TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT BUILDING AND CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECE 2404: HIGHWAY ENGINEERING I B

END OF SEMESTER EXAMINATION

SERIES: JULY 2017 SERIES

TIME: 2 HOURS

DATE: 2017

Instructions to Candidates

You should have the following for this examination: Answer Booklet, Drawing Instruments, Scientific calculator, examination pass and student ID.

This paper consists of five questions. Attempt question ONE (Compulsory) and any other TWO questions. All diagrams should be clearly drawn and labeled. Use of **Mobile Phones & programmable** calculators is not allowed. Each question should be on a fresh page of the answer booklet.

Question One (Compulsory)

(a) Explain the two major design steps that are to be considered when designing a road? (2 marks)

(b) Explain the primary aim of vertical alignment and, why are vertical curves required. (4 marks)

(c) Determine the minimum length of curve necessary to meet stopping sight distance requirements given design speed of 115km/hr and that at one section, an equal tangent vertical curve must be designed to connect grades of +1.0% and -2%. (8 marks).

(d) Draw a typical single carriageway cross section and clearly indicate all its features. (6 marks)

(e) When deciding the design standards to which a road shall be built, it is important to recognize the cost of the road and its value to the society it will serve. Discuss. (4 marks)

(f) Mention and briefly explain each of the three main parts of geometric roadway design. (6 marks)

Question Two

(a) Mention and briefly explain the three important elements of intersection design. (6 marks)

(b) Outline the factors that control the geometric design elements of a road. (6 marks)

(c) Explain the following classifications of intersections giving details and examples of the classifications:

- At Grade Intersection &
- Grade Separated Intersection (8 marks)

Question Two

(a) Passing sight distance can be analysed by dividing the overall distance into three parts. Briefly explain these three parts. (5 marks)

(b) Show how passing sight distance can be calculated by making certain fundamental assumptions. (9 marks)

(c) Mention and briefly explain the three important elements of intersection design. (6 marks)

Question Three

(a) Explain the primary reasons for widening horizontal curves. (2 marks)

(b) Illustrate curve widening diagrammatically and show how the extra width is calculated. (6 marks)

(c) Highlight four points to be noted when widening horizontal curves. (4 marks)

(d) Refer to table Q3 (d): What is the minimum radius of curvature allowable for a roadway with a 100 km/h design speed, assuming that the maximum allowable superelevation rate is 0.12? Compare this with the minimum curve radius recommended by AASHTO. What is the actual maximum superelevation 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. (8 marks)

Table Q3 (d): Recommended minimum radius of curvature

Design Speed (km/h)	30	40	50	60	70	80	90	100	110	120
Max. Curve Radius (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.

Question Four

(a) What is "superelevation"?

(b) Draw a superelevation force diagram and use it to derive the following formula:

$$R = \frac{V^2}{127(f+e)}.$$

(20 marks)

N.B: All drawings should be clearly labeled.

Question Five

(a) Define speed in traffic flow and show how it is expressed mathematically. (2 marks)

(b) Define "Design Speed" and explain how its choice affects the design of the geometric design elements. (5 marks)

(c) Draw a typical single-way carriageway cross section and indicate clearly the following features:

i. Verge

ii. Berm

iii. Carriageway slopes (i.e. cutting and embankment) (5 marks)

(d) Outline the term "Channelization" and state its purposes. (8marks)