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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	TRANSPORTATION ENGINEERING
COURSE CODE	:	BFT 40303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER ALL QUESTIONS. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED 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 **NINE (9)** PAGES

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Q1 (a) In Malaysia's efforts to modernize the transport system in line with the IoT concept, you as a Transport Engineer, have been tasked to provide a brief proposal on "Transit Signal Priority" as part of efforts to improve the management and efficiency of public transportation using Intelligent Transportation Systems (ITS) to be submitted to Ministry of Transport. Write a brief outline of your proposal, which shall include the function, process and benefits of Transit Signal Priority.

(10 marks)

(b) Ramp Metering is an intelligent traffic system that is commonly applied in arterial and freeway management.

(i) Describe the main components of a Ramp Metering system with the help of diagram.

(4 marks)

(ii) State **THREE (3)** benefits of Ramp Metering.

(3 marks)

(ii) Explain how Ramp Metering works.

(8 marks)

Q2 (a) An existing freight and passenger railway track has superelevation on a curve with a radius of 1,200 m. The track will be upgraded to accommodate a new design speed of 120 km/h.

(i) Check if the existing superelevation is adequate.

(7 marks)

(ii) Determine the minimum length of spiral curve required to connect a tangent to a horizontal curve on this upgraded track.

(5 marks)

(b) The Points of Vertical Intersection (PVI) of two vertical curves, a crest curve followed by a sag curve, on a light rail transit main line track are located 0.75 km from each other. The grade of the approaching tangent of the crest curve is 4% and the grade of the departing tangent of the sag curve is 5%. Given that the design speed of the track is 90 km/h, determine the desired, preferred minimum and absolute minimum lengths for each of these two curves.

(13 marks)

Q3 (a) An airport will be constructed 1,219 m above sea level, where the normal maximum temperature is 32.2°C. The airport will serve 100% fleet and 90% useful load of a family of airplanes having a maximum certificated load of 272,000 N. The difference in centerline elevation between the high and low points of the runway is 5.0 m.

(i) Determine the unadjusted minimum primary runway length.

(2 marks)

(ii) Calculate the minimum primary runway length, considering wet and slippery conditions during aircraft landing, and difference in centerline elevation during aircraft take-off.

(6 marks)

(ii) Estimate the minimum required length for the crosswind runway.

(2 marks)

(b) An airport runway currently serves large and heavy aircraft with characteristics shown in **Table 1**. The longitudinal separation requirements are provided in **Table 2**. Given the length of final approach is 5 nautical miles, determine:

(i) the minimum separation times (T_{ij}) for leading aircraft, i and trailing aircraft, j.

(8 marks)

(ii) the probabilities of two aircraft types leading and trailing each other (p_{ij}).

(4 marks)

(iii) the maximum throughput capacity for the runway.

(3 marks)

Q4 (a) Fenders are used to absorb the kinetic energy of a ferry berthing against a jetty or quay wall. These are used to prevent damage to ferries and berthing structures. State **FIVE (5)** factors that influence the choice of fender.

(5 marks)

(b) When estimating the kinetic energy of a berthing ferry, the mass of the design ferry and its hydrodynamic mass must be considered. Explain the meaning of "hydrodynamic mass".

(3 marks)

(c) The approach velocity is the most influential variable in calculating the kinetic energy of a berthing ferry. Define "approach velocity" and explain how it can be estimated.

(4 marks)

(d) A fendering system is to be designed at the ship berth. The design ship's displacement (M_d), length (L), width (B) and depth (D) are 9,000 tonnes, 120 m, 18 m and 7.5 m respectively. The ship moves normal to the berth line in open water. The following have been assumed:

Berthing angle (ϕ)	:	40°
Distance of point of contact from the centre of mass (r)	:	30 m
Water cushion factor (C_C)	:	0.9
Softening factor (C_S)	:	1.0
Specific gravity of sea water (ρ)	:	1.0
Safety factor	:	1.2
Berthing conditions	:	Easy, Exposed

(i) Determine the ship's berthing velocity (V) and assume the hydrodynamic mass factor (C_H).

(5 marks)

(ii) Determine the berthing coefficient (C).

(2 marks)

(iii) Calculate the energy that can be absorbed by the fender (E_f).

(2 marks)

(iv) Suggest the type of rubber fender that will be able to withstand a 2,000 kN horizontal force.

(4 marks)

- END OF QUESTIONS -

Table 1: Aircraft population characteristics

Aircraft type	Maximum takeoff weight (tons)	% of Total population	Velocity (knots)	Occupation time (sec)
Large	6.25 – 150	55	125	60
Heavy	> 150	45	160	80

Table 2: Longitudinal separation requirements (in nautical miles)

Leading aircraft, *i*	Trailing aircraft, *j*	
	Large	**Heavy**
Large	3	3
Heavy	5	4

Note: 1 nautical mile = 1.852 km

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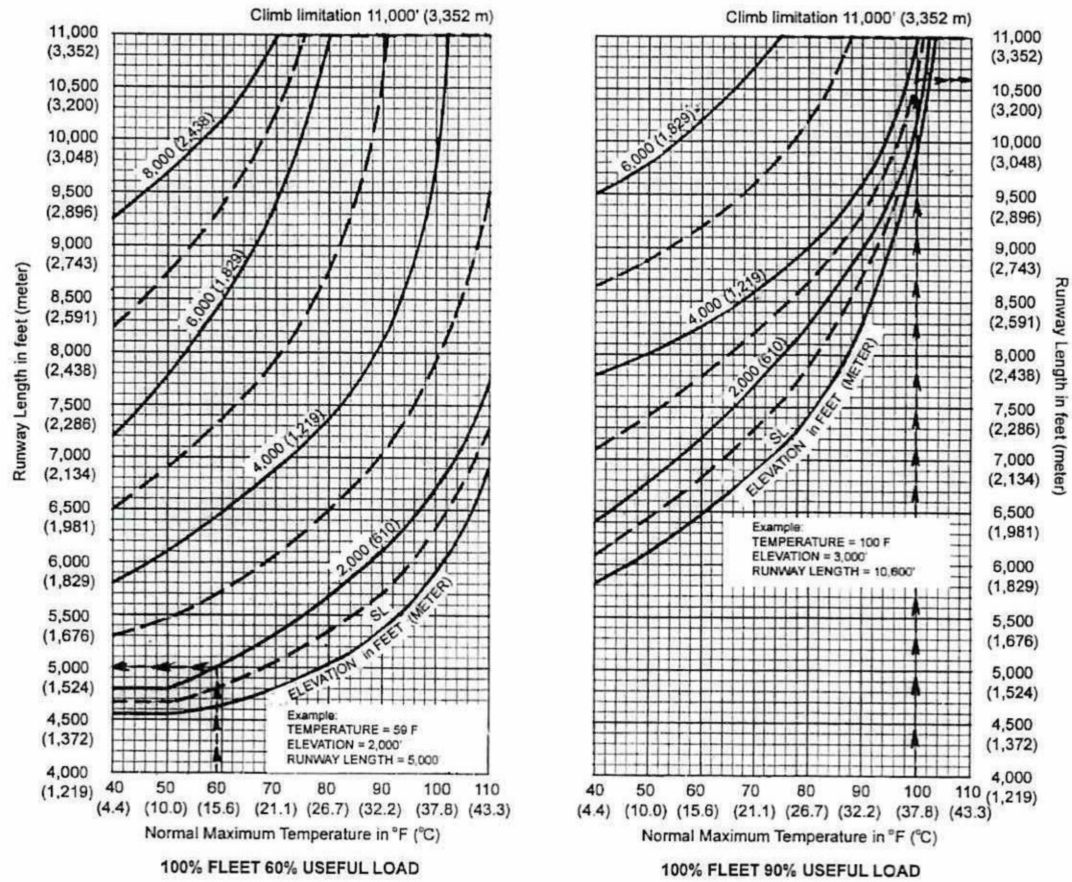
Appendix A: Design Charts

I. Runway length to serve 100% of large planes of 272,000 N or less



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II. Maximum grades for light rail main line railway tracks

Length between points of vertical intersection	**Maximum sustained grade (%)**
more than 750 m	4
up to 750 m	6
up to 150 m	7

III. 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

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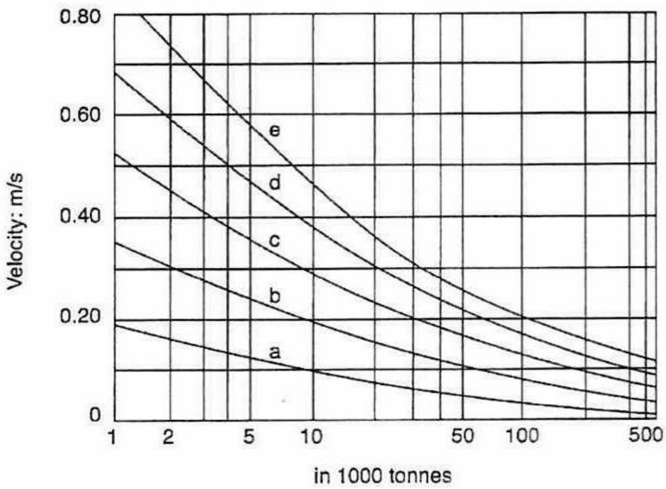
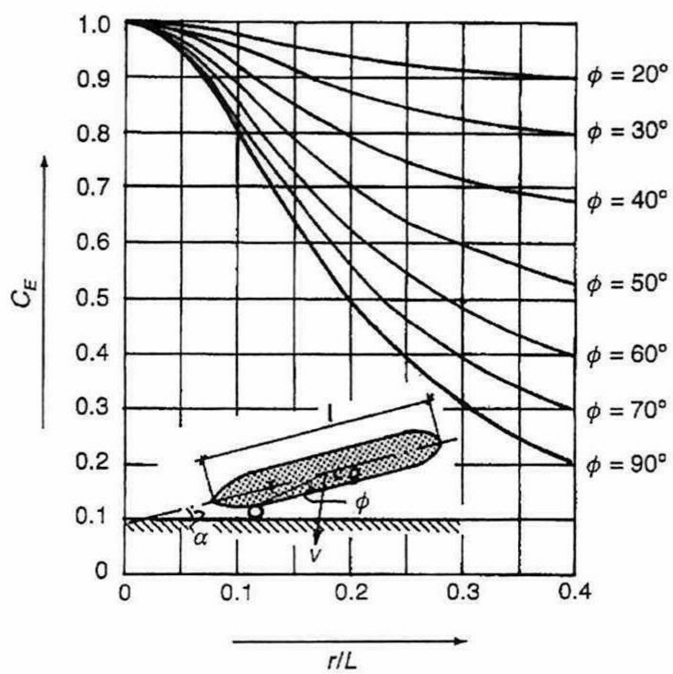
IV. Design berthing velocity due to ship displacement



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

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



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Appendix B: Design Formulas

The following information may be useful. The symbols have their usual meaning.

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

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

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

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

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

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

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

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

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

$$C = C_H \times C_E \times C_C \times C_S \qquad F_f = \frac{P}{E_f}$$