UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	TRANSPORTATION ENGINEERING
COURSE CODE	:	BFT 40303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	DECEMBER 2018/JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) Ramp Metering is an intelligent traffic system that is becoming widely applied in arterial and freeway management. Explain how Ramp Metering works and state **THREE (3)** benefits of Ramp Metering.

(11 marks)

(b) Through Advanced Public Transportation Systems (APTS), the efficiency and safety of transit services can be improved. Two examples of APTS are Traveler Information System (TIS) and Automatic Vehicle Location (AVL).

(i) Describe **THREE (3)** categories of information that are usually disseminated through a Traveler Information System (TIS).

(6 marks)

(ii) Briefly explain **FOUR (4)** location technologies applied in Automatic Vehicle Location (AVL).

(8 marks)

Q2 (a) A city transport agency is planning a Mass Rapid Transit (MRT) line that can serve 18,000 passengers per hour during peak periods. The required speed is 50 km/h to 55 km/h and required headway is 140 sec to 180 sec. Given the following information, determine the number of cars an MRT train should have to provide adequate passenger volume capacity.

Station platform limit	=	10 cars
Deceleration (d)	=	0.6 m/s^2
Car capacity (N)	=	120 passengers
Car length (L)	=	28 m
Safety factor (K)	=	1.2
Guideway utilisation factor (α)	=	0.8
Load factor (σ)	=	0.9

(12 marks)

(b) A Class I railway track that will carry trains with a design speed (V) of 175 km/h is being designed. The axle load is 18,000 kg with a stiffness modulus (k) of 170 kg/cm^3. The rail type used is R60 with an elasticity modulus (E) of 1.5×10^6 kg/cm^2 and a moment of inertia (I) of 2,300 cm^4. Calculate the

(i) Dynamic load (P_d) and maximum moment (M_m).

(6 marks)

(ii) Deflection (y) and slope (θ) at 3.0 m from the center load.

(4 marks)

(iii) Rail seat load (Q), given a tie spacing (S) of 50 cm.

(3 marks)

Q3 (a) A new airport will be constructed 1,220 m above sea level, where the normal maximum temperature is 32.2°C. The airport will serve 100% fleet and 60% useful load of a family of airplanes having a maximum certificated load of 272,000 N. Taking into consideration conditions for take-off and landing, propose the minimum length of the primary runway and the crosswind runway if the difference in centerline elevation between the high and low points of the runway is 9.5 m.

(10 marks)

(b) The runway of an airport serves arrivals of 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 fendering system will be constructed at a ship docking area in a port. The port serves large ships, the maximum being container ships with 20,000 deadweight tonnage (DWT) and characteristics shown in **Table 3**. The water density (W_o) is 1.03 tonnes/m^3 and the ship navigation condition is classified as "good berthing conditions and exposed".

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

(3 marks)

(b) Calculate the eccentricity factor (C_E) in typical seawater with a = 0.25L, where a = distance between the ship's centre of gravity and the point of contact on the ship's side, and L = length of ship.

(8 marks)

(c) Calculate the virtual mass coefficient (C_M).

(3 marks)

(d) Determine the energy to be absorbed by the fender system (E_{fender}) with softening effect (C_S) = 1.0 and cushioning effect (C_C) = 0.9.

(8 marks)

(e) Recommend a suitable type of fender for the ship docking area.

(3 marks)

- END OF QUESTIONS -

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TABLE 1: Aircraft population characteristics

Aircraft type	Maximum takeoff weight (tons)	Occupation time, *o* (sec)	Velocity, *v* (knots)	% of Total population
Large	6.25 – 150	60	125	60
Heavy	> 150	75	150	40

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

TABLE 3: 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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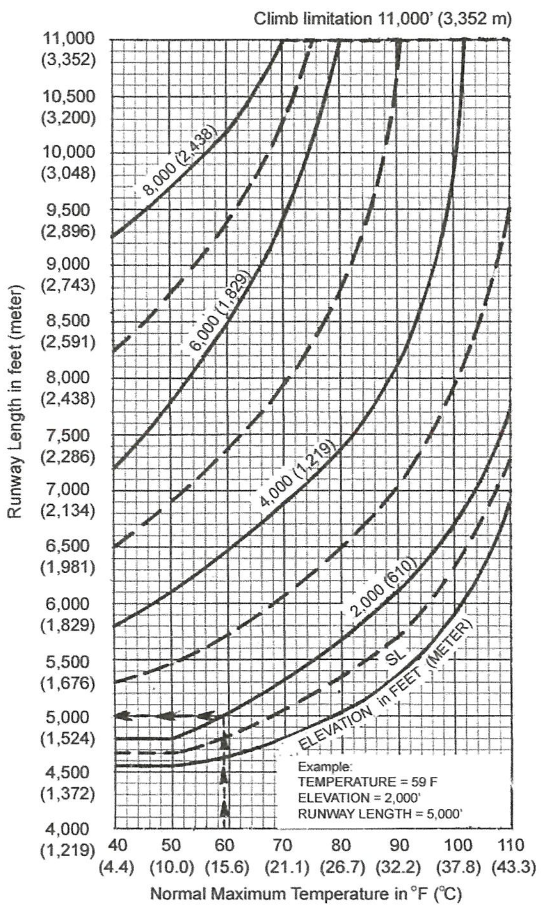
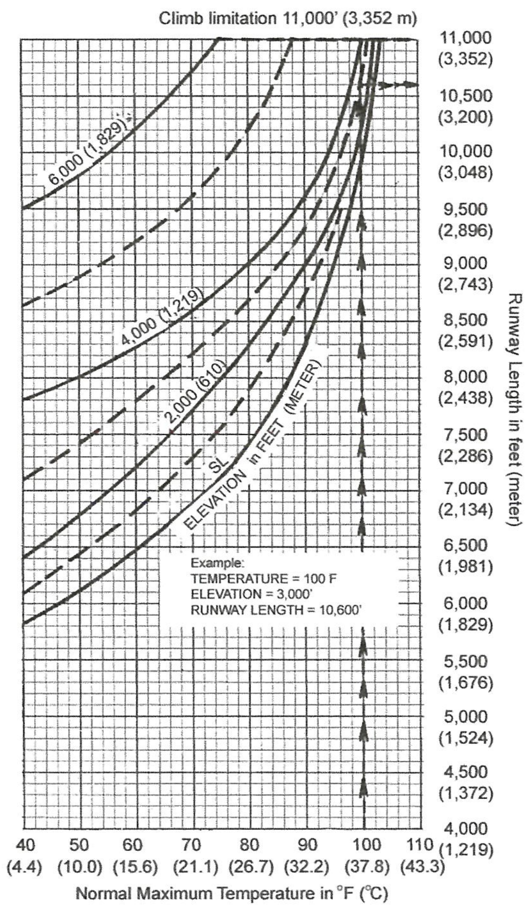
APPENDIX A: Runway length to serve 100% of large planes of 272,000 N or less



100% FLEET 60% USEFUL LOAD



100% FLEET 90% USEFUL LOAD

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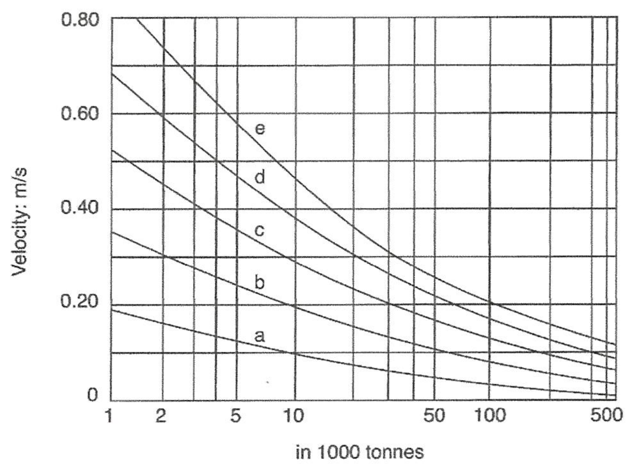
APPENDIX B: Design berthing velocity due to ship displacement



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

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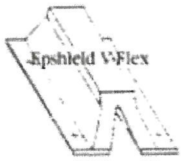
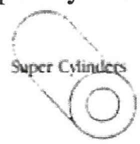
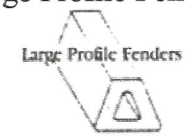
APPENDIX C: Fender types based on energy range

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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FORMULAE

$$P_d = P_s\left[1 + 0.01\left(\frac{V}{1.609} - 5\right)\right] \qquad Q = \frac{0.391PS}{X} \qquad \theta(x) = \frac{P\lambda^2}{k}\left(e^{-\lambda x}\sin\lambda x\right)$$

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

$$u = \frac{P}{S} \qquad v_o = \sqrt{\frac{2pLd}{K}} \qquad h_m = \sqrt{\frac{2pLK}{d}} \qquad C_x = \frac{3600 \times \sigma \times \alpha \times p_x \times N}{h_x}$$

$$R = \frac{1718.89}{D_c} \qquad e_q = e_a + e_u = 0.00068u^2 D_c$$

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

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

$$C_d = min\begin{Bmatrix} C_g N_{cg} \\ C_x N_{ce} \end{Bmatrix} \qquad C_e = min\begin{Bmatrix} C_g N_{cg} \\ C_g N_f / t_f \\ C_x N_{ce} \end{Bmatrix} \qquad t_{ed} = 60\left(\frac{P_d}{C_d} + \frac{L_w}{v_d} + \frac{P_e}{C_e} + \frac{L_w}{v_e}\right)$$

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

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

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

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FORMULAE (continued)

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

$$e_q = 1.184\left(\frac{u^2}{R}\right) \qquad F = \left(R^2 + d^2 - 2Rd\,sin\,A_{max}\right)^{0.5} - 0.5u - M$$

$$L_{min-spiral(absolute)} = 0.081 e_u u \qquad L_{min-spiral(desired)} = 3.72\left(e_{a2} - e_{a1}\right)$$

$$L_{min-spiral(desired)} = 0.061\left(e_{u2} - e_{u1}\right)u \qquad L_{min-spiral(desired)} = 0.082\left(e_{a2} - e_{a1}\right)u$$

$$E_{fender} = E_{ship} \times C_E \times C_M \times C_S \times C_C = \frac{1}{2} MV^2 \left(C_E \times C_M \times C_S \times C_C\right)$$

$$C_E = \frac{K^2}{a^2 + K^2} \qquad K = \left(0.19 C_B + 0.11\right)L \qquad C_B = \frac{DT}{D \times B \times L \times W_o}$$

$$C_M = 1 + \frac{\pi}{4C_B} \times \frac{D}{B} \qquad M = \frac{DT}{g}$$

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