Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	TRANSPORTATION ENGINEERING
COURSE CODE	:	BFT 40303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTIONS	:	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 **EIGHT (8)** PAGES

Q1 (a) A train with an axle load of 20,000 kg is travelling on a Class II railway track that uses rail type R50. Given that the elastic modulus of the rail, E is 2.5×10^6 kg/cm^2, the stiffness of the foundation, k is 190 kg/cm^3 and moment of inertia, I is 2,600 cm^4, calculate the following criteria:

(i) maximum shear force and maximum moment.

(6 marks)

(ii) deflection at 1.0 m and 2.0 m from the loading point.

(4 marks)

(b) A 100 m spiral curve has been proposed for the upgrading of a freight and passenger railway track. The new track will be designed for speeds of up to 125 km/h. The actual superelevation is 13 cm on a curve of 1.1 km.

(i) Show that the existing superelevation is adequate for the new track.

(8 marks)

(ii) Check if the proposed spiral length is acceptable. If it is not, suggest a suitable length.

(7 marks)

Q2 (a) **Figure Q2(a)** shows a schematic diagram of a ramp metering detection system.

(i) List **TWO (2)** benefits of ramp metering.

(2 marks)

(ii) Explain the functions of the sensors and the controller featured in this ramp metering system.

(8 marks)

(b) In an effort to provide a seamless journey for transit vehicles at signalised intersections, you as a transportation engineering consultant, have been hired by the Batu Pahat Town Council to give a briefing on Transit Signal Priority (TSP). Write short notes for your briefing, in which you must highlight the function and process of TSP. Also, include **TWO (2)** objectives, and **THREE (3)** advantages of TSP.

(15 marks)

Q3 (a) An airport is built 1,829 m above sea level, where the normal maximum temperature is 26.7°C. The primary runway length is 3,870 m and the crosswind runway length is 3,120 m. The difference in centerline elevation between the high and low points of the runway is 4.0 m. Given that the airport serves 100% fleet and 60% useful load of a family of airplanes having a maximum certificated load of 272,000 N, check whether the runway lengths are designed according to standard or not.

(12 marks)

(b) A passenger jet, classified in design group III 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)	=	25 m
Wheelbase (w)	=	15 m
Undercarriage width (u)	=	5 m

(i) Examine the adequacy of the maximum nose wheel steering angle (B_{max}).

(6 marks)

(ii) Recommend the taxiway width (W), edge safety margin (M), centerline radius (R), lead-in (L) and radius of the fillet (F) required to maintain the passenger jet cockpit over the centerline.

(7 marks)

Q4 (a) With the aid of diagrams, describe the vehicle staging area and the passenger loading area, which are facilities commonly provided at ferry terminals.

(8 marks)

(b) A single doorway ferry can accommodate up to 50 passengers per trip. At the ferry terminal, the berth has ticket machines located on-shore, a gangway with two channels and a 15-m long sloped walkway that ends in a pair of free-swinging gates. Tickets are collected manually at the gangway. Given the following information, check whether the berth will be able to accommodate 6 ferries during the busiest hour.

Capacity for ticket collection (C_f)	= 20 passengers/min
Capacity for gangway (C_g)	= 40 passengers/min/channel
Capacity for walkway exit gate (C_x)	= 25 passengers/min/channel
Clearance time (t_c)	= 6 min
Operating margin (t_{om})	= 4 min
Passenger walking speed (v_e, v_d)	= 1.25 m/s

(17 marks)

- END OF QUESTIONS -

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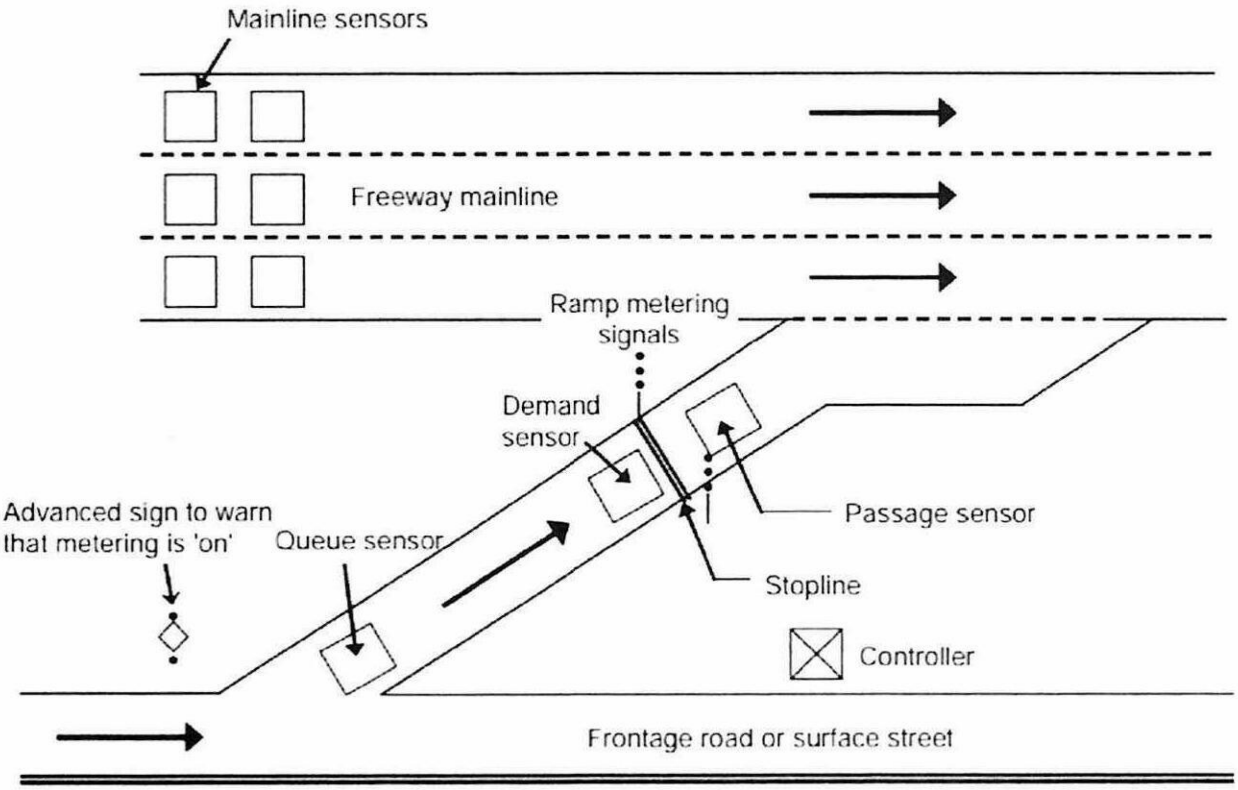

Figure Q2(a): Schematic diagram of ramp metering detection system

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Appendix A: Design Tables and Charts

I. Properties and Specifications based on Railway Classification

Class	Maximum speed, V_{max} (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

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

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II. 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

III. 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.

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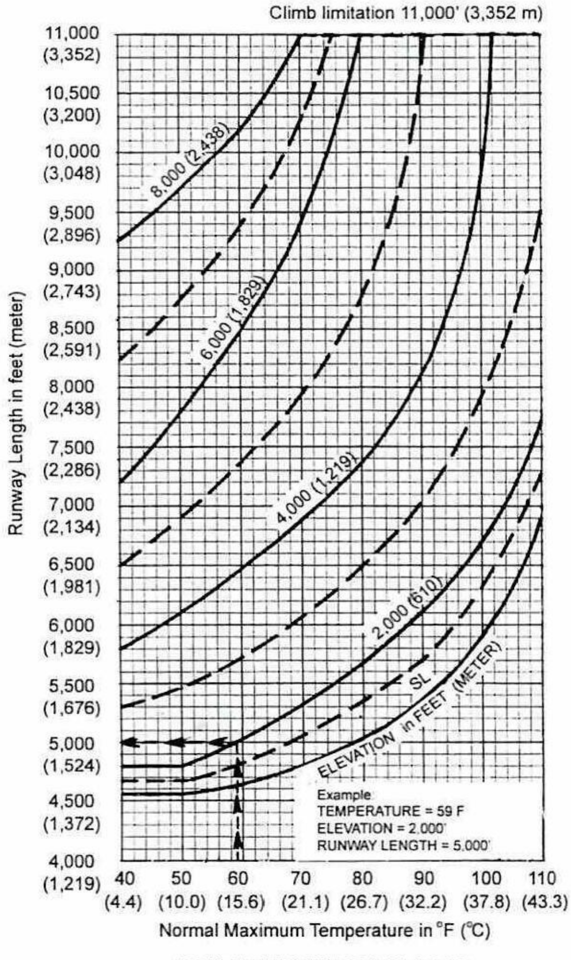
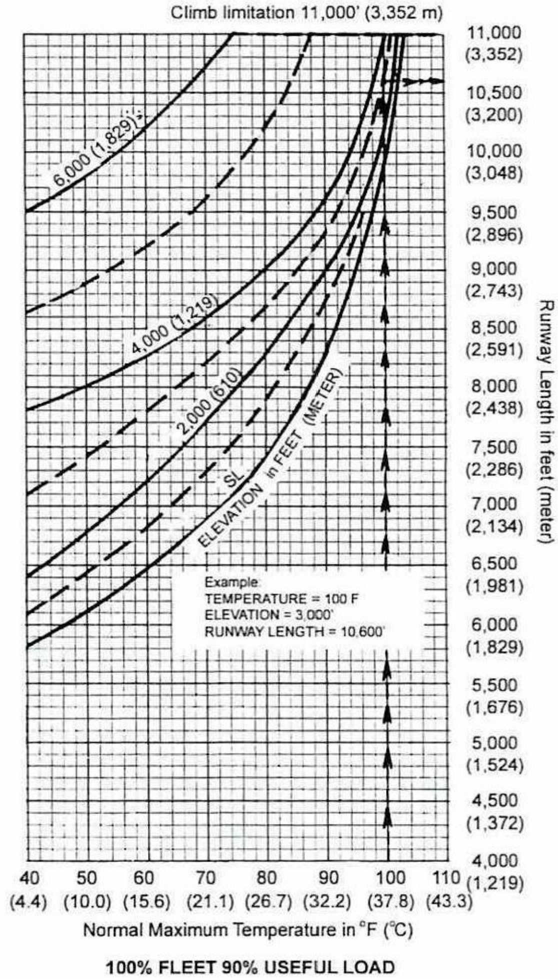
IV. Runway length to serve 100% of large planes of 272,000 N or less



100% FLEET 60% USEFUL LOAD



100% FLEET 90% USEFUL LOAD

TERBUKA

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Appendix B: Formulas

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

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

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

$$R = \frac{1718.89}{D_c} \qquad e_a = 0.79\left(\frac{u^2}{R}\right) - 1.68$$

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

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

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

$$\lambda = \sqrt[4]{\frac{k}{4EI}} \qquad u = \frac{P}{S} \qquad Q = \frac{0.391PS}{X} \qquad X = \frac{\pi}{4}\left(\frac{4EI}{u}\right)^{\frac{1}{4}}$$

$$y(x) = \frac{P_d\lambda}{2k}\left[e^{-\lambda x}(\cos\lambda x + \sin\lambda x)\right] \qquad M_m = \frac{P_d}{4\lambda} \qquad V_m = \frac{P_d\lambda}{2}$$

$$P_d = P_s\left[1 + 0.01\left(\frac{V}{1.609} - 5\right)\right] \qquad L = d \times ln\left[\frac{4d\,tan\left(\frac{A_{max}}{2}\right)}{W-u-2M}\right] - d$$

$$A_{max} = sin^{-1}\left(\frac{d}{R}\right) \qquad B_{max} = tan^{-1}\left[\left(\frac{w}{d}\right) tanA_{max}\right]$$

$$F = (R^2 + d^2 - 2Rd\,sinA_{max})^{0.5} - 0.5u - M$$