CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	TRANSPORTATION ENGINEERING
COURSE CODE	:	BFT 40303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) The transportation industry has faced several issues in the past and in current times. Discuss **THREE (3)** critical issues in transportation that should be considered for development of transportation systems in the future.

(12 marks)

(b) You are a transportation engineering consultant who has been hired by a city council to help improve the management of traffic at signalised intersections. The city council is interested in using Adaptive Signal Control (ASC) and has asked you to give a short talk about ASC. Write down the main contents of your talk.

(13 marks)

Q2 (a) A segment of a light rail transit main line track is built on two vertical curves, i.e. a crest curve followed by a sag curve. The distance between the Points of Vertical Intersection (PVIs) is 800 m. The grade of the approaching tangent of the crest curve is 3% and that of the departing tangent of the sag curve is 5%. Given the design speed of the track is 90 km/h, examine the desired length and absolute minimum length for both curves.

(10 marks)

(b) A mass rail transit line is being planned for a central business district that will serve an estimated peak-hour demand of 20,000 passengers per hour. Based on the information given below, propose the number of cars per train that will be required to provide adequate passenger volume capacity during peak periods.

Deceleration	:	0.5 m/s^2
Station platform limit	:	10 cars
Car length	:	30 m
Car capacity	:	150 passengers
Load factor	:	0.9
Guideway utilisation factor	:	0.7
Safety factor	:	1.3
Headway requirement	:	100 – 200 seconds
Speed requirement	:	40 – 45 km/h

(15 marks)

Q3 (a) Discuss the importance of taxiways in an airport runway system.

(5 marks)

(b) Describe **THREE (3)** methods an airplane can be maneuvered along a taxiway turn. Out of these three methods, suggest which method should be the least preferred and give your reasons.

(9 marks)

(c) An airplane is moving between two parallel taxiways through a connecting taxiway that has a centerline perpendicular to the parallel taxiways. The airplane has the following dimensions:

Wingspan	:	60 m
Wheelbase	:	24 m
Undercarriage width	:	7 m
Distance between undercarriage and cockpit	:	27 m

Recommend a suitable taxiway width and edge safety margin. Then, check to see if the maximum nose wheel steering angle is adequate or not.

(11 marks)

Q4 A fendering system will be installed at the ship docking area of a port. The port serves ships up to 50,000 deadweight tonnage (DWT). The ship navigation condition generally can be categorised as "easy berthing conditions and exposed". It is known that water density is 1.03 tonnes/m^3, gravitational acceleration is 9.81 m/s^2, coefficient of softening effect is 1.0 and coefficient of cushioning effect is 0.75.

(a) Determine the berthing velocity (in m/s) of the ship at the moment of impact with the fender.

(3 marks)

(b) Calculate the virtual mass coefficient and the eccentricity factor in typical seawater.

(11 marks)

(c) Evaluate the magnitude of energy that will be absorbed by the fender system and suggest a suitable type of fender for the ship docking area.

(11 marks)

- END OF QUESTIONS -

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Appendix A: Design Tables and Charts

I. Aircraft design groups

Group Number	Tail height (m)	Wingspan (m)
I	< 6.1	< 15.0
II	6.1 - < 9.2	15.0 - < 24.1
III	9.2 - < 13.8	24.1 - < 36.0
IV	13.8 - < 18.3	36.0 - < 52.2
V	18.3 - < 20.2	52.2 - < 65.3
VI	20.2 - < 24.4	65.3 - < 79.9

II. Taxiway dimensional standards (in meters)

Item	Airplane Design Group					
	I	**II**	**III**	**IV**	**V**	**VI**
Width	7.6	10.7	15.2	22.9	22.9	30.5
Edge safety margin	1.5	2.3	3.1	4.6	4.6	6.1
Shoulder width	3.1	3.1	6.1	7.6	10.7	12.2
Safety area width	14.9	24.1	36.0	52.1	65.2	79.9

III. Taxiway curvature dimensional standards (in meters)

Item	Airplane Design Group					
	I	**II**	**III[b]**	**IV**	**V**	**VI**
Radius of taxiway turn[a] (*R*)	22.9	22.9	30.5	45.7	45.7	51.8
Length of lead-in to fillet (*L*)	15.2	15.2	45.7	76.2	76.2	76.2
Fillet radius for tracking centerline (*F*)	18.3	16.8	16.8	25.9	25.9	25.9
Fillet radius for judgmental oversteering symmetrical widening (*F*)	19.1	17.5	20.7	32.0	32.0	33.5
Fillet radius for judgmental oversteering one side widening (*F*)	19.1	17.5	18.3	29.6	29.6	30.5

Notes:

a Dimensions for taxiway fillet designs relate to the radius of taxiway turns specified.

b Airplanes in airplane design group III with a wheelbase equal to or greater than 18.3 m should use a fillet radius of 15.2 m.

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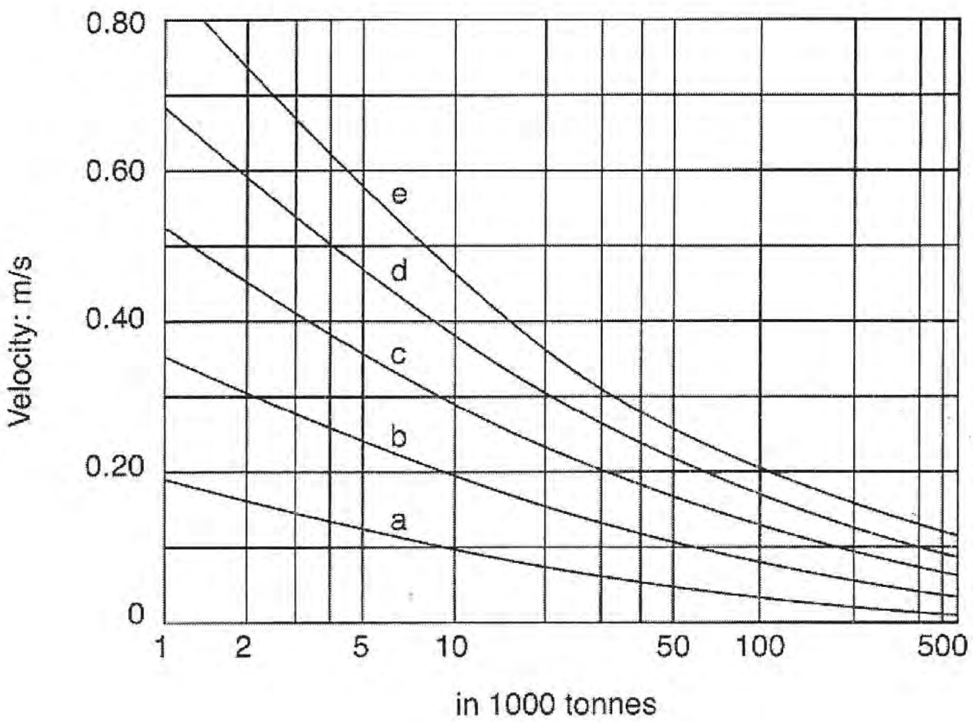
IV. Recommended grades for light rail main line track

Criteria	Grade
Maximum sustained grade (unlimited length)	4%
Maximum sustained grade (up to 750 m between PVIs)	6%
Maximum short sustained grade (up to 150 m between PVIs)	7%

V. Design berthing velocity due to ship displacement



a – Good berthing conditions, sheltered
b – Difficult berthing conditions, sheltered
c – Easy berthing conditions, exposed
d – Good berthing conditions, exposed
e – Navigation conditions difficult, exposed

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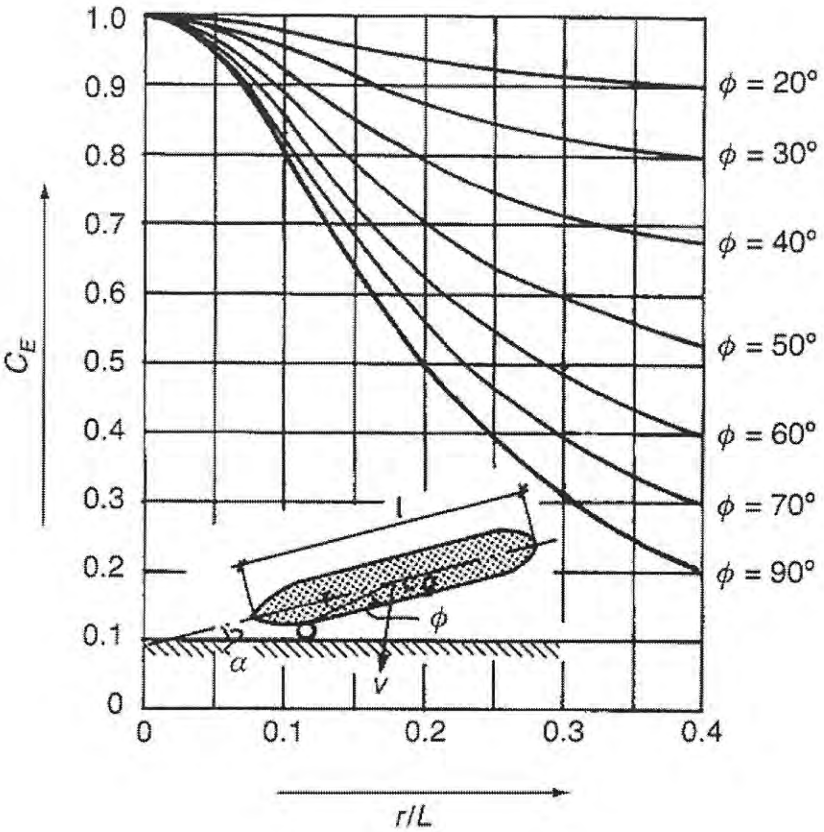
VI. Eccentricity factor as function of ϕ and r/L



VII. Vessel dimension and typical energy requirements

Tonnage (DWT)	Length, *L* (m)	Width, *B* (m)	Height, *H* (m)	Loaded draft, *D* (m)	Displacement Tonnage, *DT*	Berthing energy (Tonne-m)
10,000	175	25.6	15.8	9.8	14,030	15.77
20,000	200	27.3	16.8	10.4	27,940	25.95
30,000	290	32.0	19.8	10.3	41,740	38.29
40,000	279	32.5	22.8	11.0	55,430	47.36
50,000	290	32.4	24.2	11.3	69,000	56.58

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VIII. Fender types based on energy range

Energy range (Tonne-m)	**Fender type**	**Features**
≥ 50	Epshield V-Flex	A high efficiency fender which features rubber encapsulated steel mounting plates in its base. Rubber covered, slotted bolt holes are included.
20 to 50	Epshield V-Flex	*See above*
	Super Cylinders	Good performance characteristics are achieved. Fender can roll for even wear. It is available in a wide selection of sizes.
	Large Profile Fenders	Easily adaptable to specific mounting requirements.
10 to 20	Epshield V-Flex	*See above*
	Large Profile Fenders	*See above*
	Buckling Columns	Rubber encapsulated steel support plates. Good performance characteristics are achieved.
0 to 10	Profile Fenders	A large selection of shapes and sizes.

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Appendix B: Design Formulas

These formulas may be useful to you. The symbols have their usual meaning.

$$u = \frac{P}{S} \qquad \lambda = \sqrt[4]{\frac{k}{4EI}} \qquad Q = \frac{0.391PS}{X} \qquad P_d = P_s\left[1 + 0.01\left(\frac{V}{1.609} - 5\right)\right]$$

$$y(x) = \frac{P\lambda}{2k}\left[e^{-\lambda x}(\cos\lambda x + \sin\lambda x)\right] \qquad X = \frac{\pi}{4}\left(\frac{4EI}{u}\right)^{\frac{1}{4}} \qquad \theta(x) = \frac{P\lambda^2}{k}\left(e^{-\lambda x}\sin\lambda x\right)$$

$$M_m = \frac{P_d}{4\lambda} \qquad F = \left(R^2 + d^2 - 2Rd\sin A_{max}\right)^{0.5} - 0.5u - M \qquad A_{max} = \sin^{-1}\left(\frac{d}{R}\right)$$

$$B_{max} = \tan^{-1}\left[\left(\frac{w}{d}\right)\tan A_{max}\right] \qquad L = d * \ln\left[\frac{4d\tan\left(\frac{A_{max}}{2}\right)}{W - u - 2M}\right] - d \qquad h_m = \sqrt{\frac{2pLK}{d}}$$

$$v_o = \sqrt{\frac{2pLd}{K}} \qquad C_x = \frac{3600 \times \sigma \times \alpha \times p_x \times N}{h_x} \qquad C_H = 1 + \left(\frac{M_h}{M_d}\right)C_{HR}$$

$$E_{fender} = E_{ship} \times C_E \times C_M \times C_S \times C_C = \frac{1}{2}MV^2(C_E \times C_M \times C_S \times C_C) \qquad C_E = \frac{K^2}{a^2 + K^2}$$

$$a = 0.25L \qquad K = (0.19C_B + 0.11)L \qquad C_B = \frac{DT}{D \times B \times L \times W_o} \qquad M = \frac{DT}{g}$$

$$C_M = 1 + \frac{\pi}{4C_B} \times \frac{D}{B} \qquad M_h = \frac{1}{4}\pi \times \rho \times D^2 \times L \qquad E_f = C \times \left(0.5 \times M_d \times V^2\right)$$

$$LVC_{des} = 60A \qquad LVC_{min\,pref} = 30A \qquad LVC_{min\,abs(crest)} = \frac{Au^2}{212}$$

$$LVC_{min\,abs(sag)} = \frac{Au^2}{382} \qquad R = \frac{1718.89}{D_c} \qquad e_a = 0.79\left(\frac{u^2}{R}\right) - 1.68$$

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$$e_q = e_a + e_u = 1.184\left(\frac{u^2}{R}\right) \qquad e_q = e_a + e_u = 0.00068u^2 D_c$$

$$L_{min\,spiral} = 0.122 e_u u \quad \text{to satisfy unbalanced acceleration}$$

$$L_{min\,spiral} = 7.44 e_a \quad \text{to satisfy racking and torsional forces}$$

$$V_t = V_h \cos x \qquad V_g = V_t - V_w \sin x \qquad \sin x = \frac{V_c}{V_h}$$

$$T_{ij} = max\left[\left(\frac{r + s_{ij}}{v_j} - \frac{r}{v_i}\right), o_i\right] \quad when\ v_i > v_j$$

or

$$T_{ij} = max\left[\frac{s_{ij}}{v_j}, o_i\right] \quad when\ v_i \le v_j$$

when aircraft is at runway threshold

$$E[T_{ij}] = \sum_{i=1}^{K}\sum_{j=1}^{K} p_{ij} T_{ij}$$

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