TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING & CIVIL ENGINEERING
UNIVERSITY EXAMINATION FOR:
BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 4415: HIGHWAY ENGINEERING 1

END OF SEMESTER EXAMINATION
SERIES: JANUARY 2025
TIME: 2 HOURS

Instructions to Candidates
You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of five questions.
Attempt question ONE (Compulsory) and any other TWO questions.
Do not write on the question paper.

QUESTION ONE (COMPULSORY) (30 Marks)

a) (i) State the two basic traffic functions of roads **(2 Marks)**

(ii) Briefly explain how each of above functions impact on the design criteria to be chosen for a particular road. **(2 Marks)**
(iii) Outline three steps to be followed in the early stages of the design process to ensure that the most appropriate design criteria is chosen for a particular road**. (3 Marks)**

b) With aid of sketches, illustrate the following vehicle movements at intersections **(8 Marks)**
(i) Merging
(ii) Diverging
(iii) Weaving
(iv) Crossing

c) Outline three basic ways of resolving crossing conflicts. **(6 Marks)**

d) Refer to table Q1 (d) **(9 Marks)**

(i) What is the minimum radius of curvature allowable for a roadway with a 100 km/h design speed, assuming that the maximum allowable super elevation rate is 0.12?

(ii) What is the actual maximum super elevation rate allowable under AASHTO recommended standards for a 100 km/h design speed, if the value of *f* is the maximum allowed by AASHTO for this speed? Round the answer down to the nearest whole percent.

Table Q1 (d): Recommended Maximum Side Friction Factor and Minimum Radius of Curvature by AASHTO

Design Speed (km/h)	30	40	50	60	70	80	90	100	110	120
Maximum side Friction Factor	0.17	0.17	0.16	0.15	0.14	0.14	0.13	0.12	0.11	0.09
Minimum Radius of Curvature (m)	35	60	100	150	215	280	375	490	635	870

Source: From A Policy on Geometric Design of Highways and Streets. Copyright 1994 by the American Association of State Highway and Transportation Officials (AASHTO), Washington DC.

ANSWER ANY TWO QUESTIONS FROM THIS SECTION

QUESTION TWO (20 Marks)

(a) State the advantages and disadvantages of roundabouts as compared to other types of at-grade intersections **(11 marks)**

(b) State factors to consider when deciding to build a roundabout at a specific intersection (5Marks)

(c) Define the following as used in highways (4 Marks)

i. At- grade junction
ii. Channelised junction
iii. Traffic island
iv. Ghost island

QUESTION THREE (20 Marks)

(a)With aid of a sketch, derive an equation for the **minimum** permitted horizontal radius, of a curve for a vehicle driven at a design speed **V** in km/hr, round a highway bend of radius **R,** superelevation **e,** side friction factor **μ** and gravitational acceleration **g** = 9.81m/s^2 (17 marks)

(b) Given that, at the design speed, 55% of the centrifugal force is balanced by friction, with the remaining 45% being counteracted by the cross fall and that **e** = 5% ,Calculate the minimum radius R for a design speed of 100 km/hr (3 Marks)

QUESTION FOUR (20 Marks)

Calculate and tabulate deflection angles and chords at 20 m intervals for a 500 m radius curve with a deflection angle of 15^0 and a TC at station 17 + 25. **(20 Marks)**

QUESTION FIVE(20 Marks)

(a) State Five conditions that would warrant use of grade –separated junctions (5 Marks)

(b) State Four general categories of grade –separated junctions (4 Marks)

(c) State the two primary reasons for widening horizontal curves (2 Marks)

(d) State benefits accruing from proper geometric design of highways (5 Marks)

(e) Briefly explain how the following factors affect the highway alignment (4 Marks).
   i. Design speed
   ii. Topography