UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	TRANSPORTATION ENGINEERING
COURSE CODE	:	BFT 40303
PROGRAMME	:	BFF
EXAMINATION DATE	:	JULY 2022
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSE BOOK**. 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Briefly explain **SIX (6)** main factors that may influence the capacity of an airport runway system.

(12 marks)

(b) An airport serves large and heavy aircraft. The characteristics of the aircraft population are shown in **Table Q1(a)**, while the longitudinal separation requirements are given in **Table Q1(b)**. Given that the length of final approach is 6 nautical miles (1 nautical mile = 1.852 km), calculate the maximum throughput capacity of the runway.

(18 marks)

Q2 The transportation industry has received much criticism due to several critical issues resulting from motorised transportation. Two of the major issues are listed below:

- Deaths and injuries sustained due to transport-related accidents.
- Poor air quality as a result of fossil fuel consumption.

From the perspective of a transport engineer, comment on these two issues. Also, suggest practical solutions to reduce the adverse impacts arising from these two issues.

(20 marks)

Q3 (a) A Mass Rapid Transit (MRT) system can accommodate up to 12,000 passengers per hour during peak periods. The following information is provided:

Station platform limit	= 6 cabins
Cabin length	= 30 m
Cabin capacity	= 100 passengers
Load factor	= 0.90
Safety factor	= 1.25
Guideway utilisation factor	= 0.85
Deceleration	= 0.8 m/s^2

Will 5 cabins be adequate for achieving headways between 120 – 150 seconds?

(7 marks)

(b) A segment of a proposed Light Rail Transit (LRT) track will consist of two vertical curves; a crest curve followed by a sag curve. The design speed is 100 km/h and the distance between the Points of Vertical Intersection (PVIs) of two vertical curves is 1.2 km. The grade of the approaching tangent of the crest curve is 5%, while the grade of the departing tangent of the sag curve is 4%. Compare the desired, preferred minimum and absolute minimum lengths of both the curves.

(13 marks)

Q4 (a) To ensure on-time arrivals and departures at a ferry terminal, the operations manager has set a criterion that service time per ferry at the berth must not exceed 12 minutes during peak hours. All ferries have a single door and can accommodate up to 50 passengers. The berth has a single channel gangway and a walkway that ends in a pair of free-swinging gates. Passengers purchase tickets on shore and upon entry to the ferry, the tickets are manually collected at the gangway. Additional information are as follows:

Capacity for gangway	= 40 passengers/minute/channel
Capacity for walkway exit gate	= 30 passengers/minute/channel
Capacity for ticket collection	= 20 passengers/minute/channel
Passenger walking speed	= 1.4 m/s
Walkway length	= 12 m
Clearance time	= 3 minutes
Operating margin	= 2 minutes

Will the criterion set by the operations manager be met?

(15 marks)

(b) Ships generally move normal to the berth line in open water at a speed of 0.4 m/s. The largest ship's displacement, length, width and depth are 8,000 tonnes, 140 m, 20 m and 9 m respectively. The following information has been provided:

Distance of point of contact from the centre of ship's mass	= 25 m
Safety factor	= 1.2
Softening factor	= 1.0
Water cushion factor	= 0.8
Specific gravity of sea water	= 1.0
Berthing angle	= 30°

It has been suggested that the current pneumatic fenders be upgraded to cord strip fenders to withstand forces up to 1,600 kN of the ship when it docks at the berth. Do you agree with this? Give your justification.

(15 marks)

- END OF QUESTIONS -

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Table Q1(a): Aircraft population characteristics

Aircraft type	Maximum takeoff weight (tons)	% of Total population	Velocity (knots)	Occupation time (sec)
Large	6.25 – 150	65	145	60
Heavy	> 150	35	170	85

Table Q1(b): Longitudinal separation requirements (in nautical miles)

Leading aircraft	Trailing aircraft	
	Large	Heavy
Large	3	3
Heavy	5	4

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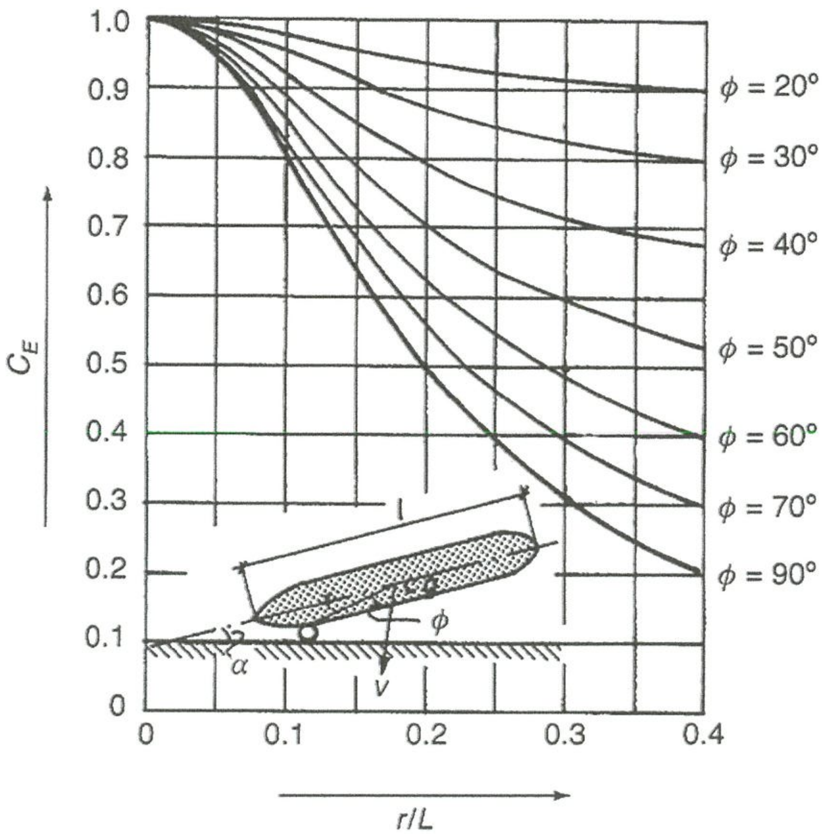
Appendix A: Design Tables and Charts

I: Fender factor for different types of rubber fender

No.	Rubber fender	Dimensions	Cross-section	Total impact reaction (kN)	Fender factor (P/E_f)
1	Pneumatic	Diameter = 2.0 m Length = 3.5 m	Circular	400	3.33
2	Cord strips	Diameter = 1.0 m	Circular	690	5.75
3	V-type	Height = 0.5 m Length = 2.0 m	Trapezoidal	750	6.25
4	Cylindrical	Diameter = 0.61 m	Circular	1200	10
5	Solid	Height = 0.15 m	Rectangular	6000	50



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

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III. 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%

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Appendix B: Formulas

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

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

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

$$E\left[T_{ij}\right] = \sum_{i=1}^{K}\sum_{j=1}^{K} p_{ij}T_{ij} \qquad C_d = min\begin{Bmatrix} C_g N_{cg} \\ C_x N_{ce} \end{Bmatrix} \qquad C_e = min\begin{Bmatrix} C_g N_{cg} \\ C_g N_f / t_f \\ C_x N_{ce} \end{Bmatrix}$$

$$t_{ed} = 60\left(\frac{P_d}{C_d} + \frac{L_w}{v_d} + \frac{P_e}{C_e} + \frac{L_w}{v_e}\right) \qquad t_v = t_{ed} + t_c + t_{om} \qquad V_b = \frac{3600}{t_v}$$

$$E_f = C \times \left(0.5 \times M_d \times V^2\right) \qquad M_h = \frac{1}{4}\pi \times \rho \times D^2 \times L \qquad C = C_H \times C_E \times C_C \times C_S$$

$$F_f = \frac{P}{E_f} \qquad C_H = 1 + \left(\frac{M_h}{M_d}\right)C_{HR}$$

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

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

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$$e_q = e_a + e_u \qquad e_q = 0.00068u^2 D_c$$

$$L_{minspiral} = 0.122 e_u u$$ to satisfy unbalanced acceleration

$$L_{minspiral} = 7.44 e_a$$ to satisfy racking and torsional forces