L-4/T-1/CE **Date : 24/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **CE 401** (Project Planning and Construction Management)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

Assume any reasonable value of missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) The network of a building project is shown in Figure-1 along with the duration of each activity. Compute activity time and total float of each activity and also locate the critical path on the network. **(22⅔)**

   (b) Manifest the safety measures that should be taken for earth excavation. Illustrate "Activity oriented network diagram" and "Event oriented network diagram" as shown in Figure-1. **(12)**

   (c) Show a milestone chart. How does it differ from a bar chart? Interpret the statement "Quality control ensures that the work proceeds in accordance with the specifications, and inspection is the tool through which quality control is exercised." **(12)**

2. (a) Explain the basic steps of formulating a linear programming model. Compile the advantages and limitations of linear programming. **(10)**

   (b) Civil Engineering Department of BUET is preparing a trip for 400 students. The company who is providing the transportation has 10 Buses of 50 seats and 8 Buses of 40 seats, but only has 9 drivers available. The rent cost for a large bus is Tk. 8000 and Tk. 6000 for the small bus. Formulate the problem by linear programming model and calculate how many buses of each type should be used for the trip to minimize the rent cost. (Using graphical method) **(16⅔)**

   (c) A construction company has an opportunity to submit a bid for the construction of a new factory building. From the specifications provided by the client, the PERT network along with three time estimate (in week) for each activity are shown in Figure-2. Compute Critical path and its Standard Deviation and probability of completion of the project within 55 weeks. **(20)**

3. (a) Identify the key characteristics of a project plan. Elucidate examples of a good plan and a bad plan with sketches. How will you salvage the bad plan? Designate a representative construction project life cycle with illustration. **(20)**

   (b) Identify the key stakeholders on every project and explain their roles. Why managing stakeholders' expectations may be difficult? Explain with examples. **(12⅔)**

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(c) Distinguish between leading and managing. Differentiate between standards and regulations with examples. **(12)**

4. (a) Ascertain construction management. List the problems encountered in construction industry and mention the factors affecting leading the problems. **(16)**

(b) List the way of managing people in construction industry. **(10⅔)**

(c) A construction company is considering three methods for acquiring company pickup trucks. The alternatives are:

A: Purchase the trucks for Tk. 3000000 each and sell after 5 years for an estimated Tk. 1000000 each.

B: Rent the trucks for 5 years for Tk. 800000 per year paid in advance at the beginning of each year.

C: Purchase the trucks on special time payments with Tk. 800000 down now and Tk. 1000000 per year at the end of each year for 4 years. The Trucks will be sold after 5 years for an estimated Tk. 1000000 each.

If the company's minimum attractive rate of return (MARR) is 10%, determine which alternative should be chosen. **(20)**

SECTION – B

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

5. (a) How does a team behave and what are the tasks of a team leader during various team development stages? **(23⅔)**

(b) Define and characterize various components of emotional intelligence. **(23⅔)**

6. (a) What are the reasons for holding inventory and what are the disadvantages of low inventory turns? **(23⅔)**

(b) Derive the equation for economic order quantity and explain its graphical representation. **(23⅔)**

7. (a) Explain (i) NPV (ii) IRR, (iii) BCR, (iv) Payback Period. **(23⅔)**

(b) What is hurdle rate and how it is used for project evaluation purpose? **(23⅔)**

8. (a) Explain the steps required to be carried out for a financial feasibility assessment. **(23⅔)**

(b) What do you understand by economic feasibility assessment and how it is used by the government for making investment decisions? **(23⅔)**

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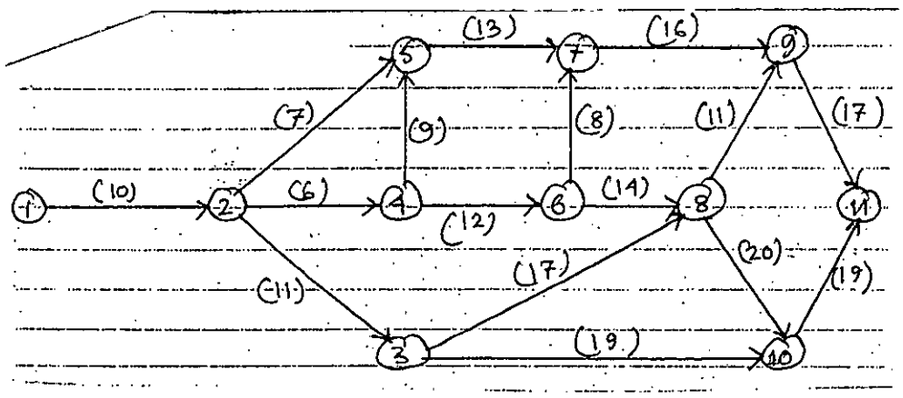

Figure – 1 for Q 1(b)

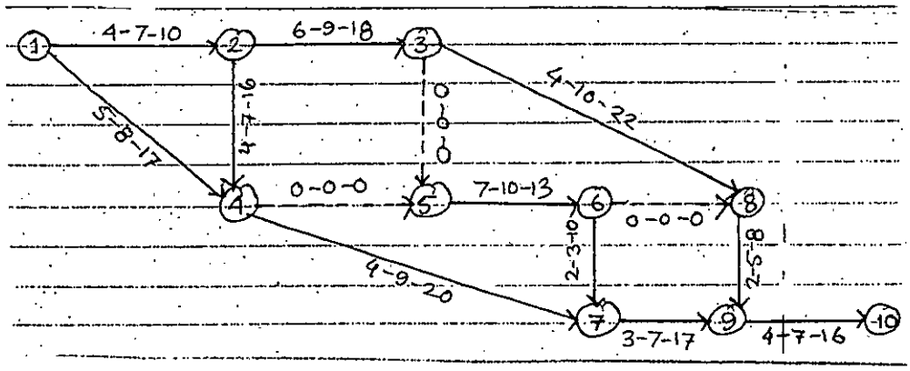

Figure-2 for Q 2(c)

Table 7.6. Standard Normal Distribution Function.

$Z(+)$	Probability $(P_r)(\%)$	$Z(-)$	Probability $(P_r)(\%)$
0	50·0	0	50·0
+0·1	53·98	−0·1	46·02
+0·2	57·93	−0·2	41·07
+0·3	61·79	−0·3	38·21
+0·4	65·54	−0·4	34·46
+0·5	69·15	−0·5	30·85
+0·6	72·57	−0·6	27·43
+0·7	75·80	−0·7	24·20
+0·8	78·81	−0·8	21·19
+0·9	81·59	−0·9	18·41
+1·0	84·13	−1·0	15·87
+1·1	86·43	−1·1	13·57
+1·2	88·49	−1·2	11·51
+1·3	90·32	−1·3	9·68
+1·4	91·92	−1·4	8·08
+1·5	93·32	−1·5	6·68
+1·6	94·52	−1·6	5·48
+1·7	95·54	−1·7	4·46
+1·8	96·41	−1·8	3·59
+1·9	97·13	−1·9	2·87
+2·0	97·72	−2·0	2·28
+2·1	98·21	−2·1	1·79
+2·2	98·61	−2·2	1·39
+2·3	98·93	−2·3	1·07
+2·4	99·18	−2·4	0·82
+2·5	99·38	−2·5	0·62
+2·6	99·53	−2·6	0·47
+2·7	99·65	−2·7	0·35
+2·8	99·74	−2·8	0·26
+2·9	99·81	−2·9	0·19
+3·0	99·87	−3·0	0·13

for Q 2(c)

L-4/T-1/CE **Date : 19/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **CE 411** (Structural Analysis and Design II)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols and notations have their usual meanings. Assume reasonable values for missing data, if any.

Neglect axial deformation of frame members unless otherwise noted.

SECTION – A

There are **FOUR** questions in this section. Answer **ALL**.

1. Answer either (a) or (b).

(a) Analyze the plane frame of Fig. 1 using stiffness method and draw the shear force and bending moment diagrams. **(26¼)**

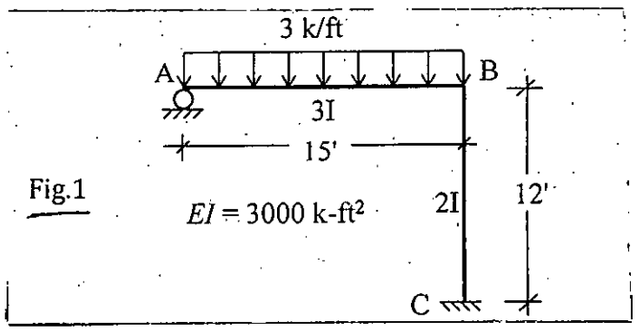

Fig.1

OR

(b) Analyze the beam shown in Fig. 2 following moment distribution method and draw the shear force and bending moment diagrams. In addition to the loads shown, the support at B moves up 0.25 ft.

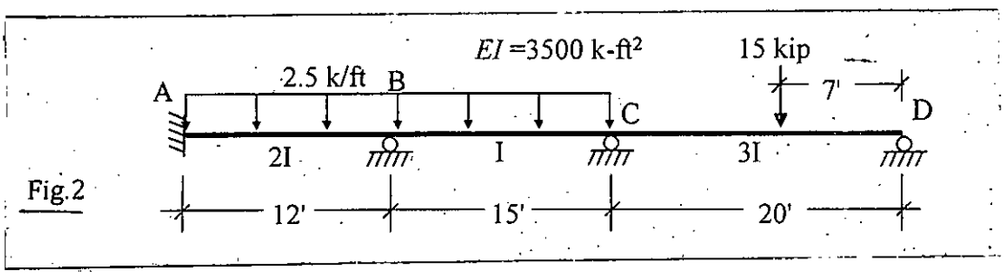

Fig.2

2. Answer either (a) or (b).

(a) Compute and write down the stiffness matrices for members 2 and 3 of the pin-connected plane truss shown in Fig. 3. Assemble the element stiffness matrices in the global stiffness matrix for these two elements. After performing matrix calculations, following displacement vector is obtained, [**u**] = [0, 0, –8.55, –8.94, 0, –4.45, 0, 0, 0]. Based on the element stiffness characteristics, determine the member forces in these two members. For all members, elastic modulus, E = 1000 k/ft^2, cross sectional area A = 0.1 ft^2 for members 1, 4 and 5; and A = 0.12 ft^2 for members 2 and 3. **(26¼)**

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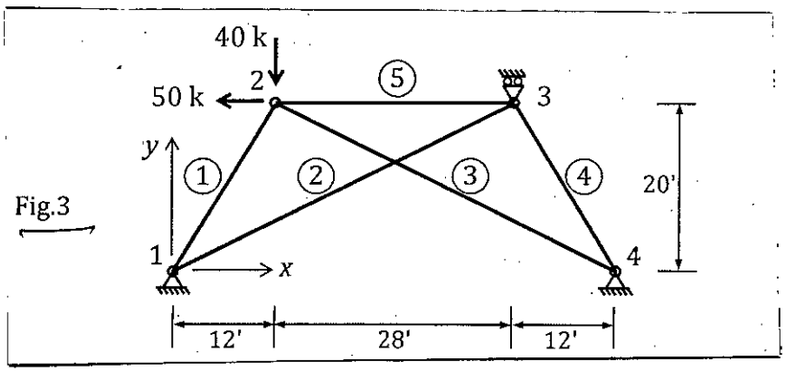

Fig.3

OR

(b) Analyze the pin-connected plane truss of Fig. 4 using stiffness method and determine axial forces in members. Figures in parentheses indicate member cross-sectional areas in ft^2. E = 1000 k/ft^2.

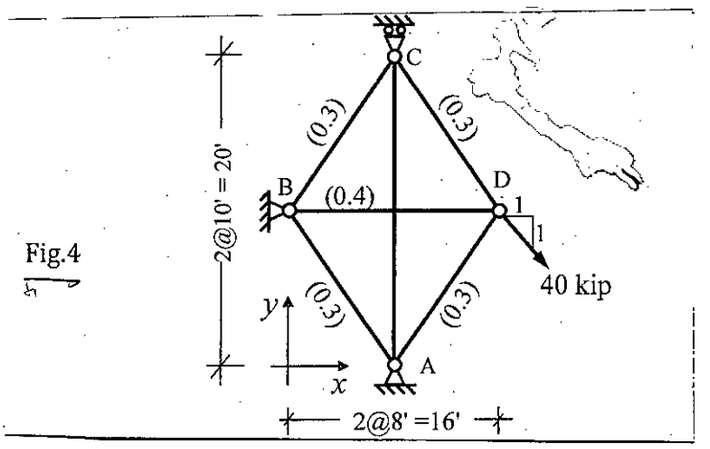

Fig.4

3. Answer all the following questions.

(a) By solving the governing differential equation of flexure of prismatic beam, determine the magnitude of force required to produce a unit lateral deflections at one end of a fixed ended beam. Hence, determine the other forces and moments that develop at both the ends. Show the results on a neat sketch. **(6¼)**

(b) For the plane frame shown in Fig. 5, support at A rotates 0.05 radian clock-wise while support at E settles down 0.15 ft. Analyze the frame using stiffness method and determine the moments and forces developed at all supports. Show your results on a neatly drawn free body of the structure. **(20)**

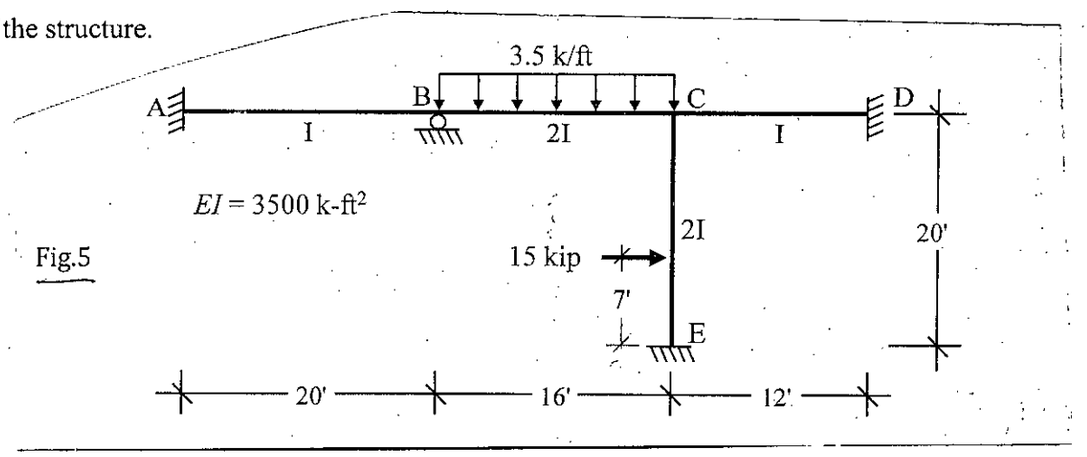

Fig.5

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4. Answer all the following questions.

(a) Show that the moment applied at a joint of a rigid-jointed frame is distributed among the connected members in proportion to their flexural stiffness. **(6¼)**

(b) Analyze the plane frame of Fig. 6 following moment distribution method and determine moments and forces at all supports. Show your results on a neatly drawn free body of the structure. **(20)**

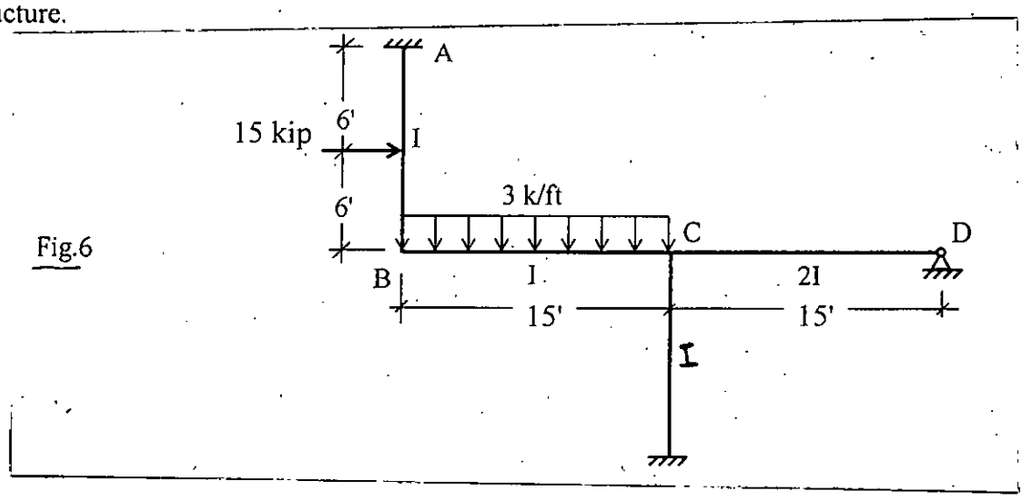

Fig.6

SECTION – B

There are **FOUR** questions in this Section. Answer **ALL**.

5. Answer either (a) or (b).

(a) Analyze the frame shown in Fig. 7. Draw bending moment diagram and sketch the deflected shape. Use flexibility method. **(26¼)**

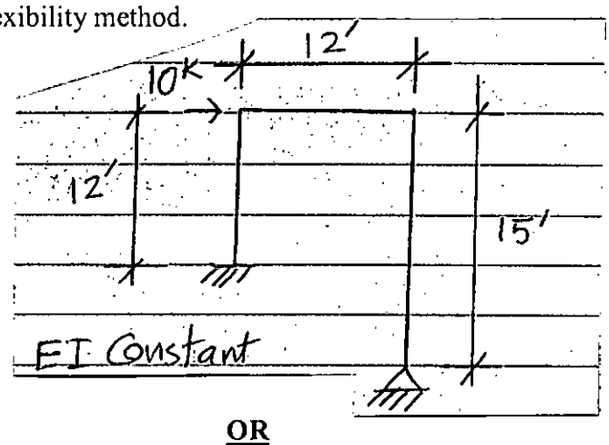

Fig. 7

OR

(b) Analyze the frame shown in Fig. 8. Draw bending moment and sketch the deflected shape. Use moment distribution method.

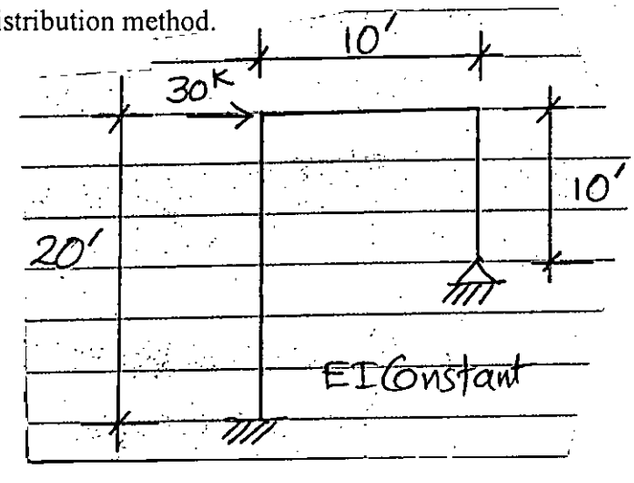

Fig. 8

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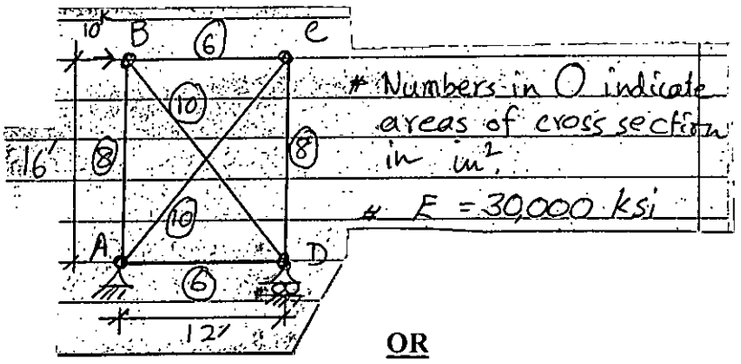
6. Answer either (a) or (b).

(a) Analyse the truss shown in Fig. 9. Use flexibility method. **(26¼)**

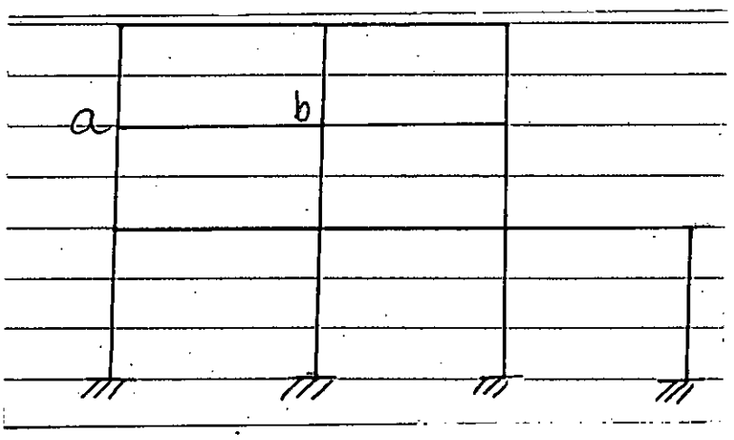
Fig. 9



OR

(b) Sketch the influence lines for moment and shear at mid span section of member a-b of the rigid frame shear shown in Fig. 10. Draw UDL pattern for maximum positive moment in the section.

Fig. 10

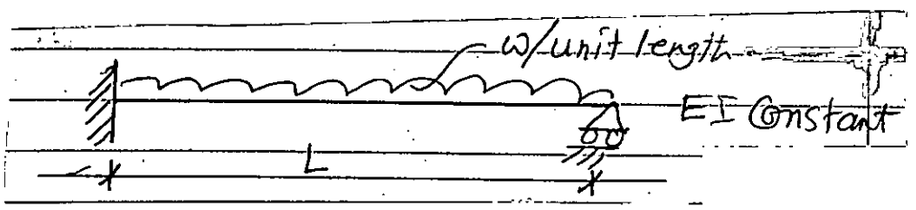


7. Answer all the following questions.

(a) Define internal release system and narrate the advantages over use of external release system in analyzing a structure using flexibility method giving an example case. **(12¼)**

(b) Analyse the beam shown in Fig. 11 using flexibility method. **(14)**

Fig. 11

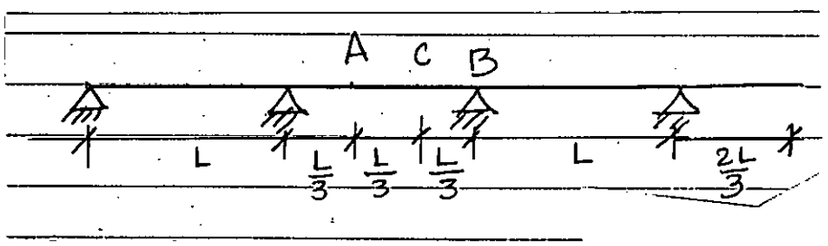


8. Answer all the following questions. **(11¼)**

(a) "The influence line for a statically determinate structure is composed of straight line (s); while that for a statically indeterminate structure is curved". Explain the reason(s) citing Muller Breslau's principle.

(b) Draw influence line for M_A, M_B, M_c, Δ_A and V_A in the continuous beam shown in Fig. 12. **(15)**

Fig. 12



L-4/T-1/CE Date : 02/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Consider that a six storied building is to be constructed on individual footings on a rectangular plot of dimensions 36 ft by 50 ft. How many borings will you suggest and at what locations (show on a sketch of plot layout)? How would you decide on the depth of borings for sub-soil exploration? **(10)**

   (b) In the design of raft foundation on sand which one of 'bearing capacity' and 'settlement' usually governs the design? Justify your answer. **(10)**

   (c) Consider that a 30 ft excavation is made in a soil that has γ = 105 lb/ft^3, c = 600 lb/ft^2, and ϕ = 15°. The side of the cut slope will make an angle of 45° with the horizontal. Determine the factor of safety of the slope by Culmann's method. Use **Table 1** for stability number, m based on Culmann's analysis, where, m = $c_d/(\gamma H)$. **(15)**

2. (a) A raft, 20 m by 30 m in plan, is to be placed 5 m below the ground surface. Sub-soil investigation showed fairly uniform sand up to the depth of exploration of 30 m. The minimum SPT-N value of the sand strata corrected for overburden pressure is 35. Excavation and sub-structure construction will be carried out in the dry season when water table will be more than 10 m below ground surface. In this situation, the sub-soil has a unit weight of 18.5 kN/m^3. However, in the monsoon, water level will rise to the ground surface. Determine the maximum allowable pressure, in kPa, at the base of the raft. **(15)**

   (b) For an infinite slope with c-ϕ soil that makes an angle β with the horizontal, derive a mathematical expression for the factor of safety against stability failure along an arbitrary plane surface parallel to and at a depth H below the slope surface. **(10)**

   (c) Compare the advantages and limitations of SPT and CPT for sub-soil exploration. **(10)**

3. (a) State, with appropriate sketches, the operational process of a piston sampler. Explain - how a Piston Sampler provides good quality undisturbed sample compared to Shelby Tube. **(10)**

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Contd ... Q. No. 3

(b) An earth slope is proposed to rise to a height of 50 ft at an angle of 25° with the horizontal. The properties of the soil forming the slope are: γ = 115 pcf, ϕ = 20°, c = 500 psf. Considering r_u = 0.25, determine the factor of safety against stability failure using Spencer's method. (Charts for Spencer's solution are provided in **Fig. 1**). **(12)**

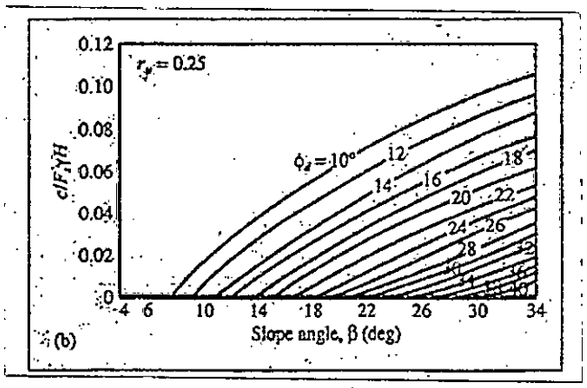

Fig. 1 Charts for using Spencer's solution for slope stability analysis.

(c) A building is to be supported on a RCC raft foundation of plan area 50 ft by 70 ft. The sub-soil is clay with an unconfined compressive strength of 1 tsf. The estimated weight of the building, including design live loads, is 8500 ton. If the unit weight of the soil is 115 pcf, design the depth of the raft with a factor of safety of 3? Consider that, though not permanently, water table will be at the ground surface sometimes over the year. (Use **Fig. 2** for bearing capacity factor N_c) **(13)**

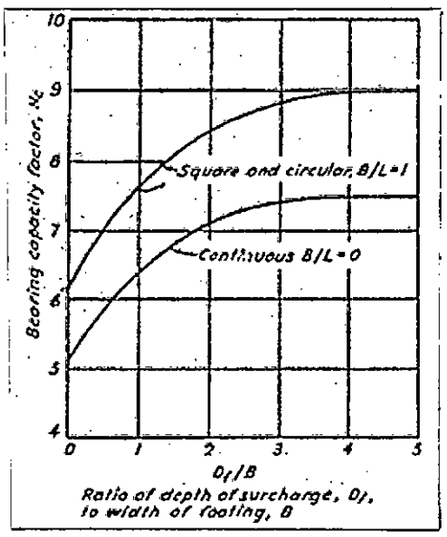

Fig.2 Bearing capacity factors for foundations on clay under ϕ = 0 conditions

4. (a) Describe the methods of determining the depth of water table in soils of low and high permeability? **(10)**

(b) Explain the principle of Electrical Resistivity Survey along with the information that can be obtained. **(10)**

(c) Discuss the effect of water on the stability of slopes. **(8)**

(d) Discuss the variation of factor of safety (against stability failure) with time for an embankment constructed on soft clay. **(7)**

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SECTION – B

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

5. (a) Assume that you are a designer to set a foundation system of a 6-storied building structure with having architectural design and subsoil report, and you are able to estimate the superimposed load on each of the column. Based on the estimated load on an interior column of the structure, you are required to set a shallow footing underneath. State, briefly, the steps/procedure of proportioning footing size, estimating the allowable capacity, q_a and hence safe bearing capacity, q_{safe}, of the footing.

Estimate the ultimate and net allowable capacities of a 2.5 × 3.5 m footing placed at a depth of 1.7 m on a stratum of soil of unit weight 20 kN/m^3. The soil properties are: c = 65 kN/m^2 and $\Phi = 0°$, and the depth of water level is at 5 m below the level of foundation. **(20)**

Given: $N_\Phi = tan^2(45^o + \frac{\Phi}{2})$. factor of safety FS= 2.5;
Use bearing capacity factors of Meyerhof (N_c = 5.14, N_q = 1 for Φ= 0°)
$s_c = 1 + 0.2N_\Phi\, {}^{B}/_{L}$, $s_q = 1 + 0.1N_\Phi\, {}^{B}/_{L}$, for $\Phi > 10°$: $s_q = s_\gamma =$, for $\Phi = 0$: $s_q = s_\gamma = 1$
$d_c = 1 + 0.2\sqrt{N_\Phi}\left({}^{D_f}/_{B}\right)$, $d_q = 1 + 0.1\sqrt{N_\Phi}\left({}^{D_f}/_{B}\right)$ for $\Phi > 10°$, $d_q = 1$ for $\Phi = 0$

(b) If the RCC footing of **Q.5(a)** is acted on by a vertical load of 1000 kN and moment of 450 kNm in one of the two orthogonal planner directions, determine the stability of the foundation and decide on the critical direction of moment (being acted on footing) for which the footing will be unstable. Also, estimate the factor of safety available for stable case of footing orientation, if there exists any such case. **(15)**

6. (a) A group of friction piles, grouped as 5×3 array with 1 m clear spacing in a horizontal planar section, in clay consists of 15 piles of 500 mm diameter. If undrained shear strength **c** of the clay is 30 kPa and the piles are embedded into soil for 20 m, estimate its group capacity and its efficiency. Assume reasonable value for missing data. **(18)**

(b) If the subsoil of **Q.6(a)** is uniform for a depth of 10 m below the pile tip with a sand layer below. The super-structural working load coming onto the pile cap that needs to be resisted by the group piles underneath is 4000 kN. Laboratory one-dimensional consolidation test yields the coefficient of compression (C_c) of clay deposit is 0.18 and initial void ratio, e_0 = 0.56. Check and decide on if the pile system will be able to withstand the imposed load safety. Given: the maximum permissible settlement = 50 mm. **Given**: γ_{soil} = 17 kN/m^3, γ_{sat} = 21 kN/m^3 and water table is at 10 m below EGL. **(17)**

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7. (a) If the pile foundation system of **Q.6(a)** has been functioning as foundation for Dolphin jetty in Karnaphuli river at Patenga Container Terminal and is being used for the anchorage of oil tanker-laden cargo ship of 50,000 DWT (dead-weight tonnage) capacity. While anchored, the maximum tension observed at the connecting cable during a worst cyclone was 92 ton; the vertical inclination of anchorage cable connecting the Dolphin jetty with cargo ship is 25°-up (maximum allowable) from jetty-to-cargo ship anchorage points (**Fig. for Q.7(a)**). The subsoil parameters are the same as in **Q.6(a)**; estimate the uplift capacity of the pile system and comment on the adequacy of embedded length of pile against the vertical force (uplift) emanating from the anchored cargo ship. Assume that floating pile length (portion of pile above ground level but into water and air) is 2 m and pile-cap weight is 18 ton. **Given**: $\gamma_{con} = 25$ kN/m^3, $\gamma_{sat} = 21$ kN/m^3. **(20)**

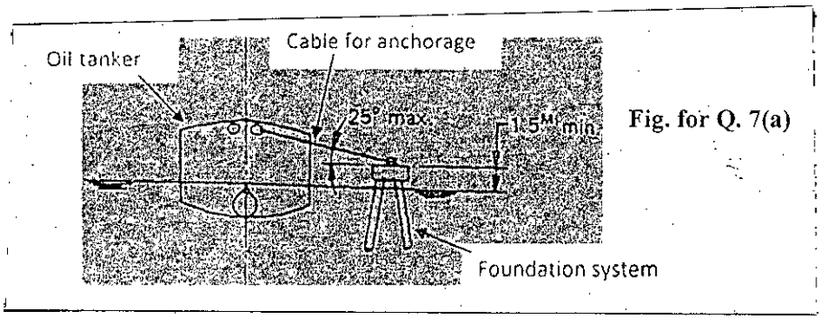

Fig. for Q. 7(a)

(b) Does method of pile installation (i.e. driven or cast-in-situ) affect the angle of internal friction of sand deposit? How do you accommodate this effect in the theoretical estimation of pile capacity?

Discuss the advantages and disadvantages of driven piles and cast-in-situ piles. **(7+8)**

8. (a) A pile group consisting of 12 piles (**Fig. For Q. 8(a)**, dimensions are in mm) is subjected to a total vertical load of 4 MN with eccentrically $e_x = 0.3$ m and $e_y = 0.4$ m. Determine the maximum load on an individual pile. **(17)**

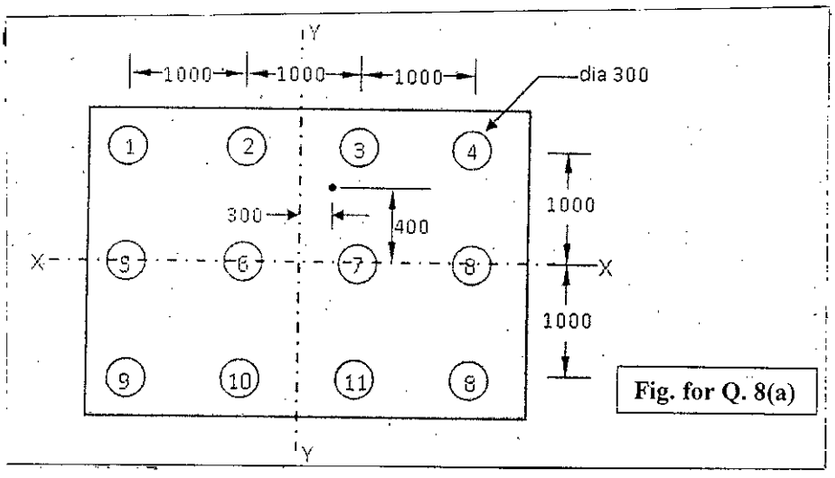

Fig. for Q. 8(a)

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(b) Sub-soil exploration was carried out at a site to a depth of 30 m. The sub-soil was found to consist of medium dense sand up to the depth of exploration. The average SPT of the strata corrected for overburden pressure is 15 which correspond to an angle of internal friction of 34°. Estimate the allowable compression capacity of an RCC pile of dia 450 mm and length 20 m. Use a factor of safety of 3. Apply critical depth concept and limiting values of skin friction and end bearing. Use Berezantsev's N_q values as given in **Fig. for Q.8(b)**. **(18)**

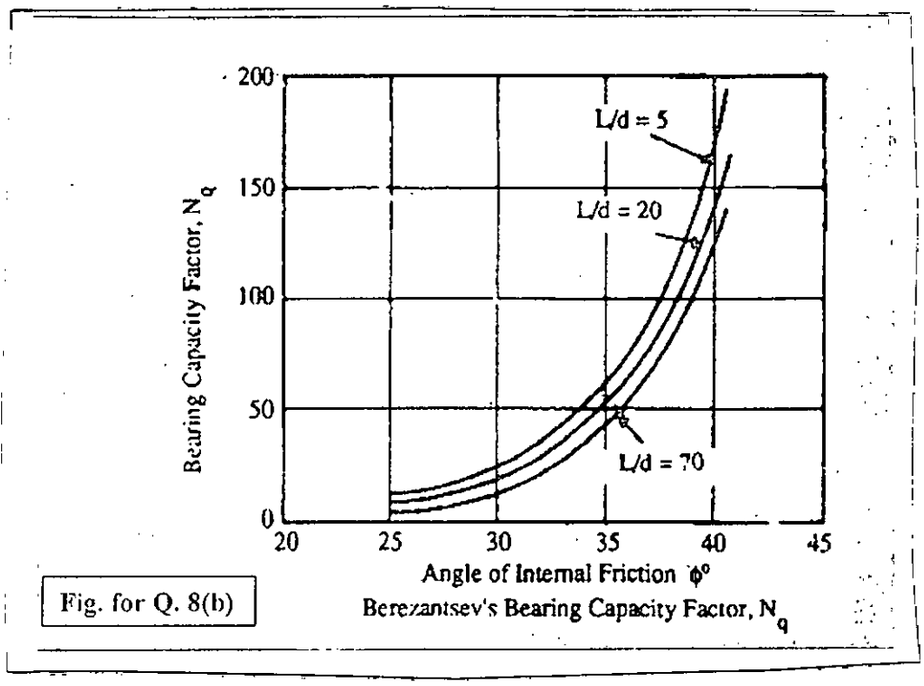

Fig. for Q. 8(b)

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Table. 1

Stability Numbers Based on Culmann's Analysis

Slope angle, β (deg)	$\phi - \alpha$ (deg)	$c/\gamma H$	Slope angle, β (deg)	$\phi - \alpha$ (deg)	$c/\gamma H$
10	0	45.72	50	20	21.49
	5	181.84		25	29.64
15	0	30.38		30	44.00
	5	67.89	60	0	6.93
	10	267.93		5	8.09
20	0	22.69		10	9.55
	5	40.00		15	11.42
	10	88.68		20	13.91
	15	347.27		25	17.36
25	0	18.04		30	22.39
	5	27.92	70	0	5.71
	10	48.86		5	6.49
	15	107.48		10	7.40
	20	417.45		15	8.51
30	0	14.93		20	9.89
	5	21.27		25	11.63
	10	32.66		30	13.91
	15	56.70	80	0	4.77
	20	123.71		5	5.29
	25	476.34		10	5.90
40	0	10.99		15	6.59
	5	14.16		20	7.40
	10	18.90		25	8.37
	15	26.51		30	9.55
	20	40.06	90	0	4.00
	25	68.39		5	4.37
	30	146.57		10	4.77
50	0	8.58		15	5.21
	5	10.42		20	5.71
	10	12.89		25	6.28
	15	16.37		30	6.93

L-4/T-1/CE **Date : 06/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Briefly describe and mention the uses of slow-curing asphalt, medium curing asphalt and rapid curing asphalt. Mention the advantage of cutbacks over emulsions. **(12+4)**

   (b) Why it is important to recognize that some aggregates appear to have a greater affinity for water than for asphalt cement? Mention the RHD specifications for course and fine aggregates for bituminous mix suitable for roads in Bangladesh. **(5+15)**

   (c) Being a developing country, Bangladesh requires significant quantities of asphalt for construction and maintenance of its roadways every year. Suppose two sources of crude oil are available for imports with their respective specific gravities being 0.93 and 0.90. Using the API gravity index, identify the crude oil that would be more suitable for our purpose. **$(10\frac{2}{3})$**

2. (a) Mention the desirable properties of stone aggregates. Why ten percent fines test is recommended for weak aggregates? State the advantages that mineral filter offers for the durability of the bituminous mixtures. **(5+5+10)**

   (b) State the main differences between Marshall and HVEEM method of mix design regarding testing of specimens and design criteria. **$(6\frac{2}{3})$**

   (c) Calculate the Approximate Bitumen Ration (ABR) i.e. the starting asphalt content in the test series of HVEEM mix design procedure for Medium Curing cutback asphalt [MC-3000]. The necessary data are provided below: **(20)**

Surface area of aggregates	34.8 ft^2/lb
Specific gravity of fine aggregates	2.62
Specific gravity of coarse aggregates	2.72
Weighted average Specific gravity of fine and coarse aggregates	2.66
% of fine aggregate	55
% of coarse aggregate	45
C.K.E of 2 fine aggregate specimens	7.4, 7.2
% Oil retained of 2 coarse aggregate specimens	2.8, 2.8

3. (a) Define railway gauges and explain the difficulties with non-uniformity with gauges. How this problem can be overcome in Bangladesh? **(12)**

Contd P/2

CE 451

Contd..... Q. No. 3

(b) What criteria are generally followed for the site selection of a railway station? Classify railway stations as per operational and functional consideration. **(16)**

(c) 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. **($18\frac{2}{3}$)**

4. (a) What are the functions and quality requirements of railway ballast? Determine the minimum depth of ballast for a BG track with wooden sleepers with sleeper spacing of 32.1 cm and width of 25.4 cm. **(12)**

(b) Explain why the following are used/provided.

(i) Flat footed rails, (ii) Vacuum brakes, (iii) Coning of wheels and (iv) Deficiency in super-elevation. **(16)**

(c) What are the functions of points and crossings? Show with a labeled diagram different components of right hand turnout. **($18\frac{2}{3}$)**

SECTION – B

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

5. (a) Explain engineered earth road and improvised low cost road concept along with typical whole life cycle cost vs. traffic diagram. Describe the names and purposes of 10 highway construction equipment. **($12\frac{2}{3}$+10)**

(b) Describe detail features of Double Bituminous Surface Treatment (DBST), Bitumen Slurry Seal and Penetration Macadam construction including materials details. **(8×3=24)**

6. (a) Analyse the material requirement, layered compaction, quality control and verification issues of highway embankment construction. **(23)**

(b) Write down possible causes, maintenance/rehabilitation/reconstruction options for the following defects of different highway pavements: Alligator cracks, Ruts, Potholes, Ravelling, Buckling, Corrugation and Shoving. **($23\frac{2}{3}$)**

7. (a) Broadly classify pavement system. Differentiate between flexible and rigid pavements w.r.t. Load Distribution Mechanism, Thickness requirement, Aggregate Type and Modulus of Elasticity. Define 'Perpetual pavement'. Schematically show the concept and layer system of 'Perpetual pavement'. **(5+6+2+6=19)**

Contd P/3

CE 451

Contd..... Q. No. 7

(b) Define 'Polymer Modified Binder (PMB)'. Briefly state the significance of PMB use in Bangladesh. Differentiate between 'Construction Joint' & 'Contraction Joint' and relatively which joint performs better and why. On which respects the moisture is 'enemy for bituminous pavement and friend for concrete pavement'. **(2+4+8+2=16)**

(c) Design reinforcement for a rigid pavement with the following data and draw reinforcement details: **($11\frac{2}{3}$)**

Thickness of rigid pavement, t =	10	inch
No of lanes =	2	
Width of pavement, w =	22	ft
Spacing of transverse joint =	44	ft (Contraction Joint @ 22ft)
Allowable strength of:		
Shrinkage steel(bar-mat) =	36000	psi
Tie bars =	32000	psi
Bond =	350	psi

8. (a) Explain with schematic diagram, the flexible pavement failure mechanism under submerged condition in Bangladesh. Why joints are used in rigid pavement? What are the main functions of Tie bars and Dowel bars in rigid pavement? What special considerations are recommended by PCI for the odd-shaped panel to reduce the risk of cracking in curved areas in concrete pavement? **(5+4+4+4=17)**

(b) Assess the significance of AASHO road test in view of pavement design. Explain how the concept of standard equivalent single axle load came up? A truck in an intercity road applies 26kip and 11kip loads by the rear and front axles. Using the 4th power approximation, determine the total equivalent damage caused by one pass movement of this truck in terms of ESALs. **(4+4+5=13)**

(c) Design a flexible pavement by AASHTO method for the data given below. Give one trial and put your comments for the next trial thickness (if any). Solution could be given in the worksheet provided at the end of question paper. **($16\frac{2}{3}$)**

Given:

Assumed Structural Number, SN = 6.5

Estimated Design ESAL, W_{18} = 25 million ESAL

Consider:

Design period = 20 years

Initial Serviceability, Po = 4.8

Terminal Serviceability, Pt = 2.5

Reliability, R = 0.95

Overall std dev., So = 0.35

Z_R = -1.645

Pavement Layer	Material Used	Resilient Modulus M_R (psi)		Layer Coefficients	Drainage Coefficients	
Surface Course (AC)	Asphalt Concrete	E_{AC} =	400,000	$a_1 = 0.169*LN(E_{AC}) - 1.764$	m_1 =	1.0
Base Course (BS)	Granular	E_{BS} =	30,000	$a_2 = 0.249*LOG_{10}(E_{BS}) - 0.977$	m_2 =	1.2
Subbase Course (SB)	Granular	E_{SB} =	11,000	$a_3 = 0.227*LOG_{10}(E_{SB}) - 0.839$	m_3 =	1.2
Roadbed Course (RB)	Compacted soil	E_{RB} =	5,700			

Contd... P/4

CE 451

HVEEM Design Charts:

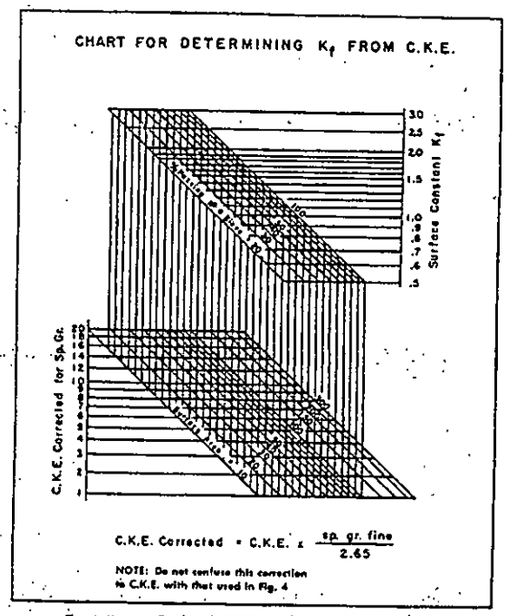

Chart No.1 - Estimating the Optimum Asphalt Content.
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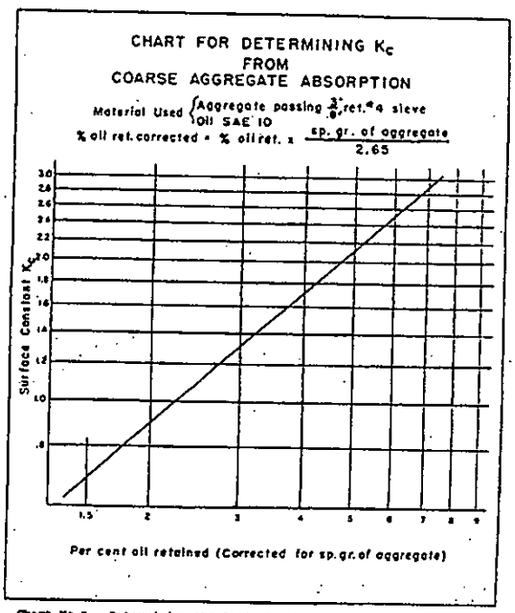

Chart No.2 - Determining the Estimated Optimum Asphalt Content.
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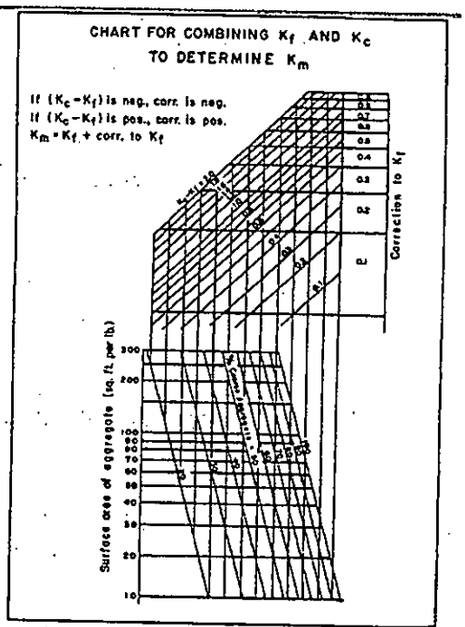

Chart No.3 - Determining the Estimated Optimum Asphalt Content.
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contd... P/5

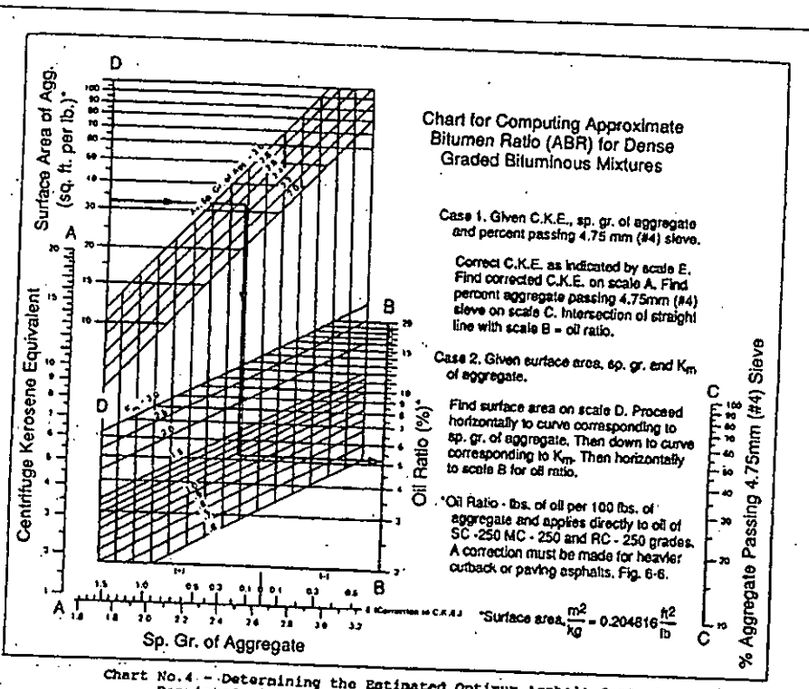

Chart No.4 - Determining the Estimated Optimum Asphalt Content.
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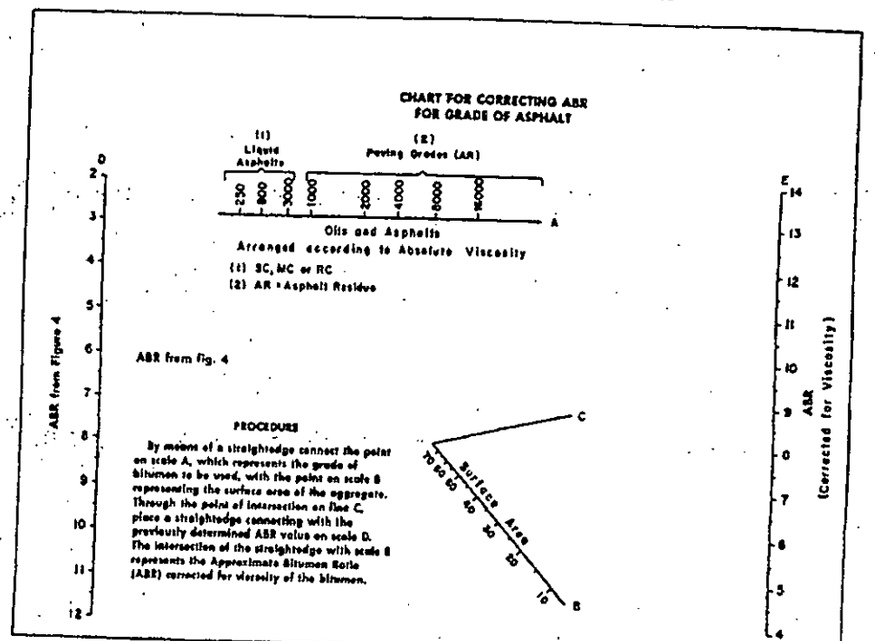

Chart No.5 - Determining the Estimated Optimum Asphalt Content.
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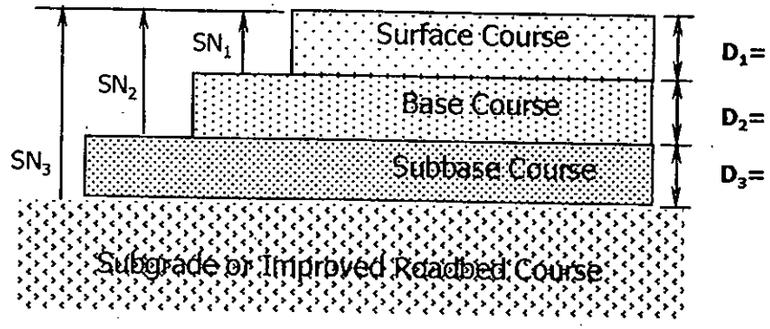
Contd... P/6

CE 451
L-4/T-1

AASHTO Worksheet For Flexible Pavement Design

Pavement Layer	Material Used	Resilient Modulus M_R (psi)		Layer Coefficients		Drainage Coefficient		Required SN above the layer	Calculations For Layer Thicknessed	Thickness D (inch)
Surface Course	Asphalt Concrete	E_{AC} =	400,000	$a_1 = 0.169*LN(E_{AC}) - 1.764$ =		m_1 =	1.0			
Base Course	Granular	E_{BS} =	30,000	$a_2 = 0.249*LOG_{10}(E_{BS}) - 0.977$ =		m_2 =	1.2			
Subbase Course	Granular	E_{SB} =	11,000	$a_3 = 0.227*LOG_{10}(E_{SB}) - 0.839$ =		m_3 =	1.2			
Roadbed Course	Compacted soil	E_{RB} =	5,700							
Check for SN3 = a1m1D1 + a2m2D2 + a3m3D3 =										

For Q 8(c)



Contd... P/T

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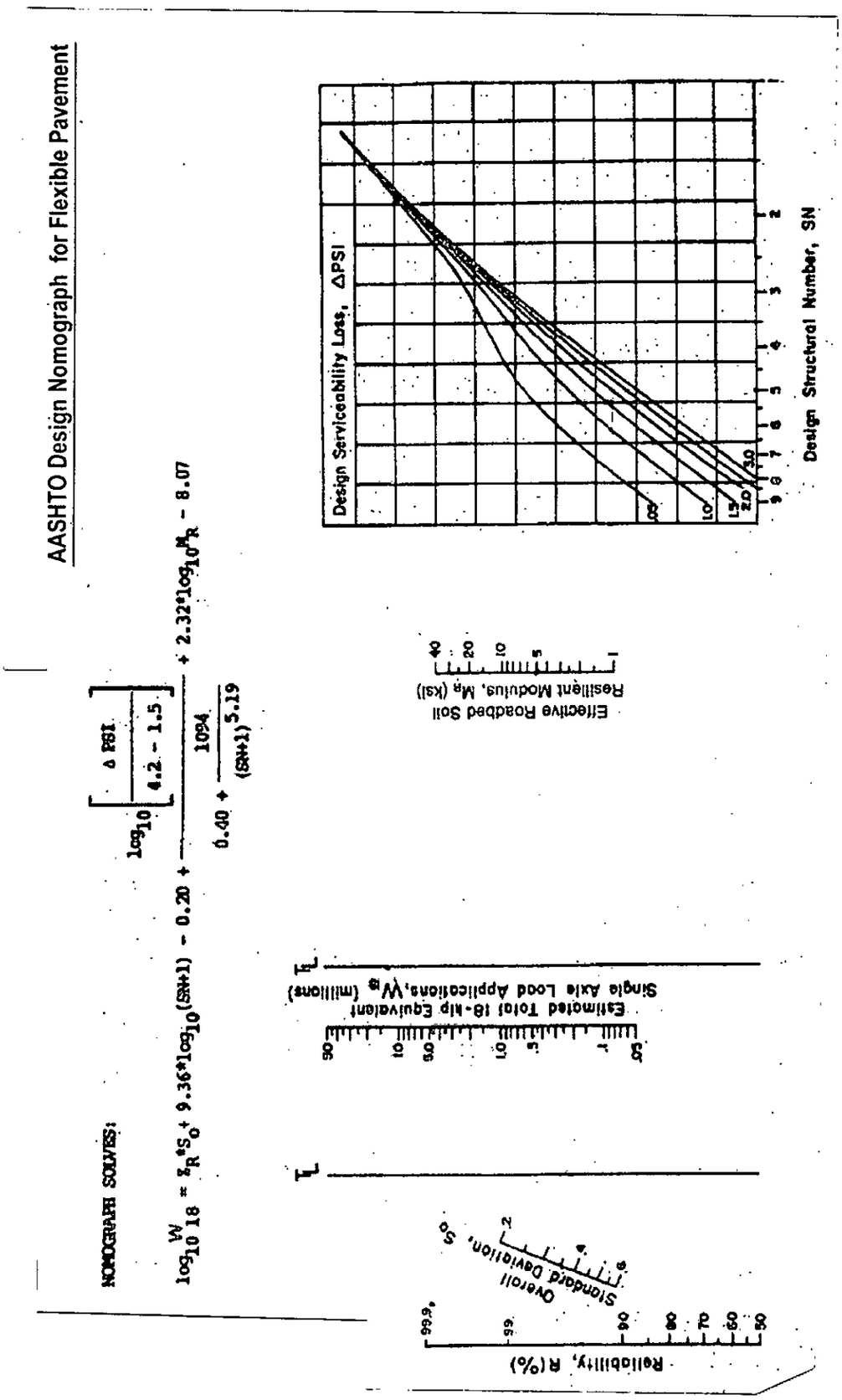
AASHTO Design Nomograph for Flexible Pavement
NOMOGRAPH SOLVES:
$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$
Reliability, R (%)
Overall Standard Deviation, So
Estimated Total 18-kip Equivalent Single Axle Load Applications, W_{18} (millions)
Effective Roadbed Soil Resilient Modulus, M_R (ksi)
Design Serviceability Loss, ΔPSI
Design Structural Number, SN

L-4/T-1/CE **Date : 29/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **WRE 451** (Hydrology, Irrigation and Flood Management)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Compare the relative advantages and disadvantages between Thiessen Polygon method and Isohyetal method in computing average rainfall. **(5)**

(b) The ordinate of 4-h unit hydrograph (UH) are given below. Compute the ordinates of 5-h UH. **(15)**

Time (hr)	0	4	8	12	16	20	24	28	32
Ordinates of 4-h UH (m^3/s)	0	8	21	16	11	7	4	2	0

(c) Calculate the precipitable water in a air column of 2 km above 10 m^2 of ground surface. Assume linear variation of air density and specific humidity in the column. The surface pressure is the standard air pressure and the surface air temperature is 25°C. The relative humidity values at surface and 2 km elevations are 70% and 90% respectively. Assume, $\alpha = 6.5$ °C/km. **(15)**

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

(b) The design precipitation intensity for a storm with a T-year return period with slope of 0.007 and maximum length of travel of water of 1500 m for the catchment is 2.5 in/hr. Estimate the deign return period (T). Also estimate the design precipitation volume (m^3) and design peak discharge (m^3/s) using Rational method for the catchment. The area of the catchment is 3 km^2 and runoff coefficient is 0.8. Use the IDF curves (Fig. 1) and Kirpich formula for your estimation. **(15)**

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

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

(b) The ordinates of a storm hydrograph of a river draining a catchment area of 165 km^2 due to a 4-h rainfall are given below. Derive the ordinates of a 4-h unit hydrograph. **(15)**

Time (hr)	0	4	8	12	16	20	24	28	32	36
Discharge (m^3/s)	20	100	400	600	300	200	90	50	40	40

(c) Four rain gages located with a pentagon with corners at (0, 0), (0, 13), (7, 20), (14, 13) and (14, 0) having the following coordinates and recorded rainfalls: **(15)**

Rain gage location	Rainfall (mm)
(2, 9)	20
(7, 11)	25
(12, 10)	30
(6, 2)	40

Contd P/2

WRE 451

Contd. ...Q. No. 3(c)

All the coordinates are expressed in kilometers. Compute the average rainfall in the area by Thiessen Polygon method. Use plain graph paper.

4. (a) Differentiate between urban and forest soils regarding infiltration capacity. **(5)**

(b) The ordinates of 6-h unit hydrograph (UH) for a catchment is given below.

Time from start (hr)	0	6	12	18	24	30	36	42	48	54
UH ordinates (m^3/s)	0	50	125	170	150	100	60	40	15	0

The average rainfall values over that catchment in three successive 6-hr intervals are known to be 6.8, 1.8, 2.8 cm. The φ-index for the catchment is estimated to be 0.3 cm/hr. The base flow is 5 m^3/s at the beginning of storm, and increases by 2 m^3/s every 12 hrs till the 24-hr point, and then decreases by 1 m^3/s every 12 hrs. Estimate the resulting flood hydrograph. **(15)**

(c) The shape of a drainage basin can be approximated by a polygon whose vertices are located at the following coordinates: (6, 6), (–6, 6), (–6, –6). (0, –12) and (6, –6). The rainfall values of a storm event were recorded by a number of gages as follows: **(15)**

Gage Number	Coordinates	Rainfall (mm)
1	(3, 4)	24
2	(–2, 5)	17
3	(–3, –3)	22
4	(2,–3)	35
5	(7, 0)	37

All the coordinates are expressed in kilometers. Determine the average rainfall on the basis of Isohyetal method (i. e., draw isohyets for 10, 20 and 30 mm). Use plain graph paper.

SECTION – B

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

5. (a) Briefly explain the concept of multipurpose project and write down the considerations for developing any water resource project as a multipurpose project. **(15)**

(b) What do you understand by duty and delta? Derive the relationship between duty and delta. **(8)**

(c) Compute the depth and frequency of irrigation required for a certain crop with data given below: **(12)**

Root zone depth = 100 cm

Field capacity = 22%

Wilting point = 12%

Apparent specific gravity of soil = 1.5 gm/cc

Consumptive use = 25 mm/day

Efficiency of irrigation = 50%

Assume 50% depletion of available moisture before application of irrigation water at field capacity.

6. (a) Write about the soil moisture depletion method to determine consumptive use of a field crop. **(6)**

(b) Describe the classes of available water in the soil. **(7)**

(c) Explain the physical properties of soil which influence irrigation. **(10)**

Contd P/3

WRE 451

Contd. ... Q. No. 4(c)

(d) A watercourse has a culturable command area of 1500 hectares. The infinity of irrigation for crop A is 45% and for B is 40%, both the crops being rabi crops. Crop A has kor period of 20 days and crop B has kor period of 15 days. Calculate the discharge of watercourse if the kor depth for crop A is 10 cm and for B is 16 cm. **(12)**

7. (a) Write short notes on **(4×4=16)**

   (i) Waterlogging

   (ii) Mixed cropping

   (iii) C2-S2 water

   (iv) Efflorescence

   (b) Discuss briefly the various techniques used for distributing water in the firm. **(12)**

   (c) Determine the change in salinity level of the soil due to evaporation of the groundwater over a period of 4 months, when the depth of groundwater evaporated is 11 cm and its EC value is 10 millimhos/cm. The depth of soil influenced by salt accumulation is 30 cm. The bulk density of soil is 1.4 gm/cc and saturation percent of soil is 63. **(7)**

8. (a) What is flood? Classify floods of Bangladesh. **(10)**

   (b) What are the approaches and measures for protection from flood? **(10)**

   (c) Prove that moisture content by volume is a product of moisture content by weight and apparent specific gravity. **(7)**

   (d) A Persian wheel discharges at the rate of 11000 litres per hour and works for eight hours each day. Estimate the area commanded by the water lift if the average depth of irrigation is 8 cm and irrigation interval is 15 days. **(8)**

WRE 451

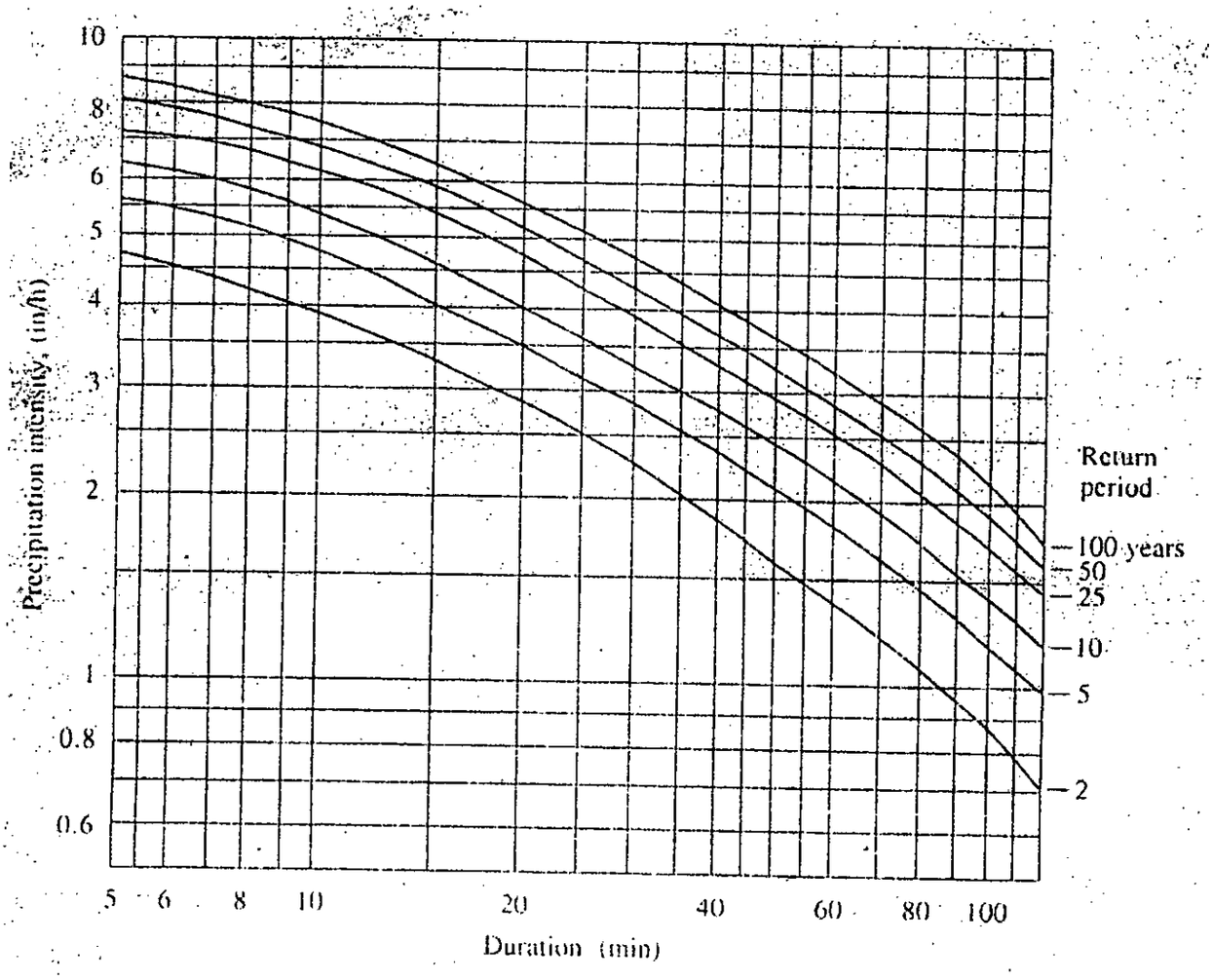

Fig. 1 : Intensity - Duration - Frequency (IDF) curves for Q. No. 2(b)