UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	TRANSPORTATION ENGINEERING
COURSE CODE	:	BFT 40303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 An important component of Intelligent Transportation Systems (ITS) technology is system detectors, which provides an updated technology for traffic surveillance and monitoring.

(a) Describe the technology used for traffic surveillance and monitoring. With the help of diagrams, give **TWO (2)** examples of detector surveillance technologies.

(5 marks)

(b) One example of vehicle detection method is Inductive Loop Detector (ILD). The method is used to measure vehicle occupancy, which can be used to determine traffic density, and the mechanism is illustrated in **Figure Q1**. Hence, the following equation is derived:

$$D = \frac{1000 \times O_{CC}}{L_V + L_{eff}}$$

where D = traffic density (veh/km/lane), O_{CC} = occupancy measurement (percent time occupied), L_V = average vehicle length (m) and L_{eff} = effective detector length (m).

A freeway detection station in one direction of a six-lane freeway (3 lanes per direction) provides the occupancy measurements and average vehicle lengths shown in **Table 1**. The effective length of each loop detector is 2.4 m.

(i) Determine the traffic density for each lane.

(10 marks)

(ii) Calculate the traffic density for the freeway. Briefly explain the benefit of using detectors to measure traffic conditions.

(10 marks)

Q2 (a) State **FIVE (5)** ways to increase line capacity of a rail transit service.

(5 marks)

(b) 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 100 sec to 150 sec. Given the following information, determine the number of cars an MRT train should have to provide adequate passenger volume capacity.

Station platform limit	=	8 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

(10 marks)

(c) A Light Rail Transit (LRT) track with a design speed of 80 km/h will have a spiral curve that connects two curves of a compound curve. The first curve will have a radius of 750 m and actual superelevation of 4.1 cm, while the second curve will have a radius of 650 m and an actual superelevation of 4.5 cm. Determine the length that should be used in constructing the spiral curve.

(10 marks)

Q3 (a) State **FIVE (5)** factors that generally influence the selection of airport runway length.

(5 marks)

(b) A new airport is to 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. Determine the minimum length of the primary and crosswind runways if the difference in centerline elevation between the high and low points of the runway is 7.6 m.

(10 marks)

(c) An aircraft (design group II) with the following dimensions is moving between two parallel taxiways through a connecting taxiway that has a centerline perpendicular to the parallel taxiways.

Distance between undercarriage and cockpit (*d*)	=	15 m
Wheelbase (*w*)	=	12 m
Undercarriage width (*u*)	=	3 m

(i) Recommend appropriate values to be used for the taxiway width (*W*), edge safety margin (*M*) and centerline radius (*R*).

(3 marks)

(ii) Calculate the required lead-in (*L*) and radius of the fillet (*F*) to maintain the aircraft cockpit over the centerline.

(7 marks)

Q4 A port authority plans to construct a fendering system at the ship docking area. The port serves large ships, the maximum being container ships with 40,000 deadweight tonnage (DWT) and characteristics shown in **Table 4**. It is known that the water density is 1.03 tonnes/m^3. The ship navigation condition is classified as "difficult 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 with softening effect (C_S) = 1.0 and cushioning effect (C_C) = 0.8.

(8 marks)

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

(3 marks)

- END OF QUESTIONS -

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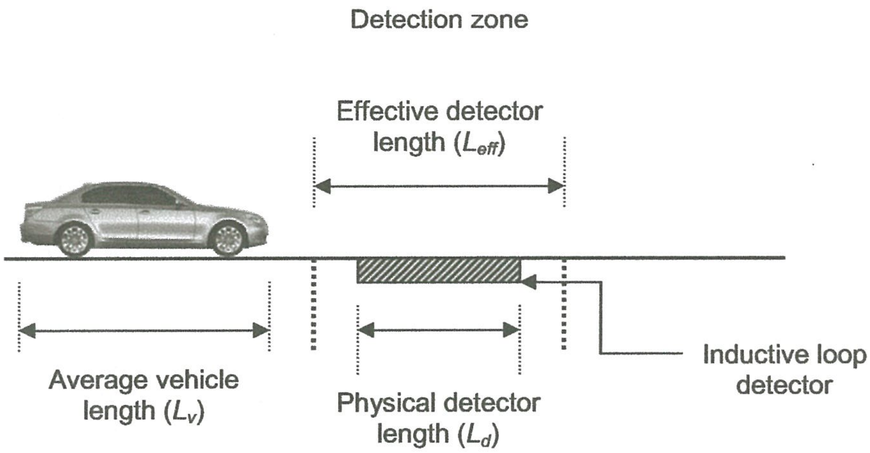

FIGURE Q1: Inductive loop detector

TABLE 1: Data recorded at freeway detection station

Lane number	Occupancy (%)	Average vehicle length (meter)
1	22	6.0
2	15	5.5
3	12	4.8

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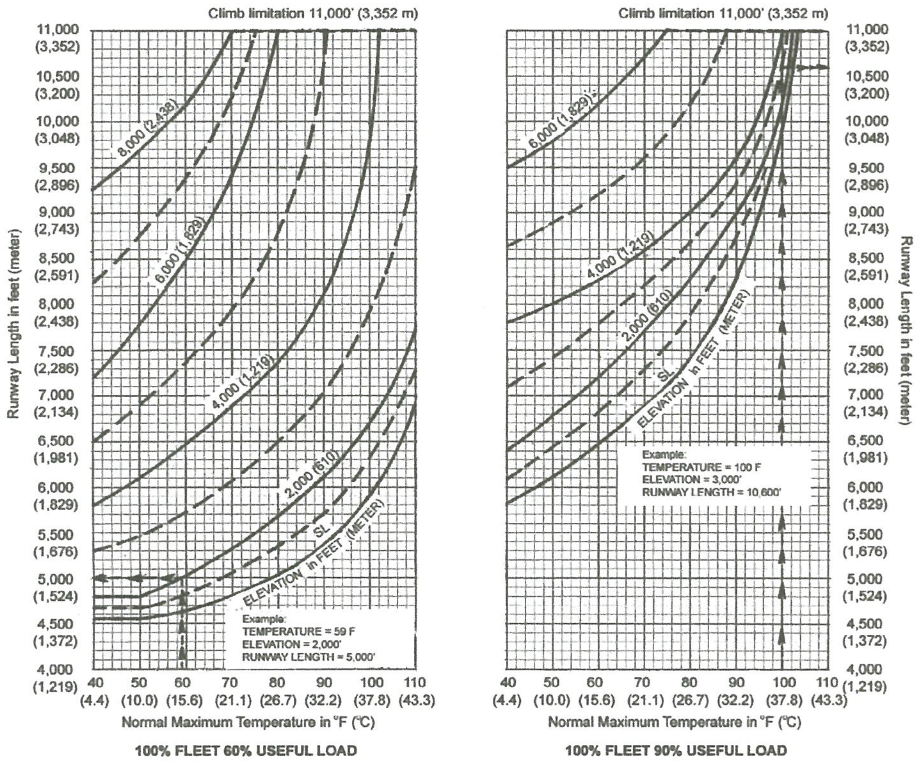
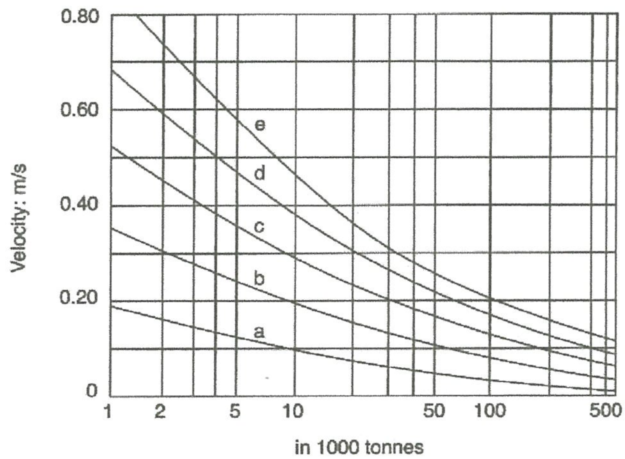


FIGURE Q3: Runway length to serve 100% of large planes of 272,000 N or less



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

FIGURE Q4: Design berthing velocity due to ship displacement

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TABLE 2: 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

TABLE 3: 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.

TABLE 4: Vessel dimension and typical energy requirements

Tonnage (DWT)	Length (m)	Width (m)	Height (m)	Loaded draft (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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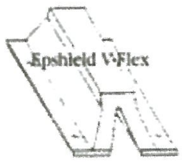
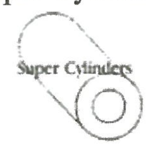
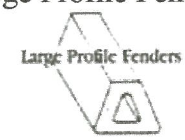
TABLE 5: Fender types based on energy range

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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FORMULAS

$$v_o = \sqrt{\frac{2pLd}{K}} \qquad C_x = \frac{3600 \times \sigma \times \alpha \times p_x \times N}{h_x} \qquad A_{max} = sin^{-1}\left(\frac{d}{R}\right)$$

$$L = d * ln\left[\frac{4d\,tan\left(\frac{A_{max}}{2}\right)}{W - u - 2M}\right] - d \qquad B_{max} = tan^{-1}\left[\left(\frac{w}{d}\right) tan\,A_{max}\right] \qquad e_q = 1.184\left(\frac{u^2}{R}\right)$$

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

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

$$L_{min-spiral(desired)} = 0.061(e_{u2} - e_{u1})u \qquad L_{min-spiral(desired)} = 00082(e_{a2} - e_{a1})u$$

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

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

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