



**TECHNICAL UNIVERSITY OF MOMBASA**

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FACULTY OF ENGINEERING AND TECHNOLOGY  
DEPARTMENT BUILDING AND CIVIL ENGINEERING

**UNIVERSITY EXAMINATION FOR:**

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECE 2404: HIGHWAY ENGINEERING I

END OF SEMESTER EXAMINATION

**SERIES: NOVEMBER 2016**

**TIME: 2 HOURS**

**DATE: 2016**

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**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.

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**Question One (Compulsory)**

- (a) i. Explain the two major design steps that are to be considered when designing a road? (2 marks)
- ii. Explain the following geometric design elements of a road or highway and indicate what they consist of:
- alignment
  - profile
  - cross section (6 marks)
- iii. Which are the three criterion used to determine the geometric design standards of a road or highway? Explain the three benefits which will be realized when a road is properly designed. (6 marks)

- (b) What is the primary aim of vertical alignment and, why are vertical curves required. (4 marks)
- (c) Determine the minimum length of a curve necessary to meet stopping sight distance requirements for a highway being designed with 120km/hr design speed. At one section, an equal tangent vertical curve must be designed to connect grades of +1.0% and -2%. (7 marks)
- (d) Mention five variables that generally determine the speed of a vehicle. (5 marks)

### **Question Two**

- (a) Define “horizontal alignment” and mention the design elements that it consists of? (4 marks)
- (b) What does the maximum comfortable speed on a horizontal curve depend on? (3 marks)
- (c) Define an intersection and mention the factors which are taken into consideration in the design and construction of roads. (3 marks)
- (d) Intersections are classified either as “at grade” or “grade separated”. Explain these two types of intersections giving details of the classifications and examples. (10 marks)

### **Question Three**

- (a) What is curve widening and, what determines the amount of widening? (3 marks)
- (b) Draw a sketch to illustrate curve widening and show how the extra width is calculated. (9 marks)
- (c) Highlight four points to be noted when widening horizontal curves. (8 marks)

### **Question Four**

- (a) Define “superelevation” and explain why it is introduced on horizontal curves. (3 marks)
- (b) Using simple sketches, explain the steps to be taken to control the length of straights on horizontal alignment. (4 marks)
- (c) With the aid of sketches, explain how superelevation is developed from a normal camber to a full superelevation at the center of the circular curve. (8 marks)
- (d) Calculate the length of superelevation runoff given the following variables
- i. Maximum runoff ( $\Delta s$ ) = 1.0
  - ii. Superelevation of the curved section = 5%
  - iii. Road camber = 2.5%
  - iv. Road width = 7.0m (5 marks)

### **Question Five**

- (a) Outline the three situations which warrant the introduction of climbing lanes and state two factors considered when designing vertical curves. (5 marks)

(b) With the aid of sketches explain the process of “channelization” and outline its purpose.

(7 marks)

(c) i. Define a transition curve and explain its purpose in horizontal curves. State THREE major factors that govern their design.

ii. Given: a curve radius of 400m, design speed of 110kph and friction 0.4 estimate the minimum length of spiral necessary for a smooth transition from tangent (straight) to the circular curve.

(8 marks)