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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	TRANSPORTATION ENGINEERING
COURSE CODE	:	BFT 40303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ 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 **TEN (10)** PAGES

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Q1 Answer the following questions.

(a) City A has experienced traffic congestion for many years due to the large number of private vehicles. This problem is expected to worsen if there is no proactive action from the local government to curb it. The local government has finally agreed to upgrade public transportation in the city. As a transportation engineer, you are expected to outline **FIVE (5)** main steps to ensure the success of this program.

(10 marks)

(b) Recently, Intelligent Transportation System has been an expanding discipline.

(i) Explain the term " Intelligent Transportation System".

(3 marks)

(ii) Road A is an arterial road in Kuala Lumpur. It often has the following problems:

I. Frequent occurrences such as accidents, construction, and lane closures. However, it can be difficult to inform motorists about this incident prior to their arrival at the scene.
II. Intersections that become congested due to fixed signalized timing. So, it is not suitable at certain times of operation of the road.
III. The road authorities were not provided with information regarding the road's condition until a relatively late moment. As a result, the control action is administered significantly later.
IV. An on-ramp vehicle entering this arterial road causes disruption in traffic flow and presents potential hazard for accidents.

Provide a method to control each of the above problems by using the Intelligent Transportation System method. Describe the way it works.

(12 marks)

Q2 Rail transportation tracks must be designed with the safety and comfort of passengers in consideration.

(a) **Figure Q2.1** shows the cross section of a rail and the direction of the forces acting on it. State the source of the vertical force, horizontal force and longitudinal force.

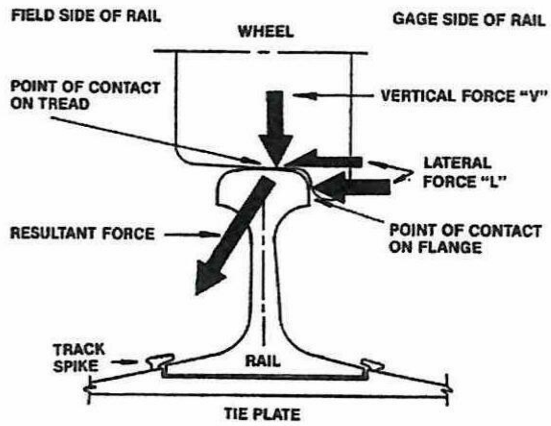


Figure Q2.1 Cross section of a rail and the direction of the forces acting on it.

(3 marks)

(b) The engineer utilized 800 m length to designate a vertical curve connecting a 1% ascent and a -1.5% descent on a main line railroad track for freight and passenger cars train.

(i) Ascertain whether this curve meets the minimum length criterion in the case where trains are anticipated to travel at a speed of 90 km/h, given that $K = 0.077$ and $a = 0.03$ m/s^2 for freight train and 0.18 m/s^2 for passenger car.

(6 marks)

(ii) Due to several causes, the speed of both types of trains must be raised. Comment on what will happen to the curve's minimum length.

(2 marks)

(c) **Table Q2.1** and **Table Q2.2** provide information regarding the rail at location B.

Table Q2.1 Classification of railway and type of rails

Class	Maximum speed, Vmax (km/hr)	Design speed (km/hr)	Load Capacity (million tons/year)	Dynamic wheel load (kg)
I	120	150	> 20	19,940
II	110	140	10 – 20	16,241
III	100	125	5 – 10	15,542
IV	90	115	2.5 – 5	14,843
V	80	100	< 2.5	14,144

Table Q2.2 Classification of railway and type of rails

Class	**Type of Rail**	**Dynamic Rail Stress (kg/cm^2)**	**Allowable stress (kg/cm^2)**
I	R60 / R54	1,043.3 / 1,176.8	1,325
II	R54 / R50	1,128.2 / 1,2318	1,325
III	R54 / R50 / R42	1,097.7 / 1,178.8 / 1,476.3	1,663
IV	R54 / R50 / R42	1,031 / 1,125.8 / 1,410	1,843
V	R42	1,343.5	2,000

(i) Calculate the dynamic load of the rail for a Class I railway. Given that the axle load is 20 tons.

(6 marks)

(ii) Calculate the maximum moment if the rail used is R54 with an elastic modulus of 2 x 10^6 kg/cm^2 and moment of inertia of 2,346 cm^4. The foundation modulus of elasticity is 180 kg/cm^2.

(4 marks)

(iii) Obtain the deflection at 5 m from the loading point.

(4 marks)

Q3 Answer the following questions.

(a) An airport will be built at 610 m above sea level in a location with average maximum temperatures of 26.7°C. The airport will serve the whole fleet and 90% of the useful load of a family of airplanes with a maximum certified load of 272,000 N. There is a 10 m drop in centreline elevation between the runway's highest and lowest point.

(i) Compute the minimum unadjusted length of the major runway.

(2 marks)

(ii) Estimate the minimum length of the primary runway by considering wet and slick conditions during landing, as well as the variation in centreline elevation during take-off.

(6 marks)

(iii) Calculate of the minimum length required for the crosswind runway.

(2 marks)

(b) **Table Q3.1** shows that airport runways are primarily used for large and heavy aircraft. The longitudinal separation criteria are shown in **Table Q3.2**. It should be noted that the final approach is 8 nautical miles.

Table Q3.1 Aircraft population characteristics

Aircraft type	Maximum take-off weight (tons)	% of Total population	Velocity (knots)	Occupation time (sec)
Large	6.25-150	80	130	50
Heavy	>150	20	140	90

Table Q3.2 Longitudinal separation requirements (in nautical miles)

Leading aircraft, *i*	Trailing aircraft, *j*	
	Large	Heavy
Large	4	4
Heavy	6	5

Note: 1 nautical mile = 1.852 km

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

(8 marks)

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

(4 marks)

(iii) Compute the maximum throughput capacity for the runway.

(3 marks)

Q4 The fendering system is an important part of port operations. It must consider both the components in seawater and the ship itself.

(a) A port is experiencing erosion issues due to the propellers and water jets emitted by ships. Propose a resolution to this issue and explain its functioning mechanisms.

(3 marks)

(b) Explain the concepts behind these parameters:

i. Eccentricity Effect, C_E
ii. Water Cushion Effect, C_C
iii. Softening Effect, C_S
iv. Approach Velocity, v

(8 marks)

(c) A ship's design characteristics include a displacement (M_d) of 5,000 tonnes, length (L) of 200 meters, width (B) of 18 meters, and depth (D) of 12 meters. When crossing open waters, the ship maintains a perpendicular attitude to the berth's line. The following assumptions were made:

Berthing angle (ϕ)	:	50°
Distance of point of contact from the centre of mass (r)	:	20 m
Water cushion factor (C_C)	:	0.8
Softening factor (C_S)	:	1.0
Specific gravity of sea water (ρ)	:	1.0
Safety factor	:	1.5
Berthing conditions	:	Good berthing conditions, exposed

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

(5 marks)

(ii) Examine the berthing coefficient (C).

(3 marks)

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

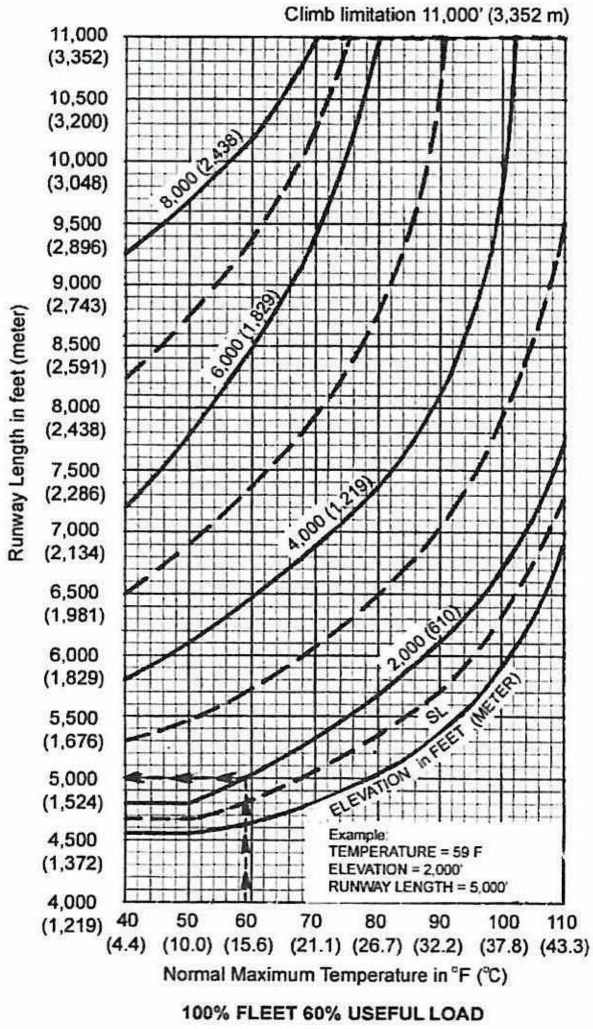
(2 marks)

(iv) Suggest the type of rubber fender that will be able to withstand a 5,000 kN horizontal force.

(4 marks)

- END OF QUESTIONS -

APPENDIX A Design Tables and Charts



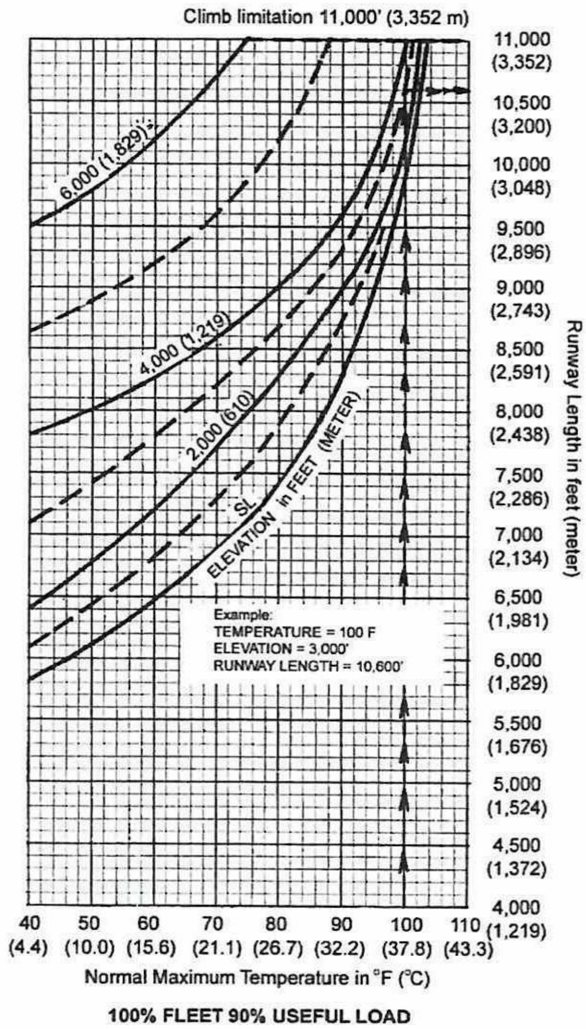


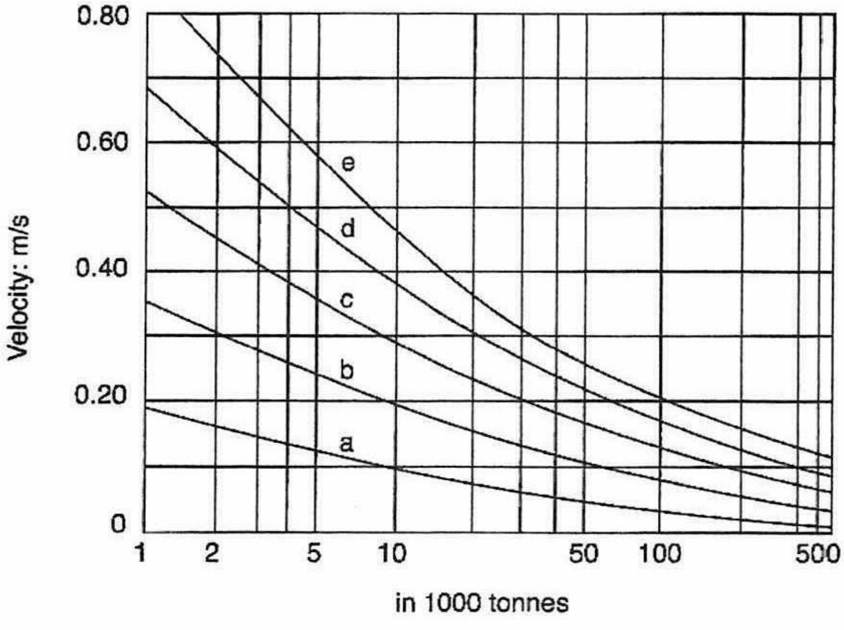
Figure APPENDIX A.1 Runway length to serve 100% of large planes of 272,000 N or less

Table APPENDIX A.1 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

Table APPENDIX A.2 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



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

Figure APPENDIX A.2 Design berthing velocity due to ship displacement

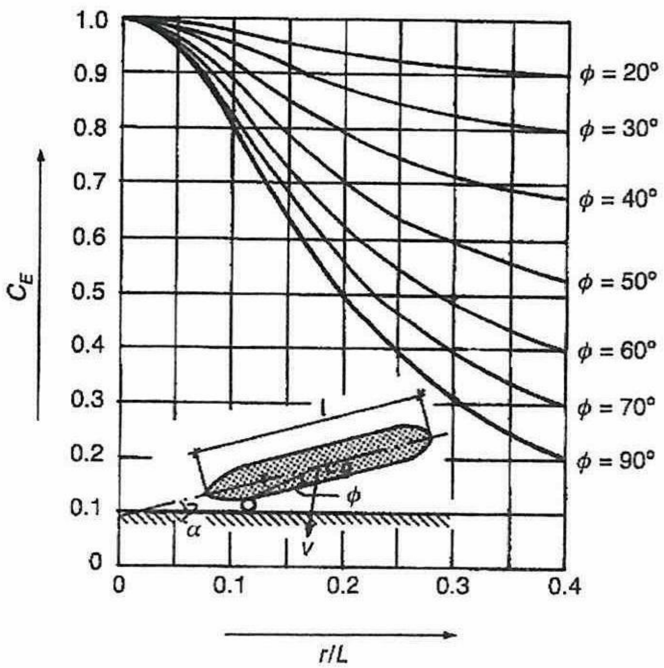


Figure APPENDIX A.3 Eccentricity factor as function of ϕ and r/L

APPENDIX B Formulas

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

$$L_{min} = \frac{0.077Au^2}{100a}$$

$$P_d = P_s \times I_p$$

$$I_p = 1 + 0.01\left(\frac{v}{1.609} - 5\right)$$

$$\lambda = \left(\frac{k}{4EI}\right)^{\frac{1}{4}}$$

$$y(x) = \frac{P\lambda}{2k}e^{-\lambda x}(\cos\lambda x + \sin\lambda x)$$

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

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

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

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

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