UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: March 2021

Module Number: CE7253 **Module Name: Highway Maintenance and Management**

[Three Hours]

[Answer all questions. each question **TWELVE** marks]
[All standard notations denote their regular meanings]

Q1. a) . Briefly outline the process of obtaining the Present Serviceability Rating (PSR) values for a road section as an unbiased estimate of the Present Serviceability Index (PSI).

[2.0 Marks]

b) Explain how the 'Performance Index' can be determined from the PSI value.

[2.0 Marks]

c) The truck traffic on a flexible pavement is 55% 90-kN (20-kip) single-axle loads and 45% 160-kN (36-ki p) tandem-axle loads. The average daily traffic at the start of the period is 7,500 per day, with a coefficient of variation of 15%. The annual traffic growth rate is 6%, the percentage of trucks is 20%, and the number of axles per truck is 2.5, each having a coefficient of variation of 10%. The directional distribution factor is 50%, and the lane distribution factor is 100%, both being considered deterministic with no variations. If the coefficient of variation of AFL, which is the product of axle load percentage and its equivalent factor, is 35% and the Asphalt Institute's equivalent factors are used, determine the mean and the variance of log W_T for a design period of 20 years.

[8.0 Marks]

Q2. a) A vehicle having 4 wheels is traveling at a constant speed of 40 kmph on a flexible pavement which can be modeled as a homogeneous half-space. Tire loads can be assumed as circular loads, each 125 mm in diameter and spaced at 1050 mm on centers on the lateral side and 1550 on the traveling direction. The contact pressure of tires is 310 kPa. The pavement has an elastic modulus of 80 MPa and a Poisson ratio of 0.5. Determine the following parameters of a point 'A', which is located 250 mm below the center of the front left tire, using the Foster and Alvin charts shown in Figures from Q2-1 to Q2-5.

i. Vertical stress
ii. Tangential stress
iii. Radial stress
iv. Shear stress
v. Vertical strain
vi. Radial strain
vii. Vertical deflection

[7.0 Marks]

b) Draw variation of vertical stress and vertical deflection with time at the point 'A' considering the time from 20 s before the front tire approach above point 'A' to 20 s after it left the point 'A'.

[5.0 Marks]

Q3. a) Explain the use of slurry seals and fog seals in the flexible pavement maintenance process

[4.0 Marks]

b) Explain how block cracks and crocodile cracks of flexible pavement differ in appearance and they affect the pavement.

[3.0 Marks]

c) There is widespread bleeding on a newly overlaid road on a 2 km segment. What are possible reasons for this and how this can be remedied?

[3.0 Marks]

d) With the help of neat sketches explain the process of crack sealing in the flexible pavement.

[2.0 Marks]

Q4. a) List six roles and responsibilities of a project manager and explain what formal education or skills he/she needs to gain to fulfill the stated roles and responsibilities.

[3.0 Marks]

b) Explain the four stages of a project life cycle and provide one example process in each of the stages.

[3.0 Marks]

c) A gang of bricklayers takes 30 minutes to lay 1 m^2 of a block wall. It was estimated that they have a 60% improvement ratio. If the gang needs to lay 500 m^2 of block wall estimate the time needed to complete this task.

[3.0 Marks]

d) If the same gang stated in Q4.c) in a similar situation was used to lay another 200 m^2 of block wall determine the time they will spend to complete the additional task.

[3.0 Marks]

Q5. a) Consider the information provided in Table Q5-1 for a construction project.

i. Compute the expected time for each activity.
ii. Compute the variance for each activity. Compute the expected project duration.
iii. What is the probability of completing the project by day 112?
iv. What is the probability of completing "Negotiate with Unions" by day 90?

[6.0 Marks]

b) Consider the schedule given in Figure Q5-1 prepared for a project in which the key resource is a tractor. There are three tractors available for the project. Activities A and D require one tractor to complete while activities B, C, E, and F require 2 tractors. Develop a resource-constrained schedule in the loading chart that follows. Use the parallel method and heuristics given. Be sure to update each period. Record the early start (ES), late finish (LF), and slack (SL) for the new schedule.

[6.0 Marks]

ANNEX: Equations, Tables, and Figures

$$\sigma^2{}_{tc} = \left(\frac{(b-a)}{6}\right)^2 \qquad \omega_o = \frac{\pi(1-\upsilon^2)qa}{2E}$$

$$\sigma_{tE} = \sqrt{\sum \sigma^2{}_{tc}} \qquad Z = \frac{T_S - T_E}{\sigma_{tE}}$$

$$\sigma_z = q\left[1 - \frac{Z^3}{(a^2+Z^2)^{1.5}}\right] \qquad \sigma_r = \sigma_t = \frac{q}{2}\left[1 + 2\upsilon - \frac{2Z(1+\upsilon)}{(a^2+Z^2)^{0.5}} + \frac{Z^3}{(a^2+Z^2)^{1.5}}\right]$$

$$w = \frac{(1+\upsilon)qa}{E}\left\{\frac{a}{(a^2+Z^2)^{0.5}} + \frac{1-2\upsilon}{a}[(a^2+Z^2)^{0.5} - Z]\right\}$$

$$\theta = \sigma_Z + \sigma_r + \sigma_t + \gamma Z(1+2K_o)$$

$$W_T = \left(\sum_{i=1}^{m} p_i F_i\right)(AADT_0)(T)(A)(G)(D)(L)(365)(Y)$$

$$G = 0..5[1 + (1+r)^Y]$$

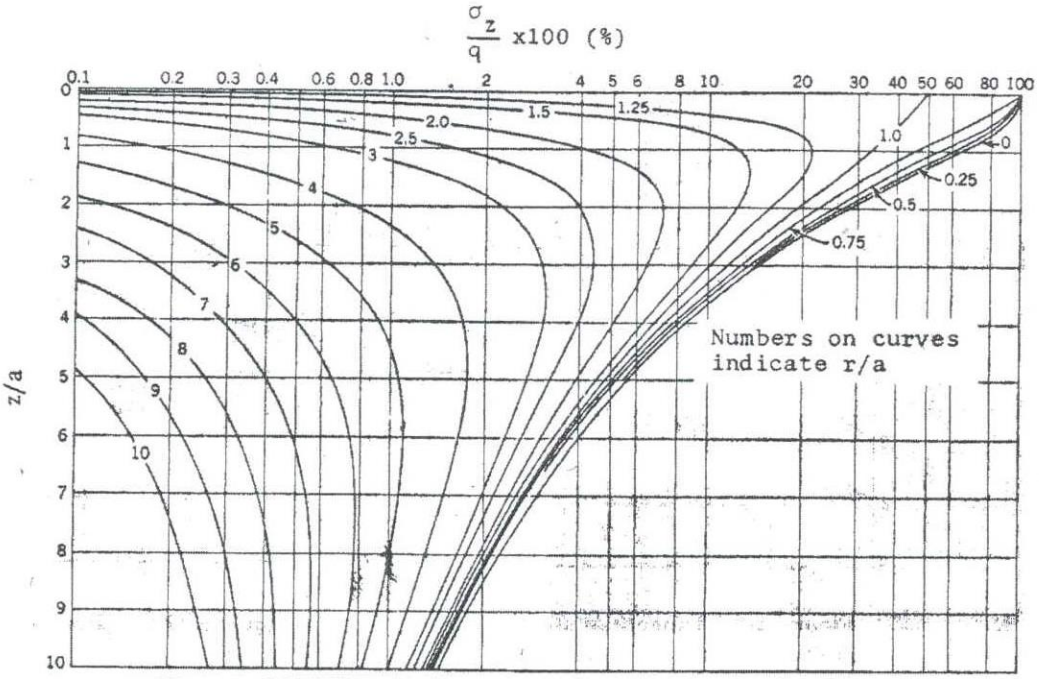

Figure Q2-1 Vertical stresses due to circular loading

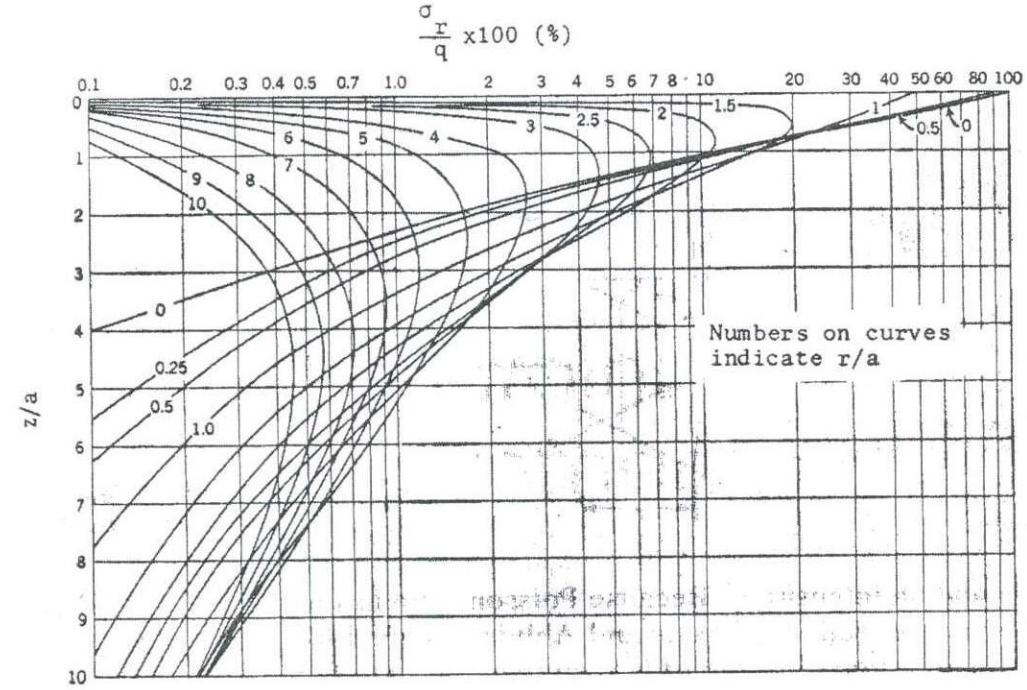

Figure Q2-2 Radial stresses due to circular loading

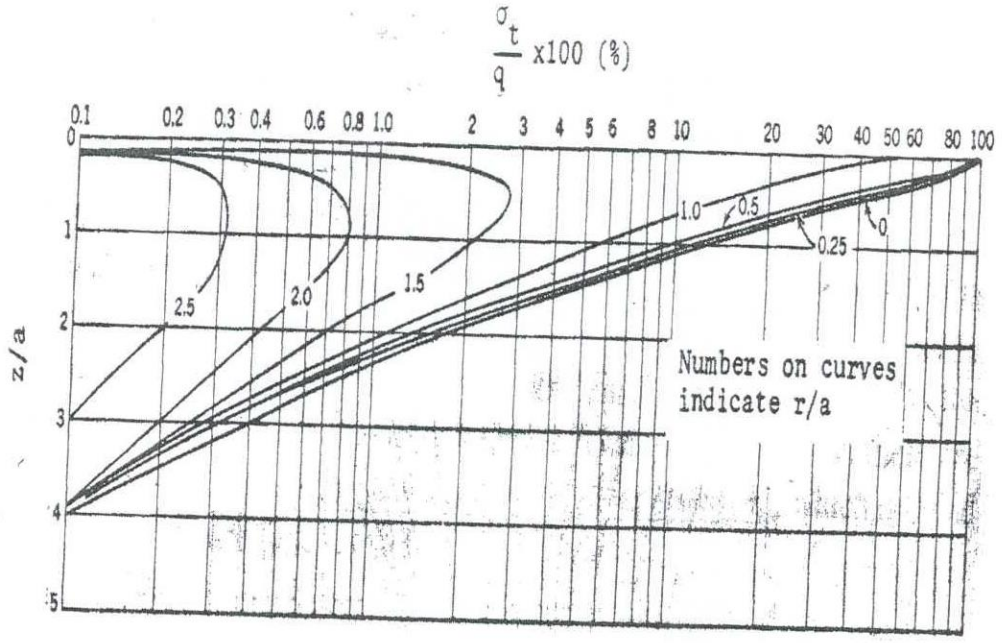

Figure Q2-3 Tangential stresses due to circular loading

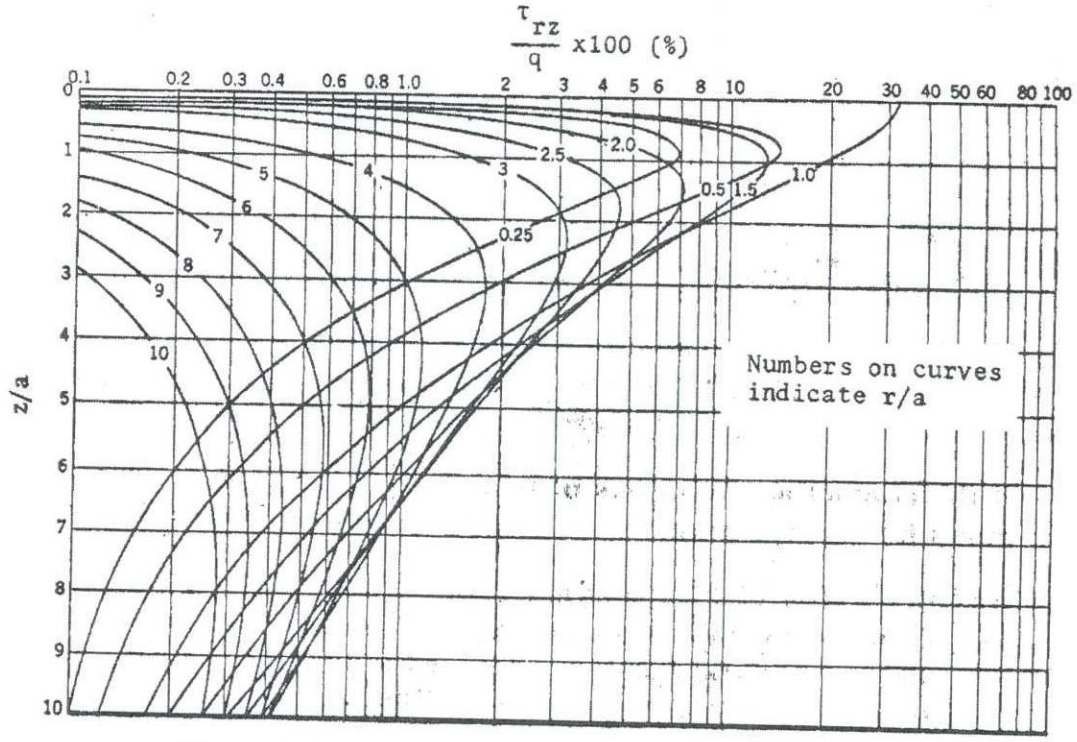

Figure Q2-4 Shear stresses due to circular loading

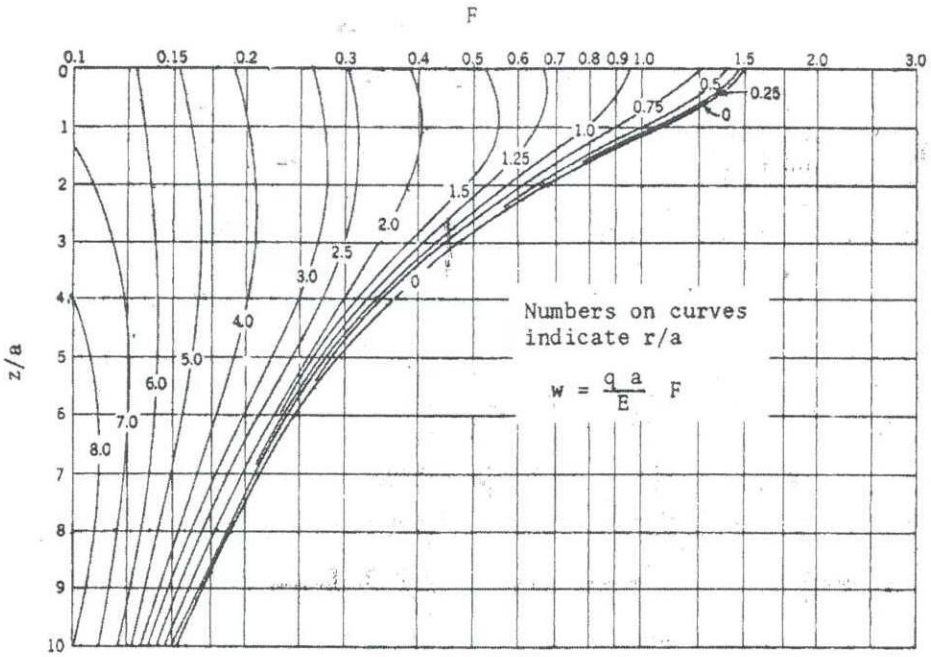

Figure Q2-5 Vertical deflections due to circular loading

Table Q5-1 Network Information

Activity	Predecessor	a	m	b
1	None	16	19	28
2	None	30	30	30
3	None	60	72	90
4	None	18	27	30
5	1	17	29	47
6	1	4	7	10
7	5	12	15	18
8	6,7	6	12	24
9	2	18	27	30
10	3	20	35	50
11	4	40	55	100
12	8	11	20	29
13	11	14	23	26
14	9,12	13	16	19
15	10,12,14	0	0	0

Detach this sheet and attach it to your answer script

Index Number_____

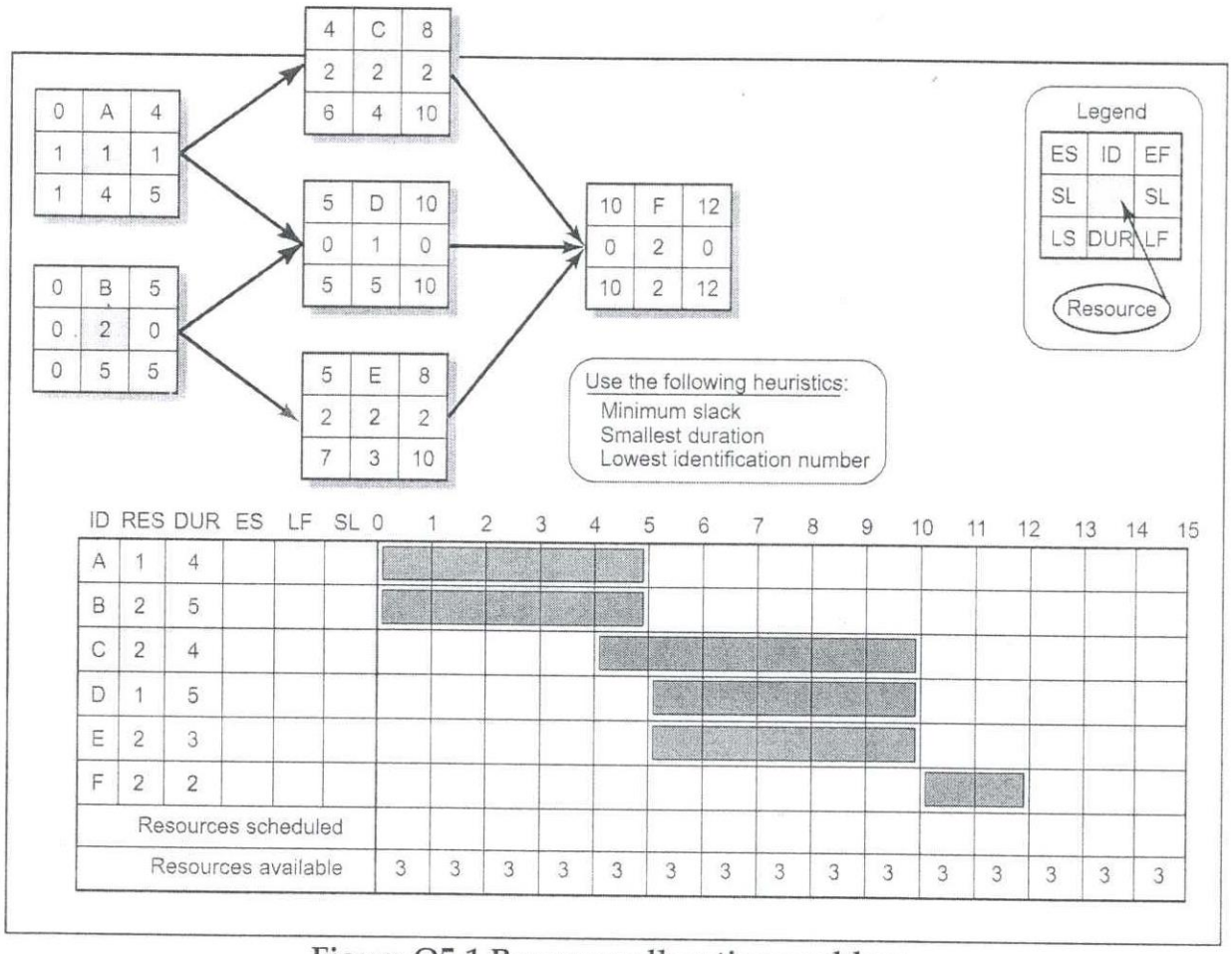

Figure Q5-1 Resource allocation problem