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THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

EXAMINATION QUESTION PAPER MASTER

PROFORMA

Semester: One **Academic Year:** 2021

A. DEPARTMENT SECTION

I ACCEPT THAT THIS EXAMINATION PAPER SATISFACTORILY EXAMINES

Subject Code: CE313 **Title:** ROAD & PAVEMENT ENGINEERING

Number of Questions: 5 **Number of Pages:** 9

1. **Subject Examiner:** MR. MURRAY KONZANG
   Signature: _____ **Date:** 09/06/21
2. **Subject Co-Examiner:** MR. JEDGE KASADIMI
   Signature: _____ **Date:** 09/06/21
   for Mr. Kasadimi
3. **Departmental Examinations Co-ordinator: Checked: YES** ✓ **NO** ____ **(Please tick)**
   Signature: _____ **Date:** 09/06/21
4. **Head of Department and Chief Examiner: Checked: YES** ✓ **NO** ____ **(Please tick)**
   Comments:
   -NIL-

   Signature: _____ **Date:** 09/06/2021

B. EXAMINATIONS OFFICE SECTION

Examination Masters Received: YES ____ **NO** ____

5. **Examinations Officer Signature:** _____ **Date:** _____
6. **Witness Signature:** _____ **Date:** _____

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING

FIRST SEMESTER EXAMINATION

CE313 – ROAD & PAVEMENT ENGINEERING

Thursday 10 June, 2021 – 8:20 am Venue: C001, C002/3 and C004/5

TIME ALLOWED: 3 HOURS

INFORMATION FOR STUDENTS

1. You have 10 minutes to read the paper. You must NOT begin writing during this time.
2. There are FIVE questions in this paper. Answer all FIVE questions.
3. All answers must be written on the answer book provided unless otherwise stated. No other written material will be accepted.

   WRITE YOUR NAME CLEARLY ON THE FRONT PAGE.
4. You may NOT consult your assignments, lecture notes and books.
5. NO MOBILE PHONE IS ALLOWED IN THE EXAMINATION ROOM.
6. You may refer to an approved copy of RN31.
7. Please return the copy of RN31 and other publications at the end of the examination, if you have borrowed any from the Department.

MARKING SCHEME

The total mark for this examination is 100 and it is worth 40% out of 100% total assessment.

QUESTION ONE

(a) Assuming **4 ½ POWER RULE**, what is the equivalent factor for the following axle loads?

5650 kg, 8200 kg, 10900 kg (3 mark)

(b) A one-way axle flow on a pavement during year one was measured to be 50 axles each of 5650 kg, 8200 kg and 10900 kg, per day. If there is no traffic growth during first two years, the design period is 12 years and for the rest of design period traffic grows at 3% per annum, estimate the cumulative axle load carried by the pavement. (5 marks)

(c) If a stage construction was to be considered, in what year will it be undertaken? (3 marks)

(d) In (b) above what percentage will the cumulative increase, if a **6 POWER RULE** is used to estimate the equivalence factor? (2 marks)

(e) A 4 days soaked sample is sometimes used to determine the CBR of subgrades. Would you justify the use of this procedure for general application in Papua New Guinea? Give your reasons (3 marks)

(f) What do you understand by the term "stage construction"? (2 marks)

(g) "If it is desired to provide at the time of construction, a pavement capable of carrying more than 0.5 million standard axles, the designer may choose either a 150 mm base with a 50 mm bituminous surfacing or 200 mm base with double surfacing".
On what basis would you choose between "double surface dressing and bituminous surfacing" List your reasons. (2 marks)

Total Mark = 20

QUESTION TWO – MULTIPLE CHOICE QUESTIONS

Select by a circle the correct answer a, b or c for each question. each correct answer will be awarded 1 (one) mark, no selection will be 0(zero) mark and each wrong answer will be given – 0.5 (minus half) mark.

i	A	An M.C. 800 cutback bitumen may be produced with petrol as cutting agent.
	B	An R.C. 800 cutback bitumen may be produced with fuel oil as cutting agent.
	C	An S.C. 800 cutback bitumen may be produced with fuel oil as cutting agent.
ii	A	A flexible pavement might consist of 50mm asphalt surfacing carried by 150mm layer of cement concrete.
	B	A flexible pavement might consist of 50mm rubberised surfacing carried by 150mm layer of cement concrete.
	C	A flexible pavement might consist of 50mm asphalt surfacing carried by 150mm layer of aggregate base.
iii		**In a Penetration Grade test on a 80/100 grade bitumen, one would expect the needle to penetrate into the sample**
	A	Minimum 80 mm in 5 seconds after load application
	B	8 to 10 mm in 5 seconds after load application
	C	80 to 100 mm in 1 second after load application
iv		**For chip sealing, an aggregate should be;**
	A	Uniformly graded
	B	Well graded
	C	Gap graded
v		**The length of an aircraft runway pavement DOES NOT depend on**
	A	The CBR of the subgrade material on which the runway is laid
	B	The gradient of the runway
	C	The elevation of the runway
vi		**The thickness of an aircraft runway pavement DOES NOT depend on**
	A	The CBR of the subgrade material on which the runway is laid
	B	The CBR of the base material used for the runway
	C	The CBR of the surface dressing material used for the runway
vii		**The following test may be used to ensure the safety of workers handling bitumen for road works**
	A	Distillation Test
	B	Flash Point Test
	C	Solubility Test
viii		**Bleeding is mainly caused by**
	A	Oil spillage on the pavement surface
	B	Polished aggregate on the pavement surface
	C	Excessive bitumen on the surface
ix		**The procedure for long term repair of a pot hole is as follows**

	A	Clean the hole, dry it. Fill the hole with cold asphalt mixture, rake smooth and compact
	B	Fill the hole and re-surface the road with surface dressing
	C	Cut out the hole to solid material on both sides and bottom and fill and compact as appropriate with base and surface material
x		**A longitudinal crack on a pavement a foot or so from the edge formed due to poor drainage is**
	A	An edge crack
	B	An edge joint crack
	C	An alligator crack

(10 marks)

QUESTION THREE (General Knowledge)

(a) It is required that an airport pavement is designed to sustain the aircraft with the main legs of the landing gear having dual tandem wheels. The aircraft maximum take-off weight is 49960 kg and the tyre pressure of 7.0kg/cm. Soaked CBR tests undertaken on samples of the Subgrade soil yielded a CBR value of 4 percent.
If you are going to use an asphaltic concrete surfacing followed by a cement stabilised base over a river gravel sub-base, determine the respective thickness of each pavement layer using the French method of aerodrome design. Material coefficients are given below;

Material Coefficients: Double surface dressing or asphaltic concrete 2.0; Cement, lime, & bitumen stabilised material 1.5; well graded crushed gravel 1.0; River gravel 0.75. (10 marks)

(b) State in NO MORE THAN 10 lines, the steps involved in surface dressing a road after the base is laid. (5 marks)

(c) Explain how you would monitor the performance of flexible pavements in road network to ascertain when they are due for upgrading. (3 marks)

(d) State the main causes of pavement failure. (2 marks)

(e) List five factors that influence Aircraft Pavement Performance. (5 marks)

(f) What is the difference between CUTTING BACK and FLUXING of bitumen?

(2 marks)

(g) Name a laboratory and field test you might undertake to ensure adequate compaction of a road embankment? Explain how you would make use of these tests in practice? (3 marks)

Marks = 30

QUESTION FOUR

(a) The following road characteristics and costs data is available for costing alternative designs.

Road Geometry
Surfacing width = 8 meters
Nominal depth of surface dressing = 70 mm
Carriageway width = 10 meters
Formation width = 11 meters

Material Cost
Bituminous surfacing = K250 / m^3
Surface Dressing = K155 / m^2
Crushed rock = K136 / m^3
Gravel = K121 / m^3

The following axle distribution has been estimated for the traffic stream that will be using a proposed road over its design life. You are required to design the road using RN31 such that it sustains this axle distribution satisfactorily over its design life. You must also determine the construction costs for building a 1 kilometer section of the road. In your costing you must also estimate the "whole-life-cost" of the pavement, that is, maintenance (i.e., 20% of the total cost) and management (15% of the total cost) of the road pavement.

The Subgrade CBR is 4 percent and design life is 10 years.
Traffic growth rate has been estimated to be 8%

Table 1.0 Axle load distribution (axle/day)

Axle Load (kg)	Total Number
2850	50
3720	100
4630	75
5550	90
7450	45

Use 4.5 power rule.

(10 marks)

(b) In NOT MORE THAN five lines, state the mechanistic procedures for designing a new flexible pavement then Illustrate with a help of a neat diagram, the pavement model for the mechanistic procedure of designing a new flexible pavement.

(5 marks)

(c) Explain the factors used in determining the thickness of a rigid pavement

(5 marks)

Total Mark = 20

QUESTION FIVE

(a) As a road design and consulting engineer you have won a contract to undertake the design of a rural road for the client, Morobe Provincial Works Department. The coordinates of the start and end including the intersection points of the road are given in Table 1. A sketch of the alignment is also shown in figure 1. The client has requested that you submit an inception report that must have data on the alignment and the first curve from point A. The data required will be obtained by completing questions (a) and (b) below.

You are required to complete the calculations for the following information that must be included in your report.

(i) Section length
(ii) Chainage along the straights, start point A will have a chainage of 00
(iii) Whole circle bearing of each line
(iv) Deflection angle at each intersection point

Table 1: Road Alignment Coordinates.

I.P	1	A	1	2	3	4	5	B
East	2	23242	23330	23430	23696	23800	23380	23700
North	3	9680	10180	10332	10642	11000	11080	11450

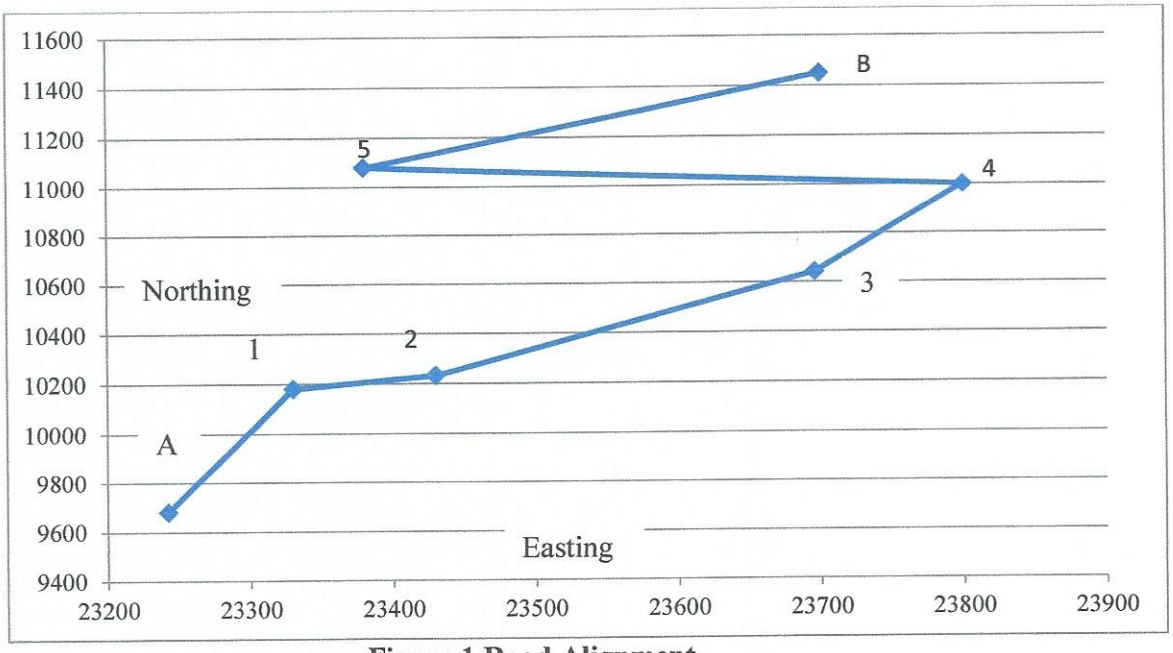

Figure 1 Road Alignment

(10 marks)

(b) Complete the setting out calculations of Curve 1 at IP1. Setting out data must be given for the entry and exit transition curves and the circular arc. All relevant data calculated in Question 1 above should be used. Setting out of the entry and exit transition will be done at 10-meter interval while the circular arc will be set out at 20 meter intervals.

The following additional information is given:

Curve radius = 100 m
Road Design Speed = 50 km/h
Normal cross fall, n = 0.03 m/m
Super-elevation Transition Rate, e = 0.08 m/m
Normal Road Width, Wn = 7.0 m
Curve radius = 200 m
Maximum relative grade, Gr = 0.75

The relationship given below will be useful in your calculations are:

$Le = 50\ Wn(n+e)/Gr$
$S = Le^2 / (24R)$
$Y = x^3 / (6LR)$

(10 marks)

Total Marks = 20

END OF EXAMINATION