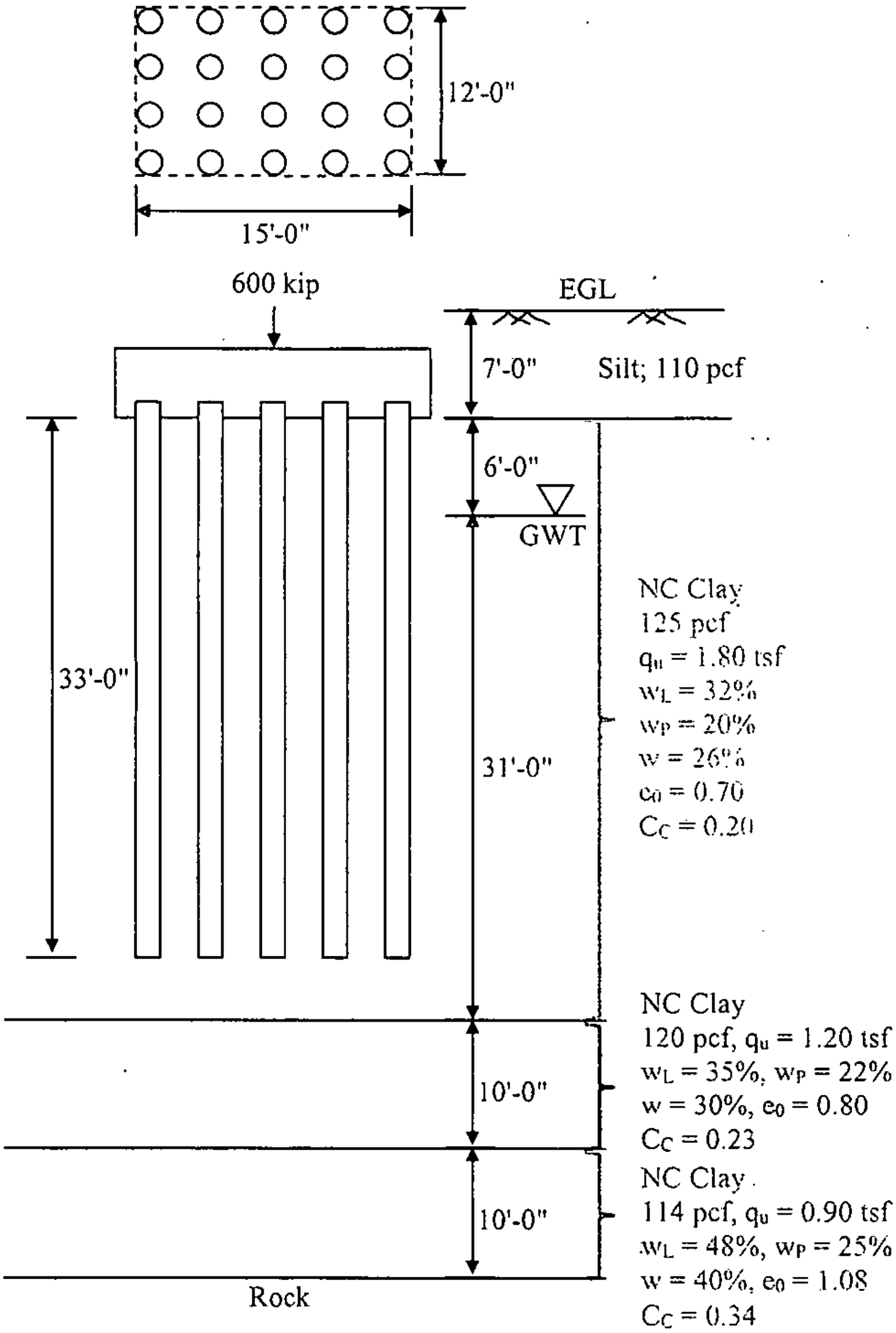
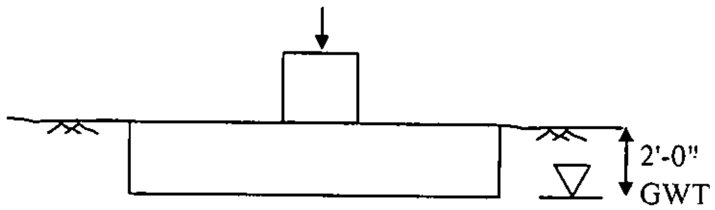


Fig. 2 for Question No. 6

7. (a) Determine the settlement for the footing shown below. Calculate the factor of safety against a bearing capacity failure. The unit weight of the sand is 120 pcf. The N-values have been corrected for overburden pressure. **(15)**



10'-0" square
Fine Silty Sand: Average N = 25

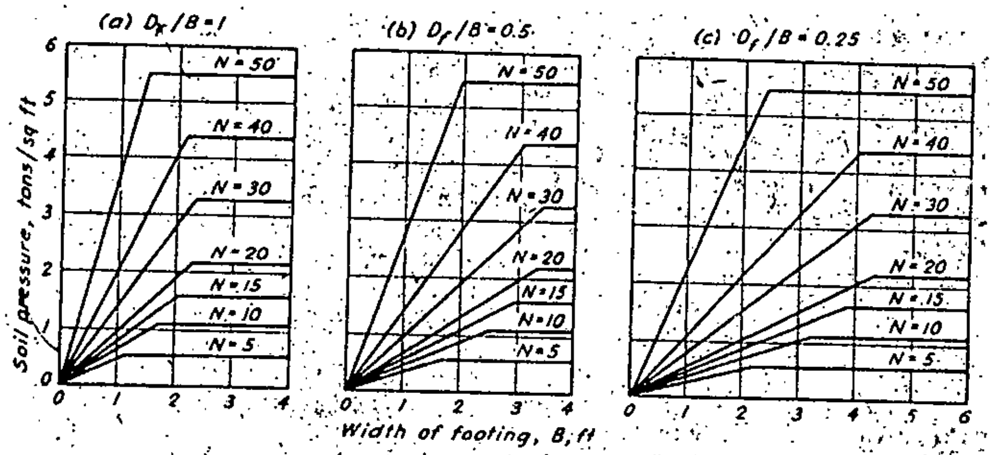


FIGURE 19.3. Design chart for proportioning shallow footings on sand.

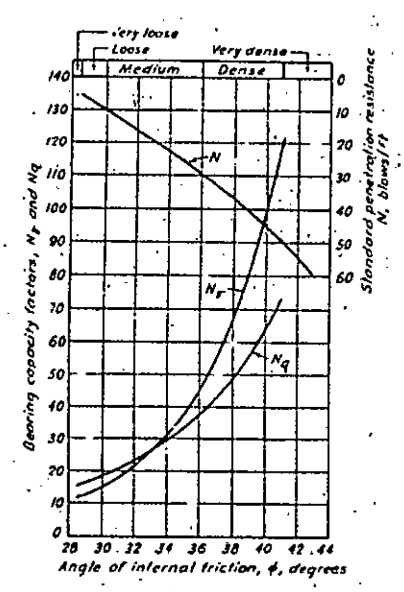


FIGURE 19.5. Curves showing the relationship between bearing-capacity factors and ϕ, as determined by theory, and rough empirical relationship between bearing capacity factors or ϕ and values of standard penetration resistance N.

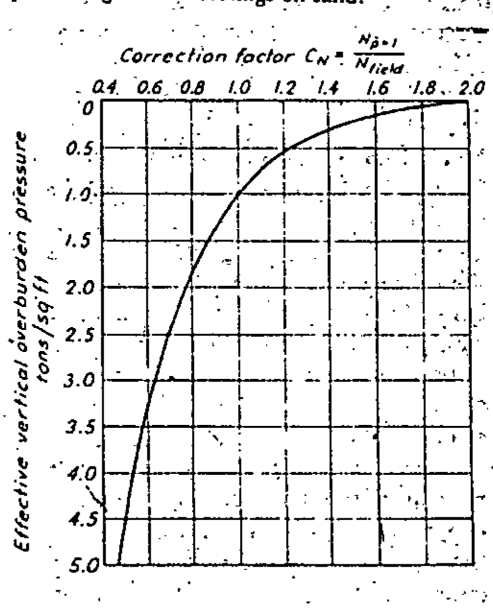


FIGURE 19.6. Chart for correction of N-values in sand for influence of overburden pressure (reference value of effective overburden pressure 1 ton/sq ft).

Fig. 3 for Question No. 7 & 8

(b) A footing 12 ft square and 2 ft thick is supported by sand with an average N value of 30 (corrected for overburden pressure). The surface of the ground is 3 ft above the top of the footing, and the water table is 4 ft below the base. Compute the maximum load that the footing can support if the settlement must not exceed 0.5 inch. The unit weight of the sand is 120 pcf. **(15)**

8. **(a)** A reinforced concrete structure 110 ft square is to be supported by a raft foundation with its base 18 ft below the surrounding ground surface. The subsoil consists of sand to great depth (115 pcf). The average N-value corrected for overburden pressure is 30. The water table is 5 ft below the existing ground level. What total load, including the weight of raft, structure, and contents, may be supported at a settlement not to exceed 2 in? Calculate the hydrostatic uplift on the base of the raft. **(15)**

(b) A continuous wall footing is 2 ft wide and 9 in. thick. The ground surface and water table are at the top of the footing. The underlying sand has an N-value of 30, after correction for the influence of overburden pressure. What load will the footing support if the settlement is not to exceed 1 in. and the factor of safety against bearing capacity failure is not to be less than 2? Which one of settlement and bearing capacity govern the load? **(15)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

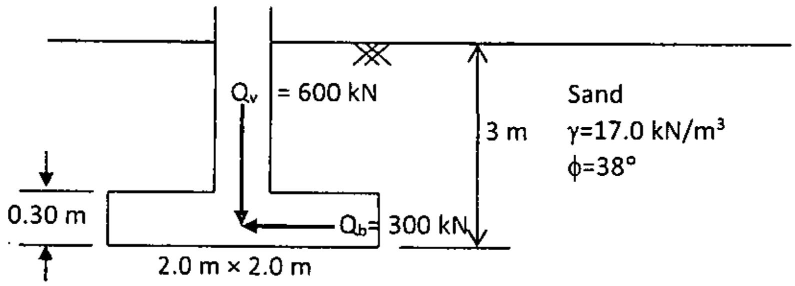
Sub: **CE 443** (Earth Retaining Structures)

Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

No.	Questions	Marks
1(a)	List the causes that may induce lateral load to foundations. How does lateral load affect the bearing capacity of foundation?	(4)
1(b)	Compare between cantilever retaining wall and counterfort retaining wall.	(4)
1(c)	Determine the factor of safety against sliding for the rectangular footing (2.0 m × 2.0 m) shown in the **Fig. 1**.  **Fig. 1 [Q. 1 (c)]**	(12)
2(a)	List the types of externally stabilized retaining walls.	(4)
2(b)	Why granular material is chosen as backfill for constructing retaining structures?	(4)

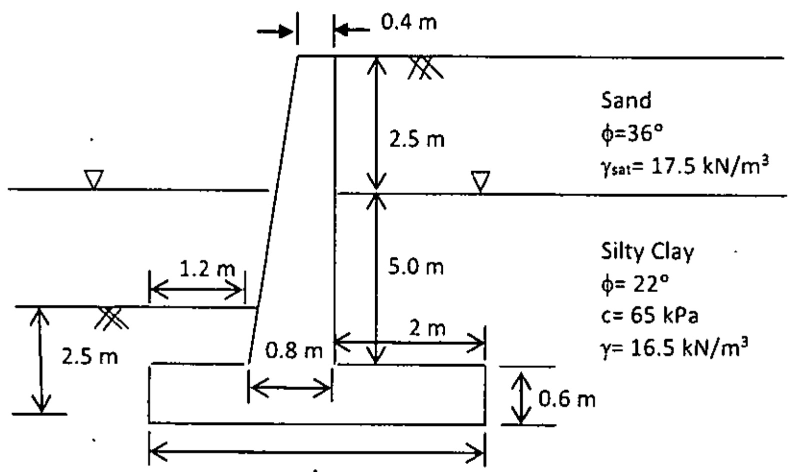
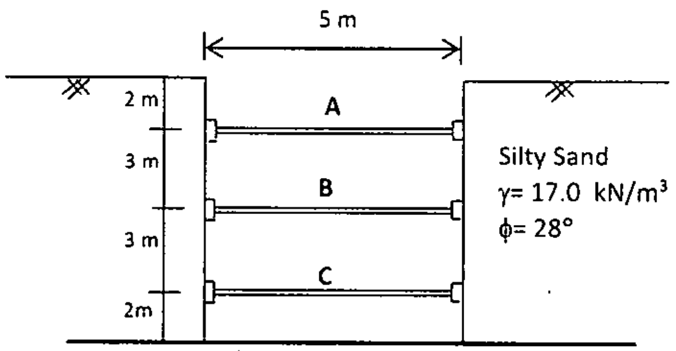
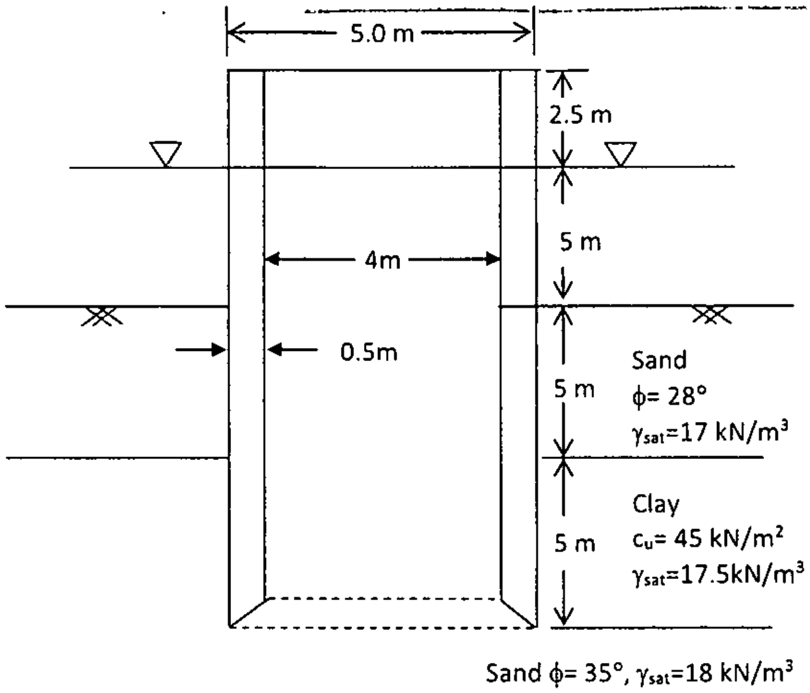
<table>
<tr><td>2(c)</td><td>Determine the factor of safety against overturning failure for the retaining wall shown in Fig. 2. Ignore the passive resistance in front of the wall. Unit weight of concrete, γ_{conc}= 24 kN/m^3.


Fig. 2 [Q. 2(c)]</td><td>(12)</td></tr>
<tr><td>3(a)</td><td>Mention the force/stress that is necessary to consider for designing each component of the cofferdam. What do you mean by 'Failure by Bottom Heaving'?</td><td>(4)</td></tr>
<tr><td>3(b)</td><td>Compare the earth pressure on braced cofferdam in 'Loose Sand' and 'Dense Sand'.</td><td>(4)</td></tr>
<tr><td>3(c)</td><td>A braced excavation system for an open cut is shown in Fig. 3. Determine the force in the struts A and B. The struts are spaced 2.5 m center-to-centre in plan.


Bottom of excavation, Water table is at greater depth
Fig. 3 [Q. 3(c)]</td><td>12</td></tr>
<tr><td>4(a)</td><td>List the types of caissons. Compare the advantages of Pneumatic Caissons and Box Caissons.</td><td>(4)</td></tr>
<tr><td>4(b)</td><td>List the primary uses of geotextile in foundation engineering. Show the different components of a reinforced earth retaining wall in a neat sketch.</td><td>(4)</td></tr>
</table>

4(c)	Will the caisson shown in the **Fig. 4** be self-sinking?  **Fig. 4 [Q. 4(c)]**	(12)

SECTION-B:-CE 443

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

5. Determine the length of a cantilever sheet pile required to retain 3.5 m of sandy backfill material overlying silty clay deposit (Fig.5). A surcharge load of 15 kPa acts on the backfill. Consider the scenario of sudden drop in water level in front of the wall by 1 m as shown in figure. Consider short term analysis. **(20)**

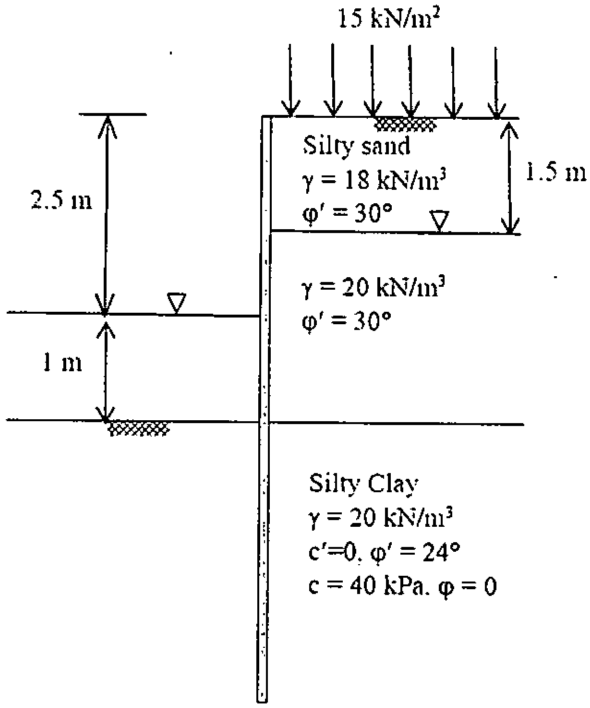


Fig. 5

6. Determine the required embedment of an anchored sheet pile, shown in Fig.6, retaining 6.5 m of sandy backfill material and embedded in silty sand deposit. Water table is 3 m below the top surface of backfill. Also determine the spacing and size of mild steel tie-rods to be used for anchor. **(20)**

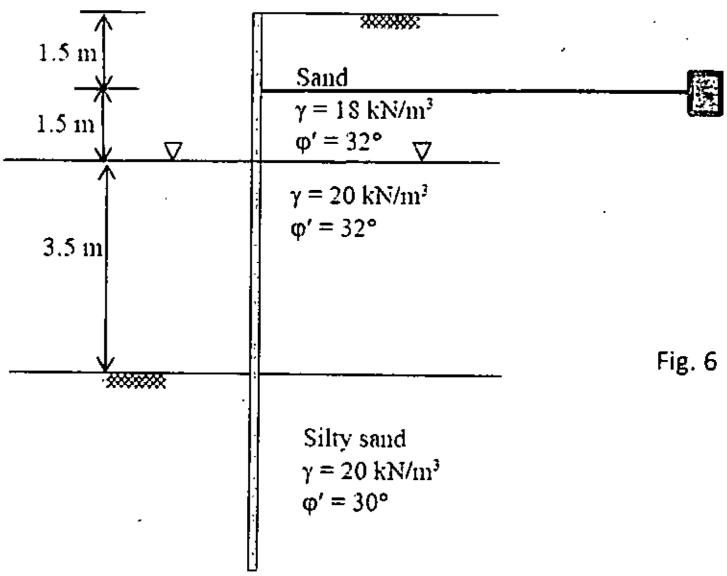


Fig. 6

7. (a) Discuss in your own words if you think slurry trench wall construction is necessary for infrastructure development works in Bangladesh. Give reasoning for your answer and discuss the challenges. **(8)**

(b) A 0.45 m diameter 8 m long pile in clay is subjected to a horizontal load of 40 kN. Consider the pile to be connected to rigid pile cap. Using Broms' method, determine the factor of safety for lateral load. Finally determine the horizontal deflection at ground level, using theoretical solutions. Soil properties are: Unit weight = 20 kN/m^3, Undrained shear strength = 35 kPa, Modulus of horizontal subgrade reaction = 1000 kN/m^3, Moment capacity of pile = 110 kN-m, Elastic Modulus of Pile = 21700 MPa. **(12)**

[Given: $\beta = \left(\frac{k_h D}{E_p I_p}\right)^{0.25}$;

For horizontal load H, $\Delta_H = \frac{2H\beta}{k_h D} K_{\Delta H}$, $\theta_H = \frac{2H\beta^2}{k_h D} K_{\theta H}$

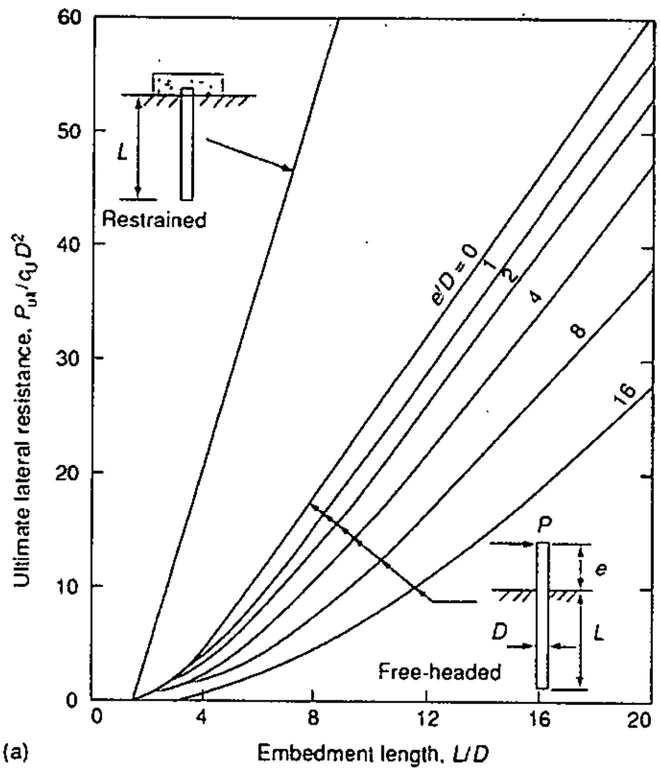
For moment M, $\Delta_M = \frac{2M\beta^2}{k_h D} K_{\Delta M}$, $\theta_M = \frac{2M\beta^3}{k_h D} K_{\theta M}$]

8. (a) Describe a procedure you would employ for analyzing the response of a laterally loaded pile in a layered soil with very different characteristics. (6)

(b) Determine the size of a anchor block at depth of 1 m below ground to resist a anchor force of 300 kN. Assume silty sand with following properties: Moist Unit weight = 18 kN/m^3, Saturated unit weight = 20 kN/m^3, Angle of internal friction = 32°. (5)

(c) With neat sketches, describe how the lateral earth pressure acting on a retaining wall depend on the movement of wall. (4)

(d) Which pumping method you would use for dewatering a construction site 50 m x 50 m for mat construction at a depth of 5 m in the following soil profile? Assume top 2 m soil to be silty clay overlying silty sand. Give your reasons and present a neat sketch of your pumping system. (5)



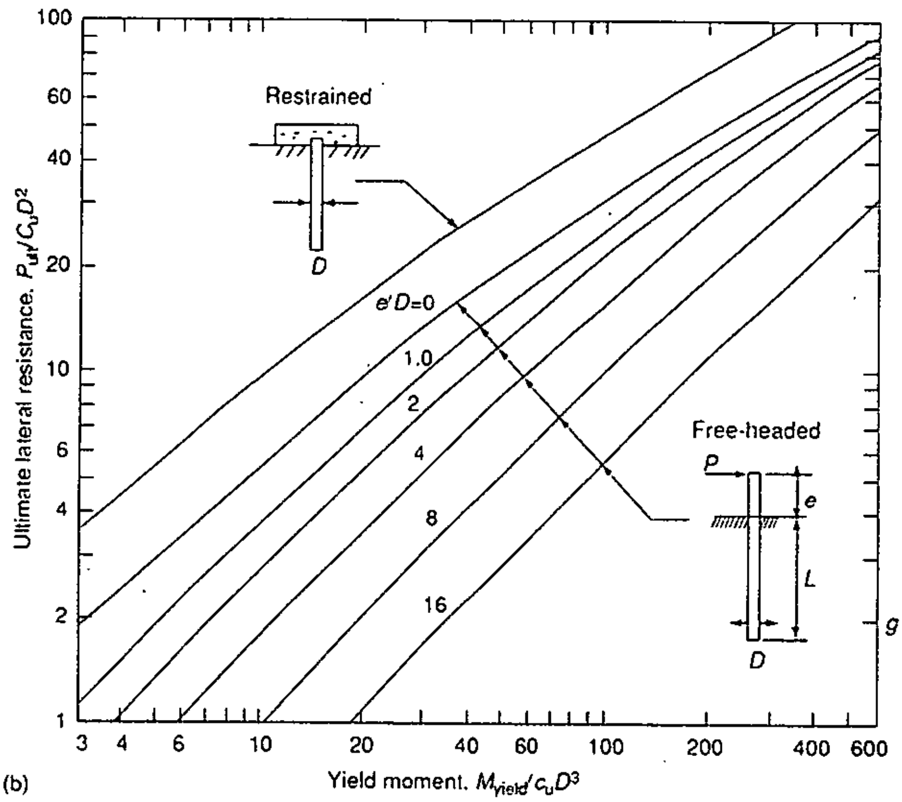


FIGURE 8.4
Ultimate lateral resistance of piles in cohesive soils: (a) short piles and (b) long piles. (From Broms, B., 1964a, *J. Soil Mech. Found. Div., ASCE*, 90(SM3):27–56. With permission.)

TABLE 8.1

Influence Factors for the Linear Solution

βL	Z/L	$K(\Delta H)$	$K(\theta H)$	$K(MH)$	$K(VH)$	$K(\Delta M)$	$K(\theta M)$	$K(MM)$	$K(VM)$
2.0	0	1.1376	1.1341	0	1	−1.0762	1.0762	1	0
2.0	0.125	0.8586	1.0828	0.1848	0.5015	−0.6579	0.8314	0.9397	0.2214
2.0	0.25	0.6015	0.9673	0.262	0.1377	−0.2982	0.6133	0.7959	0.3387
2.0	0.375	0.3764	0.8333	0.2637	−0.1054	−0.0376	0.4366	0.6138	0.3788
2.0	0.5	0.1838	0.7115	0.218	−0.2412	0.1463	0.3068	0.4262	0.3639
2.0	0.625	0.0182	0.6192	0.1491	−0.2937	0.2767	0.222	0.2564	0.3101
2.0	0.75	−0.1288	0.5628	0.0776	−0.2654	0.3747	0.1757	0.1208	0.2282
2.0	0.875	−0.2659	0.5389	0.0222	−0.1665	0.4572	0.1578	0.0318	0.1241
2.0	1	−0.3999	0.5351	0	0	0.5351	0.1551	0	0
3.0	0.125	0.6459	0.8919	0.2508	0.3829	−0.3854	0.6433	0.8913	0.2514
3.0	0.25	0.3515	0.6698	0.3184	0.0141	−0.0184	0.3493	0.6684	0.3202
3.0	0.375	0.1444	0.4394	0.285	−0.1664	0.1607	0.1429	0.436	0.2887
3.0	0.5	0.0164	0.2528	0.2091	−0.2223	0.2162	0.0168	0.2458	0.215
3.0	0.625	−0.0529	0.1271	0.1272	−0.2057	0.2011	−0.0489	0.1148	0.1353
3.0	0.75	−0.0861	0.0584	0.0594	−0.1519	0.1524	−0.0763	0.0396	0.0684
3.0	0.875	−0.1021	0.0321	0.0154	−0.0807	0.0916	−0.0839	0.0069	−0.0225
3.0	1	−0.113	0.0282	0	0	0.0282	−0.0847	0	0
4.0	0	1.0008	1.0015	0	−0.0000	0.0282	−0.0847	0.0000	0
4.0	0.1250	0.5323	0.8247	0.2907	0.2411	−0.2409	0.5344	0.8229	0.2910
4.0	0.2500	0.1979	0.5101	0.3093	−0.1108	0.1136	0.2010	0.5082	0.3090
4.0	0.3750	0.0140	0.2403	0.2226	−0.2055	0.2118	0.0178	0.2397	0.2200
4.0	0.5000	−0.0590	0.0682	0.1243	−0.1758	0.1858	−0.0558	0.0720	0.1176
4.0	0.6250	−0.0687	−0.0176	0.0529	−0.1081	0.1200	−0.0696	−0.0043	0.0406
4.0	0.7500	−0.0505	−0.0488	0.0147	−0.0475	0.0538	−0.0616	−0.0206	−0.0025
4.0	0.8750	−0.0239	−0.0552	0.0014	−0.0101	−0.0033	−0.0535	−0.0096	−0.0148
4.0	1.0000	0.0038	−0.0555	−0	0.0000	−0.0555	−0.0517	−0.0000	−0
5.0	0	1.0003	1.0003	0	1.0000	−1.0003	1.0002	1.0000	0
5.0	0.1250	0.4342	0.7476	0.3131	0.1206	−0.1210	0.4343	0.7472	0.3133
5.0	0.2500	0.0901	0.3628	0.2716	−0.1817	0.1818	0.0907	0.3620	0.2720
5.0	0.3750	−0.0466	0.1013	0.1461	−0.1919	0.1930	−0.0455	0.1002	0.1461
5.0	0.5000	−0.0671	−0.0157	0.0494	−0.1133	0.1163	−0.0654	−0.0161	0.0482
5.0	0.6250	−0.0456	−0.0435	0.0026	−0.0412	0.0461	−0.0444	−0.0409	−0.0012
5.0	0.7500	−0.0197	−0.0369	−0.0088	−0.0008	0.0055	−0.0221	−0.0276	−0.0159
5.0	0.8750	0.0002	−0.0279	−0.0044	0.0108	−0.0139	−0.0110	−0.0086	−0.0125
5.0	1.0000	0.0167	−0.0259	−0	0.0000	−0.0259	−0.0091	−0.0000	−0

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 445** (Soil Dynamics)

Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Write short notes on: (10)
   (i) Reverse Faults.
   (ii) Plate Tectonics.
   (iii) Microtremors.

   (b) Differentiate between magnitude and intensity of an earthquake. (5)

   (c) Explain vulnerability class and damage grade. (5)

2. (a) Describe different types of waves with neat sketches. (12)

   (b) Estimate the probability of seismic hazard for a bridge for a return period of (i)100 yr, (ii) 200 yr, (iii) 475 yr, and (iv) 2475 yr. (8)

3. (a) What are the collateral effects of an earthquake ? Explain one of them. (4)

   (b) Write down the factors on which local site effect depends. Explain one of them. (4)

   (c) For the data, shown in Table – 1, estimate Liquefaction Resistance Factor and Liquefaction Potential Index for a_{max} = 0.25g for M = 8.5, Ground Water Table is located at a depth of 2.5m from the EGL. (12)

Table 1

Soil Layer Thickness (m)	Soil Profile	d_{50}(mm)	SPT-N Value
0-6	Coarse Sand	1.0	9
6-12	Medium Sand	0.45	11
12-21	Fine Sand	0.15	13

4. (a). Write short note on: (9)
   (i) Attenuation Laws
   (ii) Earthquake Source Models
   (iii) Data Completeness.

   (b) There are four Seismoactive zones (Table 2) in and around a nuclear power plant site. Estimate SDE and SSE on the basis of cumulative intensity- frequency relation. (11)

Table 2

Zones	a	b	I_{max}	Attenuation Value
1	1.57	0.56	X	1.1
2	0.47	0.35	IX	1.5
3	0.79	0.46	XI	2.5
4	1.15	0.65	IX	1.6

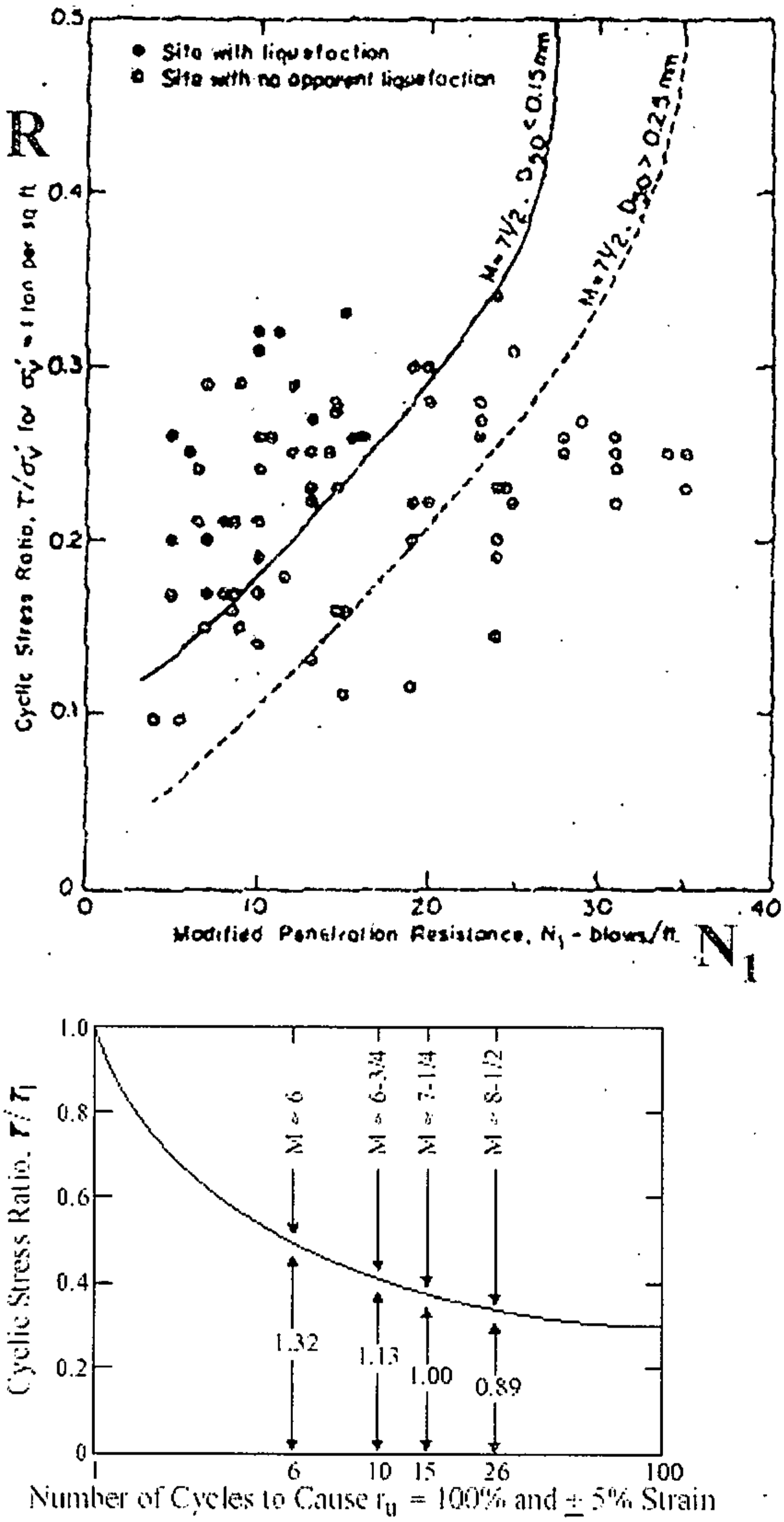

Site with liquefaction
Site with no apparent liquefaction
R
Cyclic Stress Ratio, τ/σ'v for σ'v = 1 ton per sq ft
M = 7½, D50 < 0.15 mm
M = 7½, D50 > 0.25 mm
Modified Penetration Resistance, N1 - blows/ft
N1
0
0.1
0.2
0.3
0.4
0.5
10
20
30
40
Cyclic Stress Ratio, τ/τ1
M = 6
M = 6-3/4
M = 7-1/4
M = 8-1/2
1.32
1.13
1.00
0.89
1.0
0.8
0.6
0.4
0.2
1
6
10
15
26
100
Number of Cycles to Cause ru = 100% and ± 5% Strain

Fig. 1

SECTION-B: CE 445

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

No.	Questions	Marks
5a	The mass m, stiffness k, and natural frequency ω_n of an undamped SDF system are unknown. These properties are to be determined by harmonic excitation tests. At an excitation frequency of 4 Hz, the response tends to increase without bound (i.e., a resonant condition). Next, a weight $\Delta m = 5$ lb is attached to the mass m and the resonant test is repeated. This time resonance occurs at $f = 3$ Hz. Determine the mass and the stiffness of the system.	(10)
5b.	State the learnings of the salient features of dynamic response from the following relations between ω/ω_n, and damping ratio D: $$R_d = \frac{u_0}{(u_{st})_0} = \frac{1}{\sqrt{[1-(\omega/\omega_n)^2]^2 + [2D(\omega/\omega_n)]^2}}$$	(10)
6.	In a damped free vibrating system, the amplitude of vibration in the 1st and 2nd cycles is 1.52mm and 1.21mm, respectively (recorded by Oscillogram). Calculate how many cycles will be required to bring down the amplitude to 20% of the initial one? For this system, what is the damping ratio? Explain oscillatory and non-oscillatory motions. Evaluate briefly $\delta = 2\pi D$, where δ= logarithmic decrement.	(10+10)
7.	For the system represented by the following equation: $$m\frac{d^2z}{dt^2} + c\frac{dz}{dt} + kz = Q_o \sin \omega t$$ State: • the various forces, internal and external, quantifying the respective vectors, acting in the system given by the above expression. • the complimentary and particular functions with the solutions for the system, as well as the total solution in the perspective of displacement vector. • the corresponding solution of motion for displacement at steady state conditions. Using the solution for steady-state conditions, derive that (i) resonance occurs at a frequency ratio slightly less than one and (ii) evaluate the corresponding magnification M_{max} is given by: $$M_{max} = \frac{1}{2D\sqrt{1-D^2}}$$	(20)
8a.	Define natural frequency of a vibrating system. State how does it vary with the damping ratio in forced vibration. Describe steady state conditions of a vibrating system. Explain why it is so named?	(10)
8b.	Describe briefly (if necessary, with neat sketches) the steps for the field determination of dynamic soil properties stated below: • Natural frequency using forced vibration • Damping ratio by free vibration	(10)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 447** (Soil-Water Interaction)

Full Marks: 180 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

NO.	QUESTIONS	MARKS
1.	(a) Discuss the consequences of ignoring water in soil in various geotechnical designs.	6
	(b) Discuss, with sketches, various modes of river bank failure with reference of soil characteristice.	8
	(c) For the design of a hydraulic fill, would you suggest to carry out sub-soil exploration of the insutu soil? Explain with justification.	6
2.	(a) Mention the considerations that should be made for selecting the borrow area for a hydraulic fill project.	7
	(b) Discuss the soil parameters of insitu sub-soil and filter-soil that are required for the design of the granular filter layer. Also mention relevant laboratory tests to determine the parameters.	7
	(c) Why the values of geotextile properties as determined from laboratory tests cannot be directly used in design? How are these modified?	6
3.	(a) Why dredge material type is a very important consideration for construction of a hydraulic fill?	6
	(b) How segregation affects a hydraulic fill project? If dredge material appears to be prone to segregation, what measures can be taken if there is no other alternative source of fill material?.	6
	(c) Give examples of application of filters in geotechnical design. What benefit is achieved by providing these filter layers.	8
4.	(a) Discuss compaction methods that may be adopted for an under-water hydraulic fill.	7
	(b) Explain the necessity of various components of revetment works for the protection of river banks.	7
	(c) Discuss relative merits and demerits of using granular and geotextile filters.	6

SECTION-B: CE 447

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

5. (a) Mention the principal reasons for non-Darcy behaviour in soils. With neat sketch define permeability parameters n and C. **(5)**

(b) What are the basic assumptions for determination of permeability of soils in field by pumping test? With neat diagrams briefly describe the variable head borehole permeability tests for the following two cases:

(i) Cased hole with soil flush with the bottom of hole

(ii) Cased hole with uncased or perforated extension to certain height. **(8)**

(c) Derive Kozeny-Carman equation for coefficient of permeability of soil. **(7)**

6. (a) Define potential function and stream function. Show that the potential function satisfies Laplace's equation in two dimensions while the stream function satisfies both the Laplace's equation and equation of continuity in two dimensions. **(6)**

(b) Draw neatly the conditions for the point of entrance and point of discharge of the line of seepage of an earth dam. **(5)**

(c) With neat sketch list the possible boundary conditions for drawing the flow net for an earth dam. **(5)**

(d) Calculate the height of capillary rise in metre and capillary pressure in PF for a clayey soil with $D_{10} = 5.5\ \mu m$. Assume surface tension of water and unit weight of water to be 70 dynes/cm and 9.807 kN/m^3, respectively. **(4)**

7. (a) Using a suitable method derive an expression for determining the rate of seepage for an earth dam with inclined discharge face and without any filter. The base of the dam rests on an impervious foundation. Also state the procedure of plotting line of seepage. **(8)**

(b) A dry cohesive deposit of clay of height 3 m exists at an infinite slope. The slope angle is 60°. The values of effective cohesion (c') and effective angle of internal friction (ϕ') of the soil are 25 kN/m^2 and 20°, respectively. Dry unit weight of the clay deposit is 16 kN/m^3. Compute factor of safety of the slope with respect to cohesion assuming friction has been fully mobilized. If the same slope is subjected to seepage parallel to the slope and occurring throughout the slope (i.e., water table is at surface), then what will be the factor of safety of the slope with respect to sliding? Assume saturated unit weight of the clay deposit to be 20 kN/m^3. **(6)**

(c) List the criteria for identifying soils susceptible to downslope migration. Also draw neatly the recommended filter systems for soils susceptible to downslope migration. **(6)**

8. (a) A homogeneous embankment of height 14 m was constructed on an impervious foundation with side slopes 3 : 1 (horizontal : vertical). The embankment retains water to a height of 12 m. The crest width of the embankment is 3 m. The coefficient of permeability of embankment soil is 3×10^{-5} m/sec. Calculate the rate of seepage through the embankment using Schaffernak and Van Iterson's method. **(5)**

(b) A test well, 0.5 m in diameter, has been drilled through an aquifer of 8 m thick up to the underlying impermeable stratum. The water table is at the ground surface. At the steady state, the discharge from the well is 5×10^{-3} m^3/sec at a drawdown of 3 m. Determine the coefficient of permeability of the aquifer if the observed radius of influence is 125 m. **(4)**

(c) List different types of revetment with at least three examples of each type. **(5)**

(d) With neat sketch briefly describe a direct method of determining soil suction. **(6)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 451** (Transportation Engineering II: Pavement Design and Railway Engineering.)

Full Marks: 240 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

No.	Questions	Marks
1(a)	Write short notes on the following: (i) Deficiency in super elevation. (ii) Working principles of compressed air and vacuum brakes. (iii) Types of wear on rails. (iv) Coning of wheels.	20
(b)	Determine the maximum permissible train load that can be pulled by a locomotive having four pairs of driving wheels having an axle load of 28.42 tones latch on a BG track with a rising gradient of 1 in 200 and maximum curvature of 3 degrees at a speed of 48.3 kmph. Take coefficient of friction as 0.2.	20

2(a)	Explain with neat sketches the classification of railway signals according to location.	20
(b)	What is a 'turnout'? Draw a complete labelled diagram for a left-hand turnout.	20

3(a)	Broadly classify pavement system. Differentiate between flexible and rigid pavements with respect to Load distribution mechanism, Thickness requirement, Aggregate type and Modulus of elasticity. Define 'Perpetual pavement'. Schematically show the concept and layer system of perpetual pavement.	20
(b)	Explain with schematic diagram, the flexible pavement failure mechanism under submerged condition in Bangladesh. Define 'Polymer Modified Binder (PMB)' and briefly state the significance of its uses in Bangladesh.	20
4(a)	Why structural design of pavement is a complex one? List different methods of pavement design. Why ditto copy of AASHTO is not appropriate for roadway design of Bangladesh? Schematically show the layout arrangement of different type of reinforcements that are used in concrete pavement.	20
(b)	Explain how the concept of standard equivalent single axle load (ESAL) has evolved? A truck in an intercity road applies 26 kip and 11 kip loads by the rear and front axles. Using the 4^{th} power approximation, determine the total equivalent damage caused by one pass movement of this truck in terms of ESALs. Differentiate between 'Construction Joint' and 'Contraction Joint' and relatively which one of them performs better and why?	20

SECTION – B: CE 451

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

No.	Questions	Marks
5(a)	Explain Engineered earth road and improvised low cost road concept along with typical life cycle cost vs traffic diagram. Describe name and purposes of 8 highway construction equipment.	20
(b)	Describe detail features of Double Bituminous Surface Treatment (DBST) and Penetration Macadam construction including materials requirements.	20

6(a)	Write down possible causes, maintenance/rehabilitation/reconstruction options for the following defects of different Highway pavements: Alligator cracks, Ruts, Potholes and Buckling.	20
(b)	Analyze the material requirement, layered compaction, quality control and verification issues of Highway embankment construction.	20

7(a)	Describe the functions of various materials in highway pavement construction. Explain the properties and uses of following stone aggregates: Limestones, Sandstones, Granite and Quartzite.	20
(b)	Explain the importance of particle shape and surface texture of coarse aggregates used in flexible and rigid pavement constructions. Combine the following aggregate samples to meet the given specifications.	20

Passing Sieve	Retained Sieve	% by weight			Specific Limit
		Sample 1	Sample 2	Sample 3	
¾"	½"	5	--	--	0-5
½"	3/8"	35	--	--	8-40
3/8"	#4	40	--	--	10-50
#4	#10	15	8	--	6-25
#10	#40	5	30	--	5-20
#40	#80	--	35	5	10-30
#80	#200	--	26	35	5-8
#200		--	1	60	2-6

8(a)	State the basic steps of Marshall Method of mix design. Show the qualitative shape of Marshall property curves. Explain with a figure the narrow ranges of acceptable asphalt contents to determine optimum asphalt content. Prove that $n = e / (1+e)$, where e = void ratio and n = porosity of soil.	20
(b)	Differentiate between Bitumen and Tar. Describe the sources of asphaltic materials. With a simplified flowchart explain the recovery and refining of petroleum asphalts. Describe the uses of Slow-curing asphalts and Asphalt emulsion.	20

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 455** (Transportation Engineering IV: Pavement Management, Drainage and Airport)
Full Marks: 120 Time: 2 Hours
USE SEPARATE SCRIPTS FOR EACH SECTION

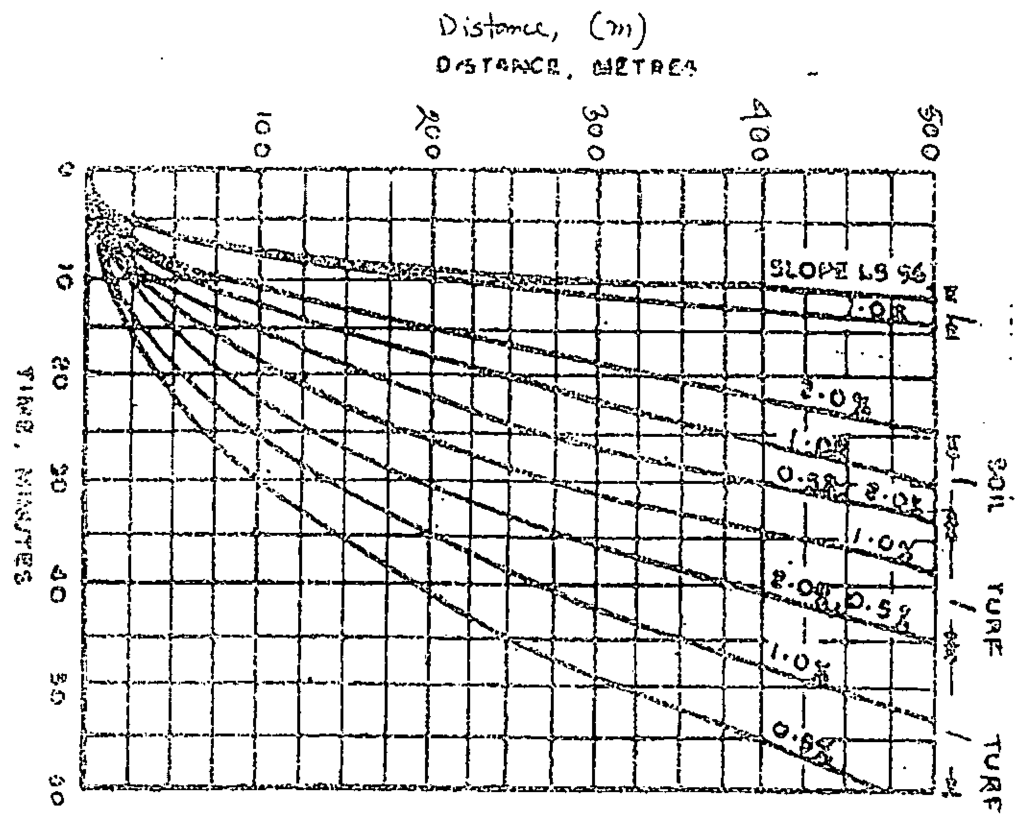
SECTION – A

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

No.	Questions	Marks
1(a)	Explain Pavement Management System and describe the Effects of Maintenance and Rehabilitation on Pavement Conditions. What are the three major components of Pavement Management? What does HDM-4 do?	11
(b)	Write short notes on: Present Serviceability Index (PSI), Present Serviceability Rating (PSR) and International Roughness Index (IRI).	9

2(a)	State the functions of an Airport drainage system. Explain the Layout of Airport Surface drainage. What are the shapes of commonly used culvert?	10
(b)	When and where Subsurface drainage are essential? Explain with suitable figure the subsurface drainage in cut slopes, Subgrade and Base course.	10

3(a)	The distance between the furthest point in the truf covered drainage (with an average slope of 1.5% towards the drain) and the point of entry to side drain is 200 meter. The weighted average value of the runoff co-efficient is 0.275. The length of the longitudinal open drain in a sandy clay soil from the inlet point to the cross drainage is 550 meter. The velocity of flow in the side drain may be assumed 0.55 m/s so that silting and erosion are prevented. Estimate the design quantity of flow on the side drain for a 25 years period of frequency of occurrence of the storm.	10
(b)	"There are three factors necessary for getting a good road: Drainage, drainage and more drainage". Explain the statement. Explain the mechanism of Road Surface water drainage with a figure.	10
4(a)	The maximum quantity of water expected in on open longitudinal drains on clayey soil is 1.0 m^3/sec. Design the X-section and longitudinal slope of Trapezoidal drain assuming the bottom width to be 1.0 meter and cross slope to be 1V:1.5H. Allowable velocity of flow in the drain is 1.15 m/sec and Manning's roughness co-efficient is 0.02. Assume a free board = 0.135 m	10
(b)	Explain the effects of drainage requirements on road geometry. Describe the mechanism of damage to highways due to faulty drainage.	10



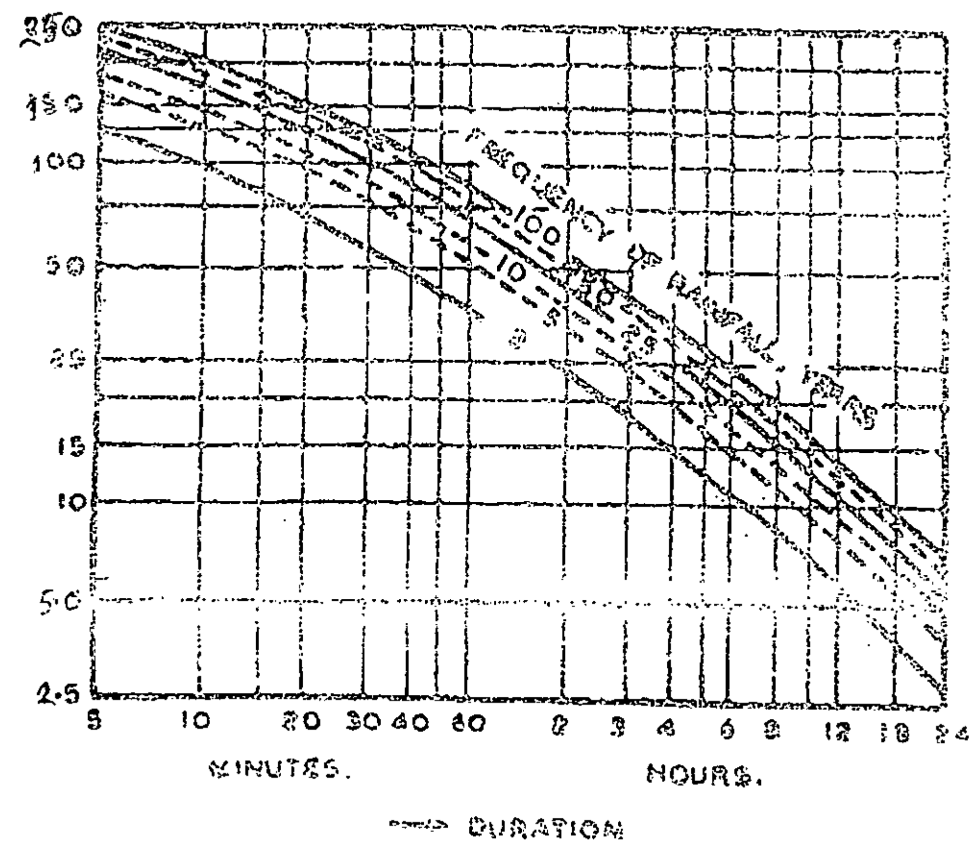


Fig. 1 Time of Flow to Inlet

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 457** (Urban Transportation Planning and Management)

Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. **Question No. 1 is COMPULSORY.**
Answer any TWO questions from Q. No. 2, 3 and 4.

NO.	QUESTIONS	MARKS
1.	(a) Write down the negative impacts of truck terminals in an urban setting from safety point of view. What are the positive effects of truck stops in creating safe road environment?	(10)
	(b) Discuss the impacts of urbanization on accidents and safety in the context of developing countries.	(08)
2.	(a) Discuss two urban transportation problems relevant to developing countries. What are the negative consequences of car dependency?	(07)

NO.	QUESTIONS	MARKS
	(b) What are the main reasons behind the lack of concern and awareness of transportation planners and traffic engineers about urban goods movement (UGM)?	(07)
	(c) "Transit is predominantly an urban transportation mode"- discuss why?	(07)
3.	(a) Write down the strategies that may be useful to solve truck loading/ unloading issues in central business district (CBD) locations.	(07)
	(b) Discuss two strategies that may be used to limit automobile circulation in urban areas.	(07)
	(c) Briefly describe the components of an urban transit system.	(07)
4.	(a) Write down the different characteristics of Urban Freight/Goods movements compared to long haul freight movement.	(07)
	(b) Draw the vicious circle of congestion. Write down the seven major causes of congestion in urban areas.	(07)
	(c) Briefly discuss the most difficult challenges faced by urban transit.	(07)

SECTION-B: CE 457

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

<table>
<tr><th>No.</th><th>Questions</th><th>Marks</th></tr>
<tr><td>5(a)</td><td>State the context of urban transportation planning. Differentiate Robert Moses' and Jane Jacobs' legacies related to approaches in urban planning.</td><td>(4+6)</td></tr>
<tr><td>(b)</td><td>Discuss the components of multimodal transportation program. The following data were used while determining gravity model adjustment factor for total attraction of zone 1: A_1 (desired)=300, A_1 (first try) =300, A_1 (after 1st iteration) =379, and A_1 (after 2nd iteration) =379. What was the A_1 (third try) value?</td><td>(5+5)</td></tr>
<tr><td>6(a)</td><td>Classify the urban transportation modes based on the type of their operation and use. Briefly discuss the various right-of-way (ROW) categories of transit modes.</td><td>(6+6)</td></tr>
<tr><td>(b)</td><td>The trip rate (y) and the corresponding household sizes (x) from a sample are shown in table below. Compute the trip rate if the average household size is 3.25.
<table>
<tr><td></td><td colspan="4">Household size (x)</td></tr>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td rowspan="3">Trips per day (y)</td><td>1</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>3</td><td>4</td><td>5</td><td>8</td></tr>
<tr><td>3</td><td>5</td><td>7</td><td>8</td></tr>
</table>
</td><td>(8)</td></tr>
<tr><td>7 (a)</td><td>"Urban trip generation models can be derived at three levels of aggregation"-elaborate. State the policy tools for system control.</td><td>(5+5)</td></tr>
<tr><td>(b)</td><td>Travel time of heavy vehicles on a 30 km stretch of highway lane connecting two activity centers has been observed to follow the equation representing the service function:
$$t = 15 + 0.02v$$
The demand function for travel connecting the two centers:
$$v = 4000 - 120t$$
Where, t in minutes and v in vehicles per hour.
Sketch the two equations and determine equilibrium time, volume of heavy vehicles, and speed of travel.</td><td>(10)</td></tr>
<tr><td>8(a)</td><td>Difference between 'all-or-nothing' and 'capacity restraint' traffic assignment techniques. Justify the most suitable trip assignment technique for Dhaka city road network.</td><td>(4+6)</td></tr>
<tr><td>(b)</td><td>A calibration study resulted in the following utility equation:
$$U_k = a_k - 0.025X_1 - 0.032X_2 - 0.015X_3 - 0.002X_4$$
Where, X_1 = access plus egress time, in min; X_2 = waiting time, in min; X_3 = line-haul time, in min; X_4=out-of-pocket cost, in Tk.
The trip-distribution forecast for a particular interchange was a target-year volume of Q_{IJ} = 5000 person-trips per day. During the target year trip-makers on this particular interchange will have a choice between the private automobile (A) and a local bus system (B). The target-year service attributes of the two competing modes have been estimated to be:
<table>
<tr><th>Attribute</th><th>X_1</th><th>X_2</th><th>X_3</th><th>X_4</th></tr>
<tr><td>Automobile</td><td>5</td><td>0</td><td>20</td><td>100</td></tr>
<tr><td>Local bus</td><td>10</td><td>15</td><td>40</td><td>50</td></tr>
</table>
Assuming that the calibrated mode-specific constants are 0.00 for the automobile mode (i.e., base mode) and -0.10 for the bus mode, apply the logit model to estimate the target-year market share of the two modes and the resulting fare-box revenue of the bus system.</td><td>(10)</td></tr>
</table>

SECTION – B: CE 455

There are FIVE questions in this part. Answer any FOUR.

(15)

5. (a) Describe the benefits of air transportation system.
   (b) What are the inherent constraints of air transportation in Bangladesh?
   (c) Enumerate the role of civil engineer in air transportation.
   (d) Draw a typical layout of an airport showing all the essential components.

(15)

6. (a) What is I.C.A.O. stands for? Mention main functions of I.C.A.O.
   (b) List and schematically show the basic forms of runway patterns/configuration.
   (c) What essential factors should be considered for proper way of selecting airport layout?
   (d) Why holding apron/run-up pad/warm-up pad is provided in runway orientation?

(15)

7. (a) Write down the factors which influence the size of an airport.
   (b) As per ICAO, define 'Obstacle' and draw an airport showing different obstacle limitation surfaces (OLS).
   (c) In airport design what is meant by "Wind Rose". Briefly explain the effect of cross-wind component in runway orientation.
   (d) What are the purposes of providing "High Speed Exit Taxiway"?

(15)

8. (a) What are the various marking and lighting systems provided at airports to meet the visual requirements of pilots?
   (b) As per ICAO write down the color convention of runway and taxiway surface marking and lighting systems.
   (c) Draw a runway and taxiway with the essential markings.
   (d) Find out the design length of a runway required if the length under standard atmospheric conditions is 1000m; the actual elevation of the site is 500m above M.S.L. and the aerodrome reference temperature is 19°C. Maximum effective gradient may be taken as 0.75%.

(15)

9. (a) What is ILS and why is it employed? What is it comprised of?
   (b) Write down the categories of ILS and advantage & disadvantage of ILS.
   (c) Schematically show how the signals transmitted by LOC and GS to guide the Pilot.
   (d) Why airport drainage is so important for airport operation? What type of measure is usually taken to minimize the hydroplaning potential of runway pavement surface?

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

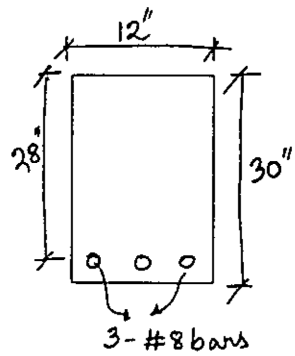
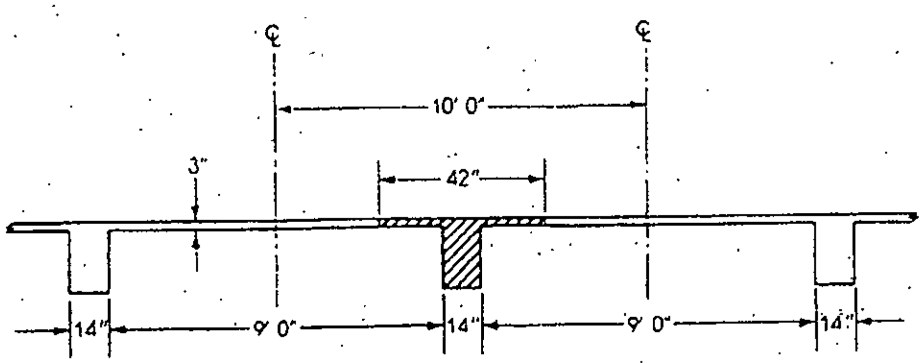
Sub: **CE 465** (Reinforced Concrete Design)

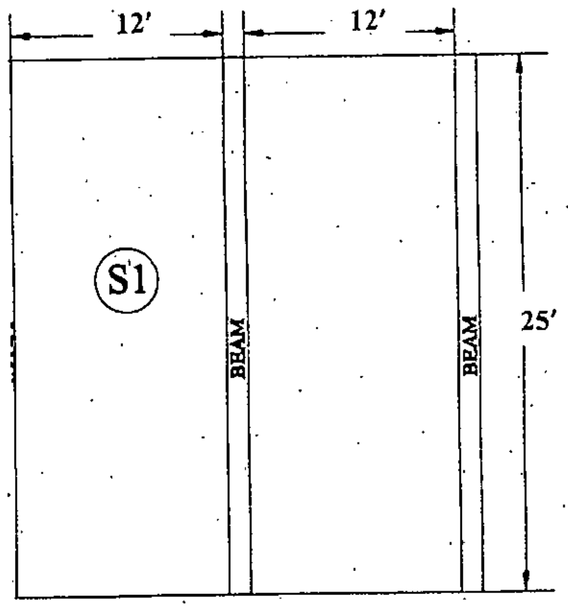
Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

NO.	QUESTIONS	MARKS
1.	A rectangular beam has the dimensions as shown in Figure 1 and reinforced with 3 - #8 bars. Determine the stresses caused by a bending moment, M = 125 K-ft. Given, $f'c = 4000$ psi, $fs = 24$ ksi, $n = 8$ fr (modulus of rupture) = 475 psi.  Figure 1	(20)
2.	The floor system shown in Figure 2 consists of 3-in. slabs supported by 14-ft-span beams spaced 10 ft on center. The beams have a web width, bw, of 14 in. and an effective depth, d, of 18.5 in. Calculate the necessary reinforcement for a typical interior beam if the factored applied moment is 3095 Kip-in.  Figure- 2	(20)

3.(a)	Write down the brief description of different types of RC floor system.	(10)
3.(b)	What are the advantages of Reinforced Concrete (RC)?	(10)
4.	A reinforced concrete slab consists of more than two spans and has unrestrained discontinuous end. Design the one way slab panel 'S_1' as shown in Figure 3. The service live load is 100 psf in addition to its self-weight. Follow the provisions of ACI code. Use Figure 4 to determine factored moment. Draw the reinforcement details also. Use ACI moment coefficients as given in Table 1, 2 and 3 for calculation. Given, $f'c = 4000$ psi, fs = 24 ksi, n = 9.  Figure-3	(20)

Summary of ACI moment coefficients: (*a*) beams with more than two spans; (*b*) beams with two spans only; (*c*) slabs with spans not exceeding 10 ft; (*d*) beams in which the sum of column stiffnesses exceeds 8 times the sum of beam stiffnesses at each end of the span.

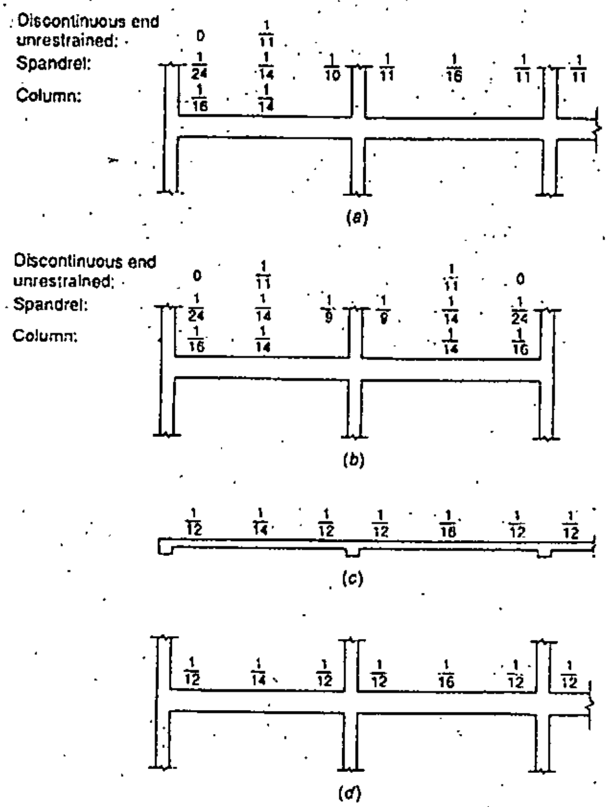


Figure- 4

Table 1: Co-efficients for Negative Moments in Slabs

$M_{a,(negative)} = C_{a,(negative)} w L_a^2$; $M_{b,(negative)} = C_{b,(negative)} w L_b^2$; where, w = total uniform dead plus live load, L_a = shorter clear span & L_b = longer clear span of a slab panel

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a\,(negative)}$	—	0.045	—	0.05	0.075	0.071	—	0.033	0.061
	$C_{b\,(negative)}$	—	0.045	0.076	0.05	—	—	0.071	0.061	0.033
0.95	$C_{a\,(negative)}$	—	0.05	—	0.055	0.079	0.075	—	0.038	0.065
	$C_{b\,(negative)}$	—	0.041	0.072	0.045	—	—	0.067	0.056	0.029
0.90	$C_{a\,(negative)}$	—	0.055	—	0.06	0.08	0.079	—	0.043	0.068
	$C_{b\,(negative)}$	—	0.037	0.07	0.04	—	—	0.062	0.053	0.025
0.85	$C_{a\,(negative)}$	—	0.06	—	0.066	0.082	0.083	—	0.049	0.072
	$C_{b\,(negative)}$	—	0.031	0.065	0.034	—	—	0.057	0.046	0.021
0.80	$C_{a\,(negative)}$	—	0.065	—	0.071	0.083	0.086	—	0.055	0.075
	$C_{b\,(negative)}$	—	0.027	0.061	0.029	—	—	0.051	0.041	0.017
0.75	$C_{a\,(negative)}$	—	0.069	—	0.076	0.085	0.088	—	0.061	0.078
	$C_{b\,(negative)}$	—	0.022	0.056	0.024	—	—	0.044	0.036	0.014
0.70	$C_{a\,(negative)}$	—	0.074	—	0.081	0.086	0.091	—	0.068	0.081
	$C_{b\,(negative)}$	—	0.017	0.05	0.019			0.038	0.029	0.011
0.65	$C_{a\,(negative)}$	—	0.077	—	0.085	0.087	0.093	—	0.074	0.083
	$C_{b\,(negative)}$	—	0.014	0.043	0.015	—	—	0.031	0.024	0.008
0.60	$C_{a\,(negative)}$	—	0.081	—	0.089	0.088	0.095	—	0.08	0.085
	$C_{b\,(negative)}$	—	0.01	0.035	0.011	—	—	0.024	0.018	0.006
0.55	$C_{a\,(negative)}$	—	0.084	—	0.092	0.089	0.096	—	0.085	0.086
	$C_{b\,(negative)}$	—	0.007	0.028	0.008	—	—	0.019	0.014	0.005
0.50	$C_{a\,(negative)}$	—	0.086	—	0.094	0.09	0.097	—	0.089	0.088
	$C_{b\,(negative)}$	—	0.006	0.022	0.006	—	—	0.014	0.01	0.003

*A crosshatched edge indicates that the slab continues across or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.

Table 2: Co-efficients for Dead Load Positive Moments in Slabs

$M_{a,pos,dl} = C_{a,pos,dl} w_{dl} L_a^2$; $M_{b,pos,dl} = C_{b,pos,dl} w_{dl} L_b^2$; where w_{dl} = total uniform dead load

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a(positive)}$	0.036	0.018	0.018	0.027	0.027	0.033	0.027	0.02	0.023
	$C_{b(positive)}$	0.036	0.018	0.027	0.027	0.018	0.027	0.033	0.023	0.02
0.95	$C_{a(positive)}$	0.040	0.02	0.021	0.03	0.028	0.036	0.031	0.022	0.024
	$C_{b(positive)}$	0.033	0.016	0.025	0.024	0.015	0.024	0.031	0.021	0.017
0.90	$C_{a(positive)}$	0.045	0.022	0.025	0.033	0.029	0.039	0.035	0.025	0.026
	$C_{b(positive)}$	0.029	0.014	0.024	0.022	0.013	0.021	0.028	0.019	0.015
0.85	$C_{a(positive)}$	0.050	0.024	0.029	0.036	0.031	0.042	0.04	0.029	0.028
	$C_{b(positive)}$	0.026	0.012	0.022	0.019	0.011	0.017	0.025	0.017	0.013
0.80	$C_{a(positive)}$	0.056	0.026	0.034	0.039	0.032	0.045	0.045	0.032	0.029
	$C_{b(positive)}$	0.023	0.011	0.02	0.016	0.009	0.015	0.022	0.015	0.01
0.75	$C_{a(positive)}$	0.061	0.028	0.04	0.043	0.033	0.048	0.051	0.036	0.031
	$C_{b(positive)}$	0.019	0.009	0.018	0.013	0.007	0.012	0.02	0.013	0.007
0.70	$C_{a(positive)}$	0.068	0.03	0.046	0.046	0.035	0.051	0.058	0.04	0.033
	$C_{b(positive)}$	0.016	0.007	0.016	0.011	0.005	0.009	0.017	0.011	0.006
0.65	$C_{a(positive)}$	0.074	0.032	0.054	0.05	0.036	0.054	0.065	0.044	0.034
	$C_{b(positive)}$	0.013	0.006	0.014	0.009	0.004	0.007	0.014	0.009	0.005
0.60	$C_{a(positive)}$	0.081	0.034	0.062	0.053	0.037	0.056	0.073	0.048	0.036
	$C_{b(positive)}$	0.010	0.004	0.011	0.007	0.003	0.006	0.012	0.007	0.004
0.55	$C_{a(positive)}$	0.088	0.035	0.071	0.056	0.038	0.058	0.081	0.052	0.037
	$C_{b(positive)}$	0.008	0.003	0.009	0.005	0.002	0.004	0.009	0.005	0.003
0.50	$C_{a(positive)}$	0.095	0.037	0.08	0.059	0.039	0.061	0.089	0.056	0.038
	$C_{b(positive)}$	0.006	0.002	0.007	0.004	0.001	0.003	0.007	0.004	0.002

*A crosshatched edge indicates that the slab continues across or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.

Table 3: Co-efficients for Live Load Positive Moments in Slabs

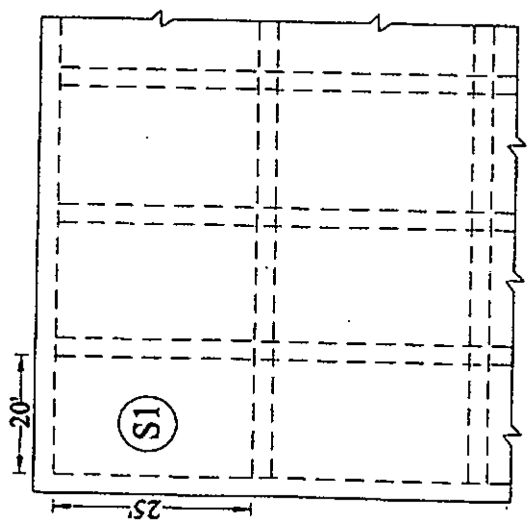
$M_{a,pos,ll} = C_{a,pos,ll} w_{ll} L_a^2$; $M_{b,pos,ll} = C_{b,pos,ll} w_{ll} L_b^2$; where w_{ll} = total uniform live load

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a(positive)}$	0.036	0.027	0.027	0.032	0.032	0.035	0.032	0.028	0.03
	$C_{b(positive)}$	0.036	0.027	0.032	0.032	0.027	0.032	0.035	0.03	0.028
0.95	$C_{a(positive)}$	0.040	0.03	0.031	0.035	0.034	0.038	0.036	0.031	0.032
	$C_{b(positive)}$	0.033	0.025	0.029	0.029	0.024	0.029	0.032	0.027	0.025
0.90	$C_{a(positive)}$	0.045	0.034	0.035	0.039	0.037	0.042	0.04	0.035	0.036
	$C_{b(positive)}$	0.029	0.022	0.027	0.026	0.021	0.025	0.029	0.024	0.022
0.85	$C_{a(positive)}$	0.050	0.037	0.04	0.043	0.041	0.046	0.045	0.04	0.039
	$C_{b(positive)}$	0.026	0.019	0.024	0.023	0.019	0.022	0.026	0.022	0.02
0.80	$C_{a(positive)}$	0.056	0.041	0.045	0.048	0.044	0.051	0.051	0.044	0.042
	$C_{b(positive)}$	0.023	0.017	0.022	0.02	0.016	0.019	0.023	0.019	0.017
0.75	$C_{a(positive)}$	0.061	0.045	0.051	0.052	0.047	0.055	0.056	0.049	0.046
	$C_{b(positive)}$	0.019	0.014	0.019	0.016	0.013	0.016	0.02	0.016	0.013
0.70	$C_{a(positive)}$	0.068	0.049	0.057	0.057	0.051	0.06	0.063	0.054	0.05
	$C_{b(positive)}$	0.016	0.012	0.016	0.014	0.011	0.013	0.017	0.014	0.011
0.65	$C_{a(positive)}$	0.074	0.053	0.064	0.062	0.055	0.064	0.07	0.059	0.054
	$C_{b(positive)}$	0.013	0.01	0.014	0.011	0.009	0.01	0.014	0.011	0.009
0.60	$C_{a(positive)}$	0.081	0.058	0.071	0.067	0.059	0.068	0.077	0.065	0.059
	$C_{b(positive)}$	0.010	0.007	0.011	0.009	0.007	0.008	0.011	0.009	0.007
0.55	$C_{a(positive)}$	0.088	0.062	0.08	0.072	0.063	0.073	0.085	0.07	0.063
	$C_{b(positive)}$	0.008	0.006	0.009	0.007	0.005	0.006	0.009	0.007	0.006
0.50	$C_{a(positive)}$	0.095	0.066	0.088	0.077	0.067	0.078	0.092	0.076	0.067
	$C_{b(positive)}$	0.006	0.004	0.007	0.005	0.004	0.005	0.007	0.005	0.004

*A crosshatched edge indicates that the slab continues across or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.

SECTION-B: CE 465

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

No.	Questions	Marks
1.	A floor slab 3" thick is supported by RC beams 50" center to center which together with slab, act as T beams. The beams are simply supported and their span is 22 ft. The cross-section of each beam below the slab is 11 x 23 in. The reinforcement consists of 3 - # 11 bars in one row the center of which is 3" above the bottom of the beam. Maximum allowable stress in the materials are fc = 1125 psi and fs = 24 ksi, with n = 10. What is the allowable uniformly distributed load which can be superimposed?	20
2 (a)	What do you mean by serviceability and safety of a structure? Draw the stress-strain diagram of steel and concrete, and explain briefly	10
2(b)	Why are temperature and shrinkage reinforcement required in one-way slab? What are the recommended ratios for such steel?	10
3.	Design the two-way slab panal 'S1' as shown in Figure 1. The slab carries a uniform live load of 40 psf and a super-imposed dead load of 30 psf in addition to its self-weight. Draw the reinforcement details also. Use ACI moment coefficients as given in Table 1, 2 and 3 for calculation. Given, f'_c = 4000 psi, fs = 24 ksi, n = 8.  Figure: 1	10 20
4.	(a) Draw diagrams to show the various types of web reinforcement. (b) Give reasons for the minimum cover requirements in the *ACI/BNBC* code. What are the recommended values of 'cover' as per ACI/BNBC code? (c) A simply supported rectangular beam 16 inch wide having an effective depth of 21 inch carries a total factored load of 10 kips/ft as shown in Figure 2. Design the web reinforcement of the beam. Given, f'_c = 3.5 ksi and f_y = 60 ksi.	 5 5

20

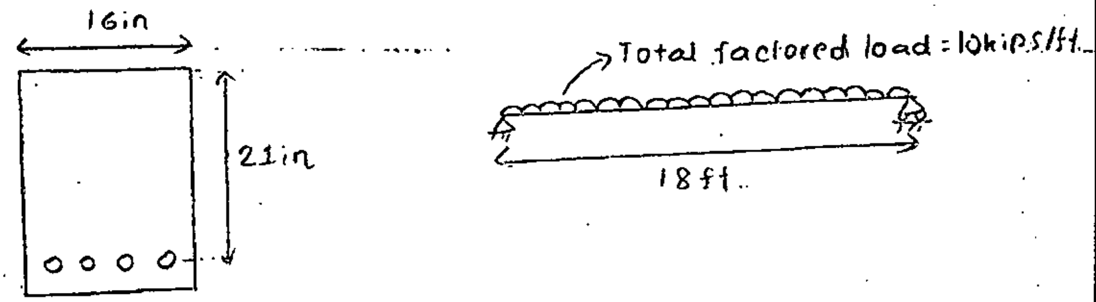


Figure: 2

Table 1: Co-efficients for Negative Moments in Slabs

$M_{a,negative} = C_{a,negative} w L_a^2$; $M_{b,negative} = C_{b,negative} w L_b^2$; where, w = total uniform dead plus live load, L_a = shorter clear span & L_b = longer clear span of a slab panel

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a\,(negative)}$	—	0.045	—	0.05	0.075	0.071	—	0.033	0.061
	$C_{b\,(negative)}$	—	0.045	0.076	0.05	—	—	0.071	0.061	0.033
0.95	$C_{a\,(negative)}$	—	0.05	—	0.055	0.079	0.075	—	0.038	0.065
	$C_{b\,(negative)}$	—	0.041	0.072	0.045	—	—	0.067	0.056	0.029
0.90	$C_{a\,(negative)}$	—	0.055	—	0.06	0.08	0.079	—	0.043	0.068
	$C_{b\,(negative)}$	—	0.037	0.07	0.04	—	—	0.062	0.053	0.025
0.85	$C_{a\,(negative)}$	—	0.06	—	0.066	0.082	0.083	—	0.049	0.072
	$C_{b\,(negative)}$	—	0.031	0.065	0.034	—	—	0.057	0.046	0.021
0.80	$C_{a\,(negative)}$	—	0.065	—	0.071	0.083	0.086	—	0.055	0.075
	$C_{b\,(negative)}$	—	0.027	0.061	0.029	—	—	0.051	0.041	0.017
0.75	$C_{a\,(negative)}$	—	0.069	—	0.076	0.085	0.088	—	0.061	0.078
	$C_{b\,(negative)}$	—	0.022	0.056	0.024	—	—	0.044	0.036	0.014
0.70	$C_{a\,(negative)}$	—	0.074	—	0.081	0.086	0.091	—	0.068	0.081
	$C_{b\,(negative)}$	—	0.017	0.05	0.019			0.038	0.029	0.011
0.65	$C_{a\,(negative)}$	—	0.077	—	0.085	0.087	0.093	—	0.074	0.083
	$C_{b\,(negative)}$	—	0.014	0.043	0.015	—	—	0.031	0.024	0.008
0.60	$C_{a\,(negative)}$	—	0.081	—	0.089	0.088	0.095	—	0.08	0.085
	$C_{b\,(negative)}$	—	0.01	0.035	0.011	—	—	0.024	0.018	0.006
0.55	$C_{a\,(negative)}$	—	0.084	—	0.092	0.089	0.096	—	0.085	0.086
	$C_{b\,(negative)}$	—	0.007	0.028	0.008	—	—	0.019	0.014	0.005
0.50	$C_{a\,(negative)}$	—	0.086	—	0.094	0.09	0.097	—	0.089	0.088
	$C_{b\,(negative)}$	—	0.006	0.022	0.006	—	—	0.014	0.01	0.003

*A crosshatched edge indicates that the slab continues across or is fixed at the support, an unmarked edge indicates a support at which torsional resistance is negligible.

Table 2: Co-efficients for Dead Load Positive Moments in Slabs

$M_{a,pos,DL} = C_{a,pos} w_{DL} L_a^2$; $M_{b,pos,DL} = C_{b,pos} w_{DL} L_b^2$; where w_{DL} = total uniform dead load

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a(positive)}$	0.036	0.018	0.018	0.027	0.027	0.033	0.027	0.02	0.023
	$C_{b(positive)}$	0.036	0.018	0.027	0.027	0.018	0.027	0.033	0.023	0.02
0.95	$C_{a(positive)}$	0.040	0.02	0.021	0.03	0.028	0.036	0.031	0.022	0.024
	$C_{b(positive)}$	0.033	0.016	0.025	0.024	0.015	0.024	0.031	0.021	0.017
0.90	$C_{a(positive)}$	0.045	0.022	0.025	0.033	0.029	0.039	0.035	0.025	0.026
	$C_{b(positive)}$	0.029	0.014	0.024	0.022	0.013	0.021	0.028	0.019	0.015
0.85	$C_{a(positive)}$	0.050	0.024	0.029	0.036	0.031	0.042	0.04	0.029	0.028
	$C_{b(positive)}$	0.026	0.012	0.022	0.019	0.011	0.017	0.025	0.017	0.013
0.80	$C_{a(positive)}$	0.056	0.026	0.034	0.039	0.032	0.045	0.045	0.032	0.029
	$C_{b(positive)}$	0.023	0.011	0.02	0.016	0.009	0.015	0.022	0.015	0.01
0.75	$C_{a(positive)}$	0.061	0.028	0.04	0.043	0.033	0.048	0.051	0.036	0.031
	$C_{b(positive)}$	0.019	0.009	0.018	0.013	0.007	0.012	0.02	0.013	0.007
0.70	$C_{a(positive)}$	0.068	0.03	0.046	0.046	0.035	0.051	0.058	0.04	0.033
	$C_{b(positive)}$	0.016	0.007	0.016	0.011	0.005	0.009	0.017	0.011	0.006
0.65	$C_{a(positive)}$	0.074	0.032	0.054	0.05	0.036	0.054	0.065	0.044	0.034
	$C_{b(positive)}$	0.013	0.006	0.014	0.009	0.004	0.007	0.014	0.009	0.005
0.60	$C_{a(positive)}$	0.081	0.034	0.062	0.053	0.037	0.056	0.073	0.048	0.036
	$C_{b(positive)}$	0.010	0.004	0.011	0.007	0.003	0.006	0.012	0.007	0.004
0.55	$C_{a(positive)}$	0.088	0.035	0.071	0.056	0.038	0.058	0.081	0.052	0.037
	$C_{b(positive)}$	0.008	0.003	0.009	0.005	0.002	0.004	0.009	0.005	0.003
0.50	$C_{a(positive)}$	0.095	0.037	0.08	0.059	0.039	0.061	0.089	0.056	0.038
	$C_{b(positive)}$	0.006	0.002	0.007	0.004	0.001	0.003	0.007	0.004	0.002

*A crosshatched edge indicates that the slab continues across or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.

Table 3: Co-efficients for Live Load Positive Moments in Slabs

$M_{a,pos,LL} = C_{a,pos} w_{LL} L_a^2$; $M_{b,pos,LL} = C_{b,pos} w_{LL} L_b^2$; where w_{LL} = total uniform live load

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a(positive)}$	0.036	0.027	0.027	0.032	0.032	0.035	0.032	0.028	0.03
	$C_{b(positive)}$	0.036	0.027	0.032	0.032	0.027	0.032	0.035	0.03	0.028
0.95	$C_{a(positive)}$	0.040	0.03	0.031	0.035	0.034	0.038	0.036	0.031	0.032
	$C_{b(positive)}$	0.033	0.025	0.029	0.029	0.024	0.029	0.032	0.027	0.025
0.90	$C_{a(positive)}$	0.045	0.034	0.035	0.039	0.037	0.042	0.04	0.035	0.036
	$C_{b(positive)}$	0.029	0.022	0.027	0.026	0.021	0.025	0.029	0.024	0.022
0.85	$C_{a(positive)}$	0.050	0.037	0.04	0.043	0.041	0.046	0.045	0.04	0.039
	$C_{b(positive)}$	0.026	0.019	0.024	0.023	0.019	0.022	0.026	0.022	0.02
0.80	$C_{a(positive)}$	0.056	0.041	0.045	0.048	0.044	0.051	0.051	0.044	0.042
	$C_{b(positive)}$	0.023	0.017	0.022	0.02	0.016	0.019	0.023	0.019	0.017
0.75	$C_{a(positive)}$	0.061	0.045	0.051	0.052	0.047	0.055	0.056	0.049	0.046
	$C_{b(positive)}$	0.019	0.014	0.019	0.016	0.013	0.016	0.02	0.016	0.013
0.70	$C_{a(positive)}$	0.068	0.049	0.057	0.057	0.051	0.06	0.063	0.054	0.05
	$C_{b(positive)}$	0.016	0.012	0.016	0.014	0.011	0.013	0.017	0.014	0.011
0.65	$C_{a(positive)}$	0.074	0.053	0.064	0.062	0.055	0.064	0.07	0.059	0.054
	$C_{b(positive)}$	0.013	0.01	0.014	0.011	0.009	0.01	0.014	0.011	0.009
0.60	$C_{a(positive)}$	0.081	0.058	0.071	0.067	0.059	0.068	0.077	0.065	0.059
	$C_{b(positive)}$	0.010	0.007	0.011	0.009	0.007	0.008	0.011	0.009	0.007
0.55	$C_{a(positive)}$	0.088	0.062	0.08	0.072	0.063	0.073	0.085	0.07	0.063
	$C_{b(positive)}$	0.008	0.006	0.009	0.007	0.005	0.006	0.009	0.007	0.006
0.50	$C_{a(positive)}$	0.095	0.066	0.088	0.077	0.067	0.078	0.092	0.076	0.067
	$C_{b(positive)}$	0.006	0.004	0.007	0.005	0.004	0.005	0.007	0.005	0.004

*A crosshatched edge indicates that the slab continues across or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

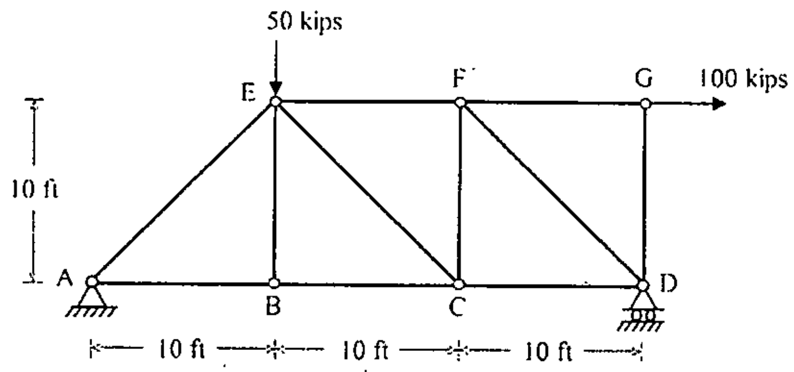
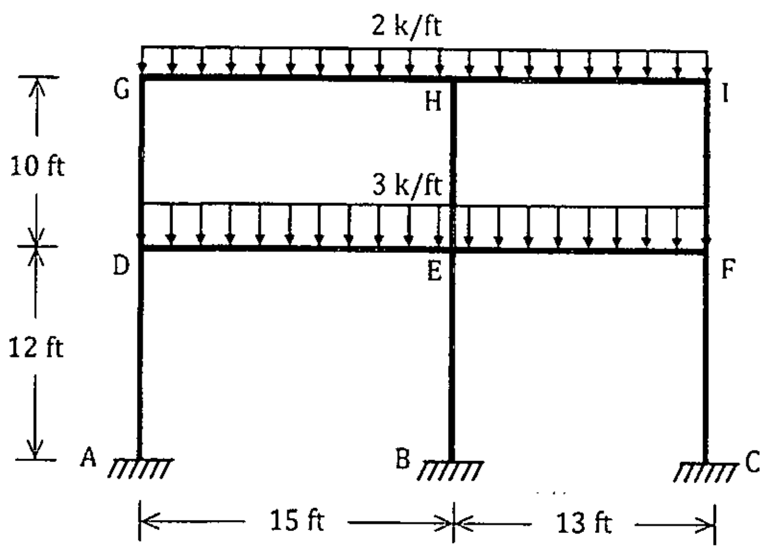
Sub: **CE 467** (Structure IV: Elements of Building Structure)

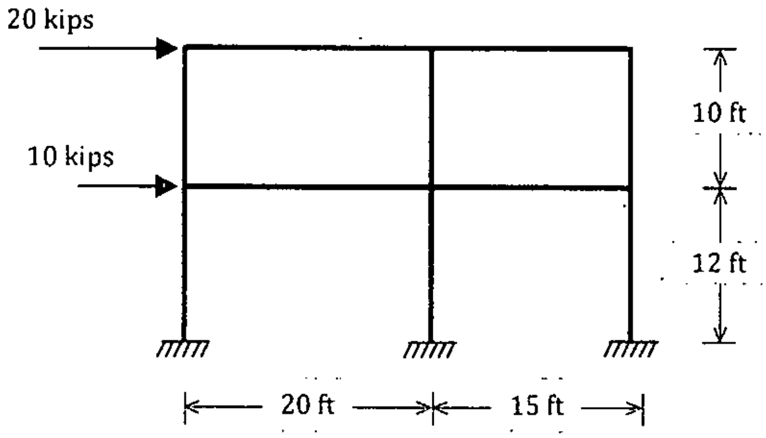
Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

No.	Questions	Marks
1.	The truss shown in Figure 1 is pinned at point A and supported by a roller at point D. Determine the support reactions and the forces of the members AE, CE, and FG.  **Figure 1**	20
2.	Using approximate method of analysis for gravity loads, draw the bending moment diagrams and shear force diagrams of all the girders and axial force diagram of the interior column HEB of the building frame shown in Figure 2. All the members have the same cross sectional and material properties. 	20

No.	Questions	Marks
	Figure 2	
3.	Draw the shear force diagrams and bending moment diagrams of only the columns of the frame shown in Figure 3. Use the portal method of analysis.  **Figure 3**	20
4.	a) Write down the names of some methods used for the approximate analysis of indeterminate structures? What are the assumptions of portal method used for analysis of indeterminate structures?	8
	b) What are the various systems that are generally present as an assembly in a building? What are the different types of structural systems of building structures?	12

SECTION-B: CE 467

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

No.	Questions	Marks
5.	(a) What is the principle of prestressing? (b) A simply supported 18 ft span prestressed concrete rectangular beam has a cross section of 16 X 24 inches. The beam is loaded by a uniform load of 2 kips/ft excluding its self-weight. The prestressing tendon has an eccentricity of 5 inches and produces an effective prestress of 200 kips. Compute the fiber stresses in concrete at the mid span section and show the stress distribution in neat sketch.	5 15
6.	(a) What do you mean by limit state? Write down the philosophy behind any engineering design. (b) Select the lightest W section of A992 steel to serve as a pinned-end main member column of 15 ft long to carry an axial compression load of 100 kips dead load and 160 kips live load. Use ASD approach. Given: $F_y = 50$ ksi, $E = 29000$ ksi. (Make only two trials and then comment on your results)	5 15
7.	(a) What is lateral torsional buckling? How this type of buckling can be prevented? (b) Select a standard W shape of A36 steel ($F_y = 36$ ksi) for a simply supported beam of span 18 ft carrying a uniformly distributed dead load of 1 kips/ft and live load of 2 kips/ft in addition to its own weight. The compression flange of the beam is fully supported against lateral movement. Follow ASD principle.	5 15
8.	(a) What are the purposes of foundation? Write the types of foundations. (b) When pile foundations are used in building construction? Which one would you prefer between pre-cast pile and cast-in-situ pile for foundation in a congested area? Give reasons of your answer from engineering point of view.	5 15

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations: January 2020 Term

Sub: **CE 481** (Foundation Engineering)

Full Marks: 180 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

No.	Questions	Marks
1. (a)	Determine the height of a finite slope, 1-vertical to 2-horizontal, that should have a factor of safety of 2 against sliding (assume plane failure surface). For the soil, the following values are given: $c' = 18$ kPa, $\varphi' = 20°$, $\gamma = 17$ kN/m^3. Also, find the height of the slope for critical equilibrium.	(15)
1. (b)	Explain the difference between a flow and a slide. Which one often travels farther, and thus can be a hazard to sites far from the slope.	(15)

2. (a)	Most limit equilibrium analysis methods include one or more simplifying assumptions. Why are these assumptions necessary? Give an example of one of the methods and its assumptions.	**(15)**
2. (b)	What do you mean by '2500 aggregate SPT N values' for defining/ choosing the depth of boring required in case of bridge foundation? How do you determine the value of '2500 aggregate SPT N values'?	(15)

3. (a)	For an infinite slope in sand that makes an angle β with the horizontal, show that the value of F_s (factor of safety) is independent of height H and the slope is stable as long as $\beta > \varphi'$ (the angle of internal friction of sand).	(15)
3. (b)	Evaluate the principle of correcting N-values for input energy or hammer efficiency. State various factors to assess the quality of undisturbed samples.	(5+10)

4.(a)	State the procedure of estimating consolidation settlement of a group of piles.	(15)
4.(b)	State Standard Penetration Test (SPT) with limitations. Differentiate between wash boring and rotary boring.	(15)

SECTION-B: CE 481 (Foundation Engineering)

There are FOUR questions in this section. Answer any THREE. Assume reasonable value (values) for missing data only. State any assumptions that you make.

1. A footing 8 feet square supporting a column is resting on a bed of clay at a depth of 7.5 feet from the ground surface. The 15.5 feet clay layer overlies a sand layer. The unconfined strength of clay as determined in the laboratory was found to be 3.0 ksf. The compression index and initial void ration of the clay layer are given as 0.20 and 1.2 respectively. Determine the maximum column load such that it provides a minimum factor of safety of 3.0 against bearing capacity failure as well as footing settlement must not exceed one inch. Draw the schematic diagram of the described problem. Assume water table exists 3 feet below the ground surface. The unit weight of clay and footing thickness are given as 125 lb/ft^3 and 2.5 feet respectively. 30

2. Discuss the factors affecting bearing capacity of a shallow foundation. 30

3. A footing 10 feet square and 2.5 feet thick is supported by sand with an average value N value of 25. The surface of the ground is 5 feet above the bottom face of the footing. And the water table is 2 feet below the base of the footing. Compute the maximum load that footin can support if the settlement must not 3/4th of an inch. The unit weight of soil above and below the water table are given as 112 lb/ft 3 and 118 lb/ft 3 respectively. Draw the schematic diagram of the described problem. 30

4. A bored pile of 60 feet length with 30 inch diameter was installed at a site. Soil characteristics of the site are given in the following table.

Soil layer depth in feet	Soil type	Consistency/Relative Density	Undrained shear strength (ksf)	Number of Blows, "N"	Unit Weight (lb/ft 3)
0-10	Clay	Medium stiff	1.4	8	120
10-20	Sand	Loose	-	10	115
20-30	Sand	Medium	-	20	115
30-40	Sand	Medium	-	23	115
40-50	Sand	Medium	-	30	115
50-60	Sand	Dense	-	50	115

Assume N value beyond the depth of 60 feet is 75 and the water table exists 5 feet below the ground surface. Draw the schematic diagram of the problem.

Calculate axial load carrying capacity of the pile using O'Neill & Reese Method. What will be the pullout capacity of the same pile? 30

L-4/T-2/CE Date: 19/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

L-4/T-2 B.Sc. Engineering Examinations January 2020

Sub: **WRE-409** (River Engineering)

Full Marks: 120 Time: 2 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**.

1. (a) Figure 1 shows an area map which includes a river. An industrial area and a residential area will be developed at the left side of the river. Right side of the river is mostly agricultural lands. i) Which part of the river reach will require bank protection works? ii) In Figure 1, two bridges are located- which bridge location is the correct one. Justify your answer. (5)

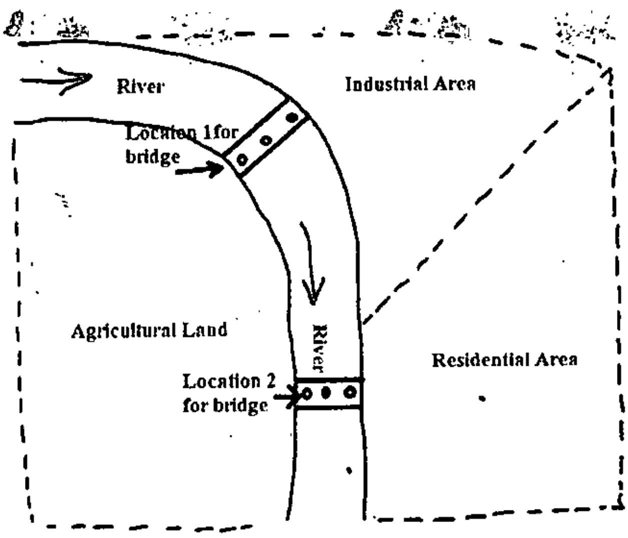


Figure 1: For question 1(a)

(b) Following hydraulic data are recorded at Hardinge Bridge gauging station of the River Padma: maximum discharge = (70,000 +20*R) m^3/s, highest flood level = 10 m PWD, bank full water level = 6 mPWD, low water level = 2 mPWD, bed material size = 0.22 mm. Now, design a guide bank for the bridge site. Sketch your design. [Given, R is the last three digit of your student ID]

(15)

2. (a) Draw a figure showing different types of bridge scour. (5)

(b) In Figure 2, elevation, plan view and section of a typical bridge abutment are shown. If the upstream approach flow hit the abutment with a velocity of (1.2+0.001*R) m/s, estimate the possible scour depth using the Froehlich equation. Here, R is the last 3 digits of your student ID. Assume reasonable data if necessary. (15)

$$\frac{Ys}{Ya}=2.27\ K_1\ K_2\ \left(\frac{L'}{Ya}\right)^{0.43}\ Y_a^{0.57}\ Fr_1^{0.61}+1$$

Table1: Values of K_1 and K_2

Description	K_1
Vertical-wall abutment	1.00
Vertical-wall abutment with wing walls	0.82
Spill-through abutment	0.55

K2 = Coefficient for angle of embankment to flow

$K2 = (\theta/90)^{0.13}$

$\theta < 90$ if embankment points downstream

$\theta > 90$ if embankment points upstream

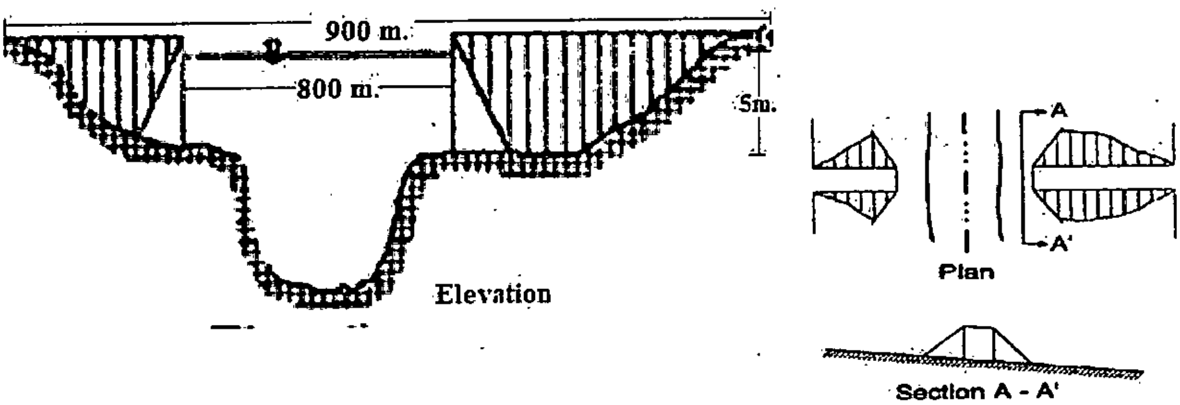


Figure 2: For question 2(b)

3. (a) List the main causes of failure of an earthen embankment with sketches. (8)

(b) For a wide river, determine the maximum depth for which scour of the bed material can just be prevented. The river bed material has a median size of (2.5+0.0001*R) mm non-cohesive material and it is laid on a slope of 0.0005. Here, R is the last 3 digits of your student ID. Assume reasonable data if necessary. Use Figure 3 for your calculation. (12)

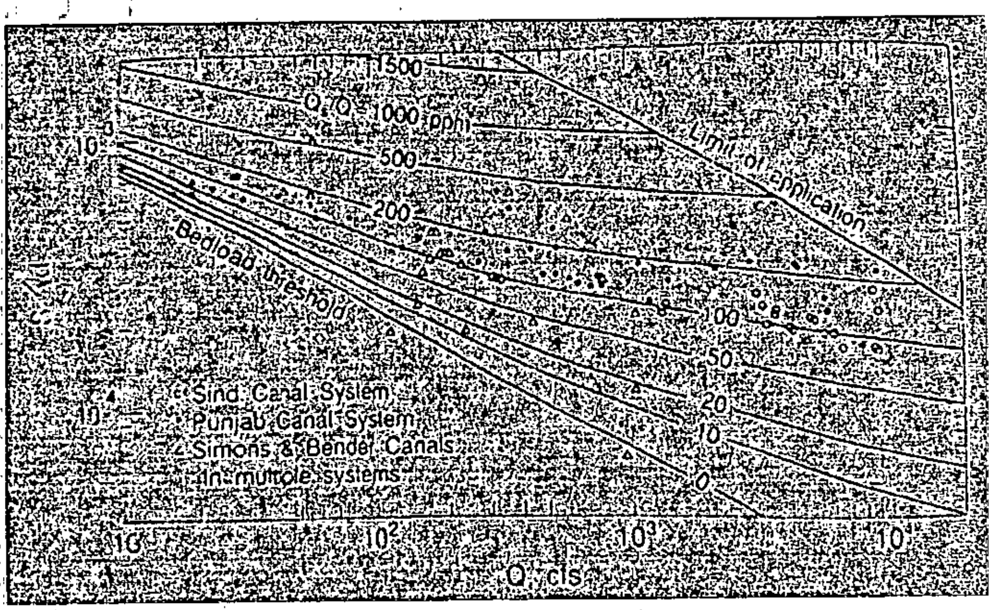


Figure 4: For question 4(b)

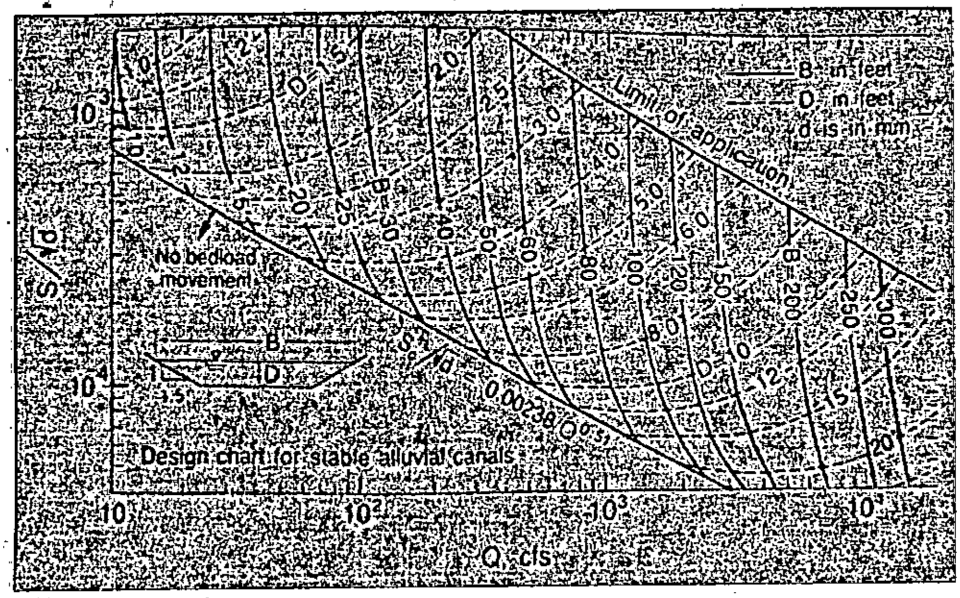


Figure 5: For question 4(b)

SECTION – B

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

Assume reasonable value for any missing data

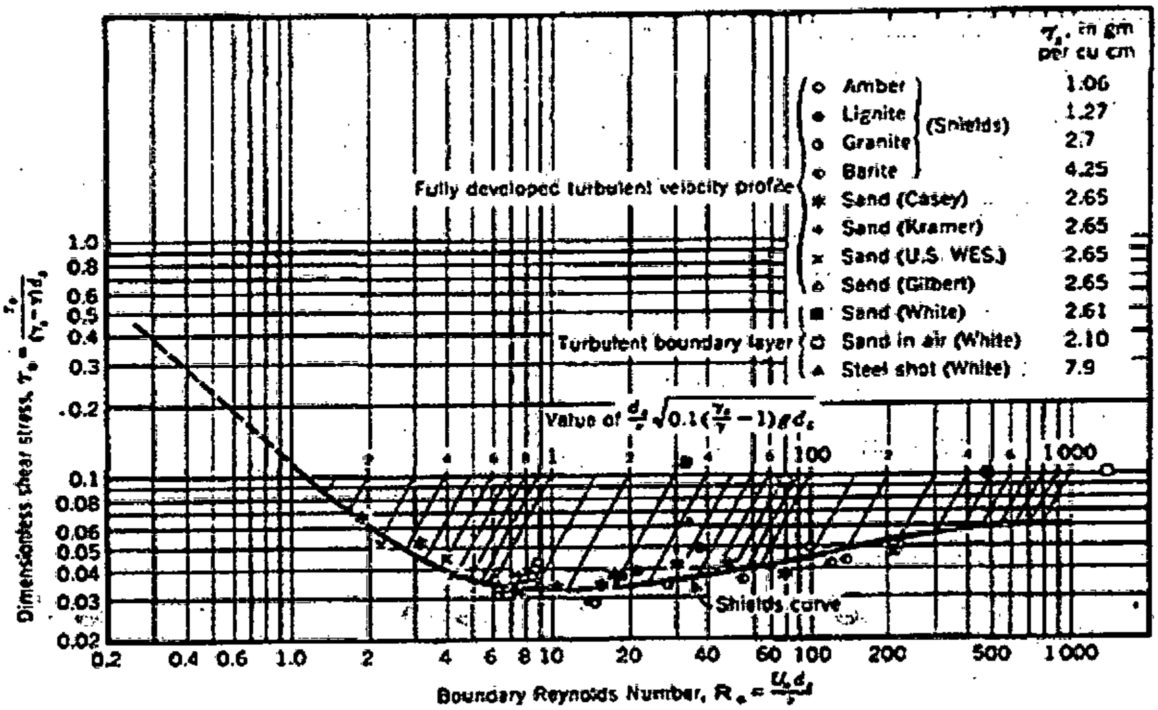


Figure 3: For question 3(b)

4. (a) Payra Sea Port has about 75 Km long inner channel, in general it has enough water depth for berthing the deep draught vessels but the long outer channel is too shallow for port operation. What type of measures should be taken to solve this issue? What should be the project objectives? **(8)**

(b) Teesta irrigation project requires (150+R) cfs to flow through the 12 km long main canal. If this alluvial canal is to be constructed on a slope of 0.0002 and it has a median bed sediment size of 0.22 mm, determine the stable width, depth and concentration of bed material load that should be admitted to this main canal. Given, R is the last three digits of your student ID. Use Figure 4 and 5. **(12)**

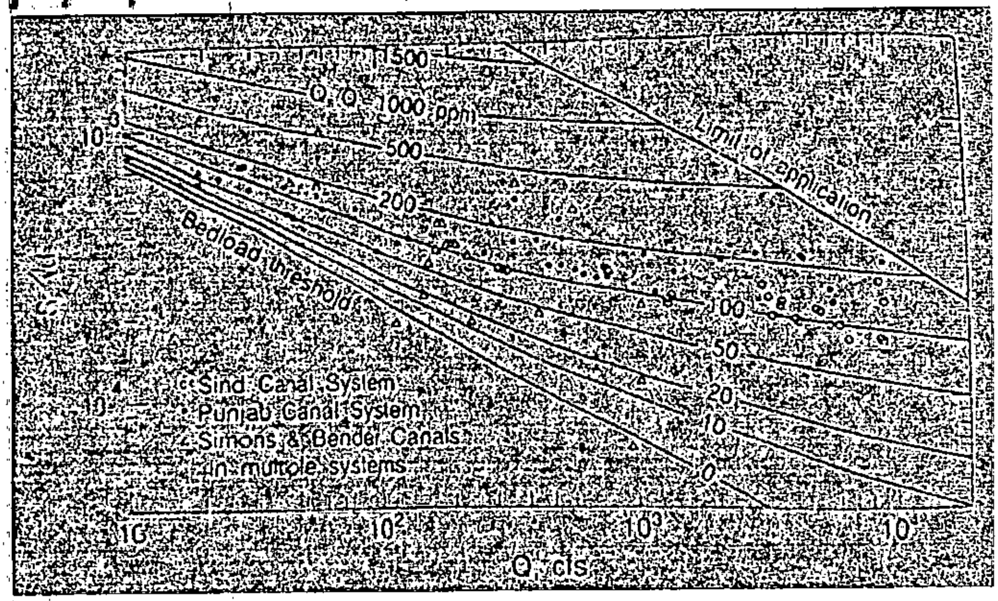


Figure 4: For question 4(b)

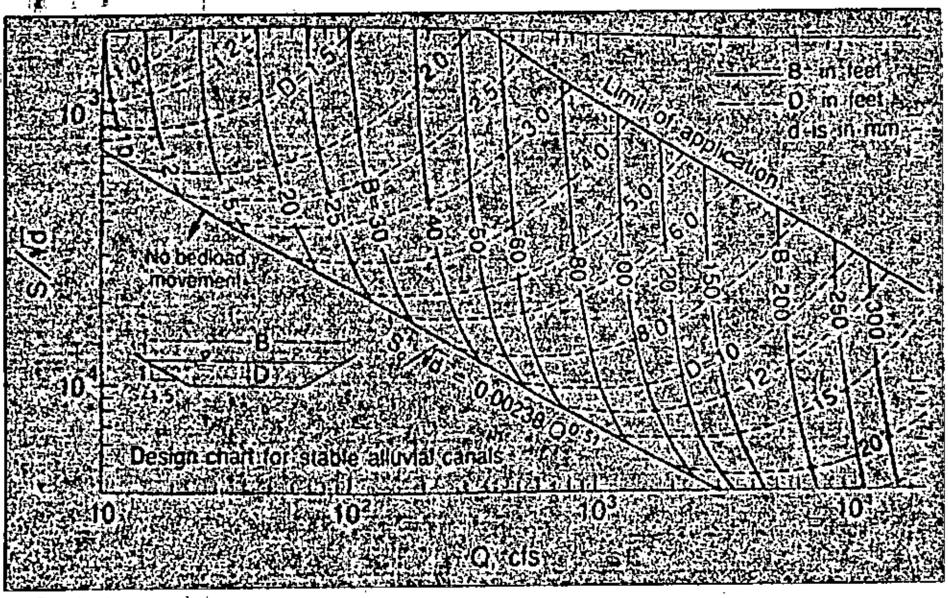


Figure 5: For question 4(b)

SECTION – B

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

Assume reasonable value for any missing data

5.(a) Define: (i) Thalweg (ii) Helical flow (iii) Regime Condition (6)

(b) What is 'Hydraulic Geometry'? Briefly discuss Leopold and Maddock's Hydraulic Geometry relationship, and prove that the sum of exponents of hydraulic geometric relationship is unity. (6)

(c) Bankful discharge of the river Jamuna is 48,000+ (last two digits of your student ID) m^3/s. Calculate the water surface width, mean depth and average velocity using the concept of at a station hydraulic geometry. Also determine the transverse slope of the water surface at a bend, if radius of the channel at a section is 650 m. (8)

6.(a) In a schematic diagram, show the typical vertical profile of flow velocity, suspended sediment concentration and sediment transport of a channel. (4)

(b) What is bed form and how are they affected by flow regimes? Briefly discuss different types of bed forms according to their flow regime along with neat sketches. (8)

(c) For the following data of a channel, determine the dimensionless particle parameter (d^*) and channel bed form height (Δ): (8)

Wavelength of bed form = 30 m

Median size of channel bed sediment = 2 mm

Specific gravity of sediment = 2.65

Channel bed slope = 0.00009

Shield's parameter, $\beta = 0.055$

Kinematic viscosity of water, $\mu = 1.1 \times 10^{-6}\ m^2/s$

7.(a) Draw a neat sketch of Idealized Profile of a river, showing the major reaches. (5)

(b) What is Channel Forming Discharge? If bankful flow area of a river is 2 ha and the water surface slope is 0.00011, determine the channel forming discharge. (5)

(c) What is shear stress? Derive the general expression of shear stress for water moving through a trapezoidal channel section. (10)

8.(a) Compare between the salient features of straight, meandering and braided river. (4)

(b) What are 'Cut-Offs' and 'Oxbow Lakes'? Explain with sketches. In which type of river planform, these features are commonly seen? (6)

(c) Define "aggradation and degradation". What are the common factors affecting the long-term bed elevation changes? **(10)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

L-4/T-2 B.Sc. Engineering Examinations January 2020 (Online)

Sub: **WRE-411** (Hydraulic Structures)

Full Marks: 120 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

USE SEPARATE SCRIPTS FOR EACH SECTION

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

1. (a) What is hydraulic structure? How do these structures differ from any other civil engineering structures? **(7)**

(b) Sketch the following: **(2 x 3 = 6)**
 (i) Water pressure on gravity dam
 (ii) Earthquake forces on gravity dam

(c) Describe and show with neat sketches **any one** of the following two types of spillways: **(7)**
 (i) Chute Spillway
 (ii) Side Channel Spillway

2. (a) What is the function of a drainage gallery in a gravity dam? How shear strength at the base of the gravity dam can be increased? **(2+2)**

(b) The following figure shows the section of a non-overflow portion of gravity dam built of concrete. Dimension of the base of the dam = (60 + 0.1***Last three digits of St ID**) m. Calculate the various kinds of stresses developed at the heel and toe when the reservoir is full with uplift and earthquake forces. The acceleration for earthquake forces may be taken as equivalent to $0.1g$ for horizontal forces and $0.05g$ for vertical forces. The uplift may be taken as equal to the hydrostatic pressure at the either ends and is considered to act over 60% of the area of the section. A tail water depth of 6 metres is assumed to be present. Assume the unit weight of concrete as 24 kN/m³; and unit weight of water 10 kN/m³. **(16)**

Von Karman: $P_e = 0.555\, k_h\, \gamma_w\, H^2$

Zanger: $P_e = 0.726\, p_e\, H;\ p_e = C_m\, k_h\, \gamma_w\, H\ ;\ C_m = 0.735\, (\frac{\theta}{90})$

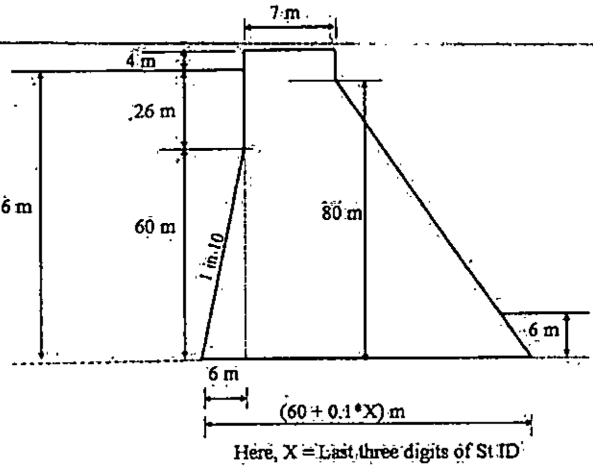


Figure 1 for Question 2(b)

3. (a) List the names of energy dissipation devices used to dissipate excess energy of water based on Y_2 curve and tail water level. **(6)**

(b) Design the downstream profile of an ogee spillway crest having the downstream face at a slope of 2H: 1V. The design discharge for the spillway is Q = [9000 + (10* **Last two digits of your ST ID**)] cumecs. The spillway crest elevation is at RL 312 m and the bed elevation RL is 200 m. Spillway length consists of 6 spans having clear width of 10 m each. Pier thickness is 2.5 m, $K_p = 0.01$ and $K_a = 0.1$. **(14)**

4. (a) Under what circumstances will you recommend the use of following cross drainage works: **(6)**

(i) Syphon
(ii) Inlet - Outlet

(b) The following data is given for the design of a suitable cross drainage work at the crossing of a canal and a drainage. **(14)**

RL of bed of drainage = 520.00 m
High Flood Level of drainage = 523.00 m
High Flood Discharge in drainage = (100+ R*2.5) cumec [where, R = Last 3 digits of your student ID]
RL of ground = 525.00 m
RL of bed of canal = 524.50 m
Full Supply Discharge in canal = R cumec [where, R = Last 3 digits of your student ID]
Full Supply Level in canal = 526.2 m
Bed width of canal = 22.0 m
Depth of water in canal = 1.70 m
Trapezoidal Canal Section with side slopes 1.5 H: 1V

Determine (i) Drainage Waterway, (ii) Canal Waterway and (iii) Bed Levels at following sections:-at the end of the diverging portion where the canal returns to its normal section and at the end of the flumed section when the flumed portion begins to diverge.

SECTION – B

USE SEPARATE SCRIPTS FOR EACH SECTION

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

Assume reasonable value for any missing data

5.(a) Draw a typical layout of a Diversion Head Works, with canals taking off from both banks of the river, also write the names of different components. **(6)**

(b) Briefly discuss the difference in ponding mechanism of barrage and weir, with necessary sketches. What are the key factors to consider when deciding between constructing a weir or barrage across a waterway? **(7)**

(c) The head regulator of a canal has 5 openings. The water is flowing between the upper and lower gates of the regulator. Each bay has a width of 2 m and vertical opening of the gate is 1.25 m. The head on the regulator is 0.5 m. If water level rises by 0.15 m in the upstream, how much the upper gates must be lowered to maintain the canal discharge unchanged? Assume a reasonable value of coefficient of discharge. **(7)**

6(a) Derive the expression of critical exit gradient for structures founded on pervious foundation. Show that, for typical sandy rivers, magnitude of critical exit gradient is unity. **(5)**

(b) Neglecting the floor thickness and pile thickness for the weir shown in Figure-2, determine the percentage pressures at nine key points (include effects of mutual interference of piles and slope of the floor). Also determine the exit gradient and if the structure is safe against piping. Use relevant equations of Khosla. **(15)**

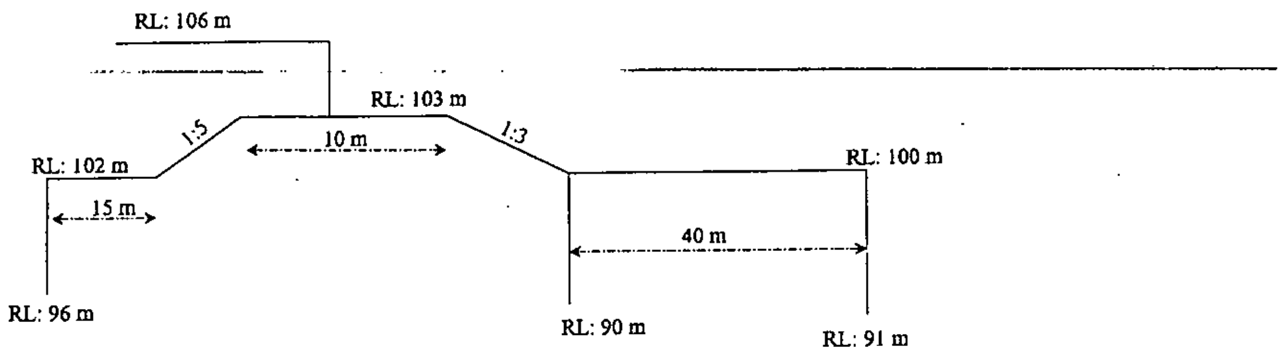


Figure-2 for Question 6(b)

7.(a) Briefly outline the salient features of Khosla's Theory of seepage below a hydraulic structure. **(5)**

(b) A barrage is to be constructed on a river having a high flood discharge of (8590+R*3.5) cumec [where, R = Last 3 digits of your student ID]. The relevant data are as follows: **(15)**

Average bed level of river	299.50 m
High flood level (before construction of barrage)	305.00 m
Permissible Afflux	1.00 m
Pond level	303.00 m
Lacey's silt factor	0.75
Safe Exit Gradient for river bed material	1/6

Stage discharge curve of the river at barrage site is given below in Figure-3:

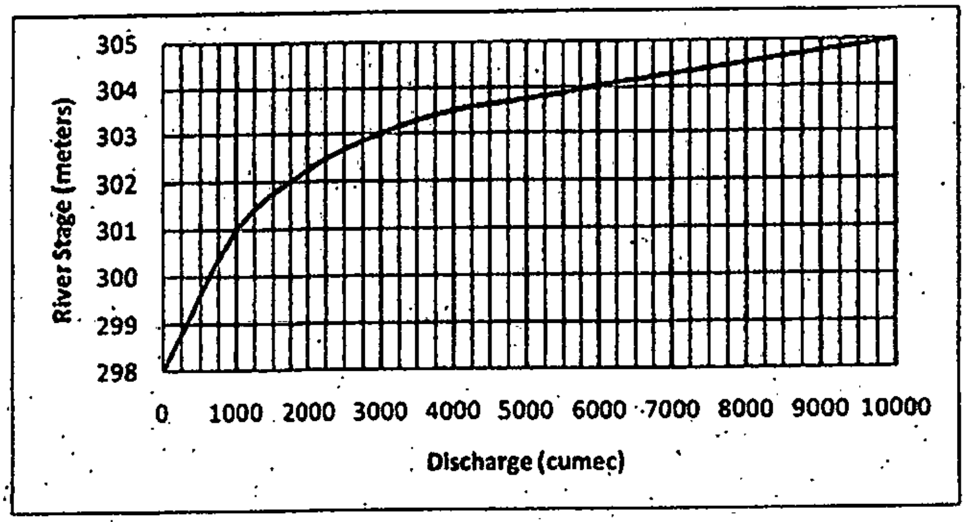


Figure-3 for Question 7 (b)

Determine (i) the crest level of under-sluices and barrage bays (ii) the waterway to pass the flood discharge (iii) downstream floor level for under-sluices portion considering a retrogression of 0.5 m and 20% discharge concentration

8.(a) Define: (i) Afflux (ii) Retrogression (iii) Concentration Factor. What are the typical values assumed for these terms, in the design of weirs and barrages? (5)

(b) What are the key similarities and differences between weir, barrage, dam and embankment? Discuss briefly. (5)

(c) A weir on permeable soil is 45 m long and has sheet piles at both ends. The upstream pile is 3.5 m deep and downstream pile is 4 m deep (Figure-4). The upstream FSL is 0.03*R [where, R = Last 3 digits of your student ID] above the crest level. Determine the thickness of the floor at its junction with the upstream and downstream piles, and also at mid-length. Also plot the subsoil HGL. (10)

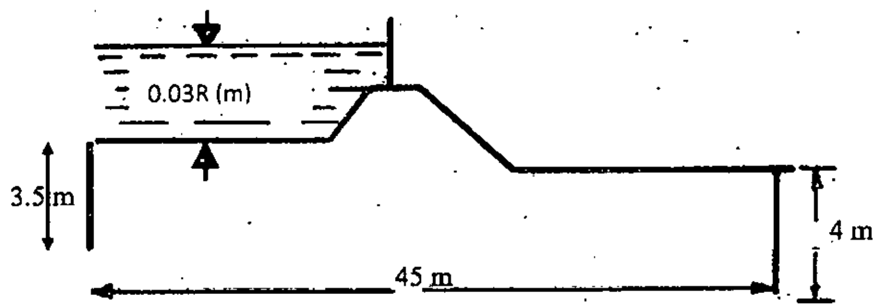


Figure-4 for Question 8(c)