



TECHNICAL UNIVERSITY OF MOMBASA  
**Faculty of Engineering &  
Technology**

DEPARTMENT OF BUILDING & CIVIL ENGINEERING  
UNIVERSITY EXAMINATION FOR BACHELOR OF SCIENCE IN CIVIL  
ENGINEERING (BSCE)

ECE 2404: HIGHWAY ENGINEERING I

**END OF SEMESTER EXAMINATION**

**SERIES: AUGUST 2013**

**TIME ALLOWED: 2 HOURS**

**Instructions to Candidates:**

You should have the following for this examination

- Answer Booklet

This paper consists of **FIVE** questions.

Answer question **ONE (COMPULSORY)** in section **A** and any other **TWO** questions from section **B**

Maximum marks for each part of a question are as shown

This paper consists of **TWO** printed pages

---

**SECTION A**

**Question One (Compulsory)**

- a) A vertical curve crosses a 1.22m diameter pipe at right angles. The pipe is located at station 3 + 38 and its centre line is at elevation 333M. The PI of the vertical curve is at station 3 + 353 and elevation 335M. The vertical curve is equal tangent 183m long and connects an initial grade +1.2% and a final grade of -1.08%. Using offsets:
- (i) Determine the depth, below the surface of the curve, of the top the pipe
  - (ii) Determine the station of the highest point on the curve. **(15 marks)**
- b) (i) A roadway is being designed for a speed of 113km/hr. At one horizontal curve, it is known that the super elevation is 8% and the coefficient of side friction is 0.10. Determine the minimum radius of curve that will provide for safe vehicle operation **(10 marks)**
-

(ii) State **TWO** situations where roundabouts are placed.

**(5 marks)**

## **SECTION B (Attempt any TWO questions)**

### **Question Two**

a) With the aid of diagrams, illustrate the following interchange configurations:

- (i) Channelized y intersection
- (ii) Plain Four-leg intersection used for minor Roads
- (iii) Trumpet
- (iv) Clover leaf with off-line weaving section

**(12 marks)**

b) Compute curve elevations and offsets from tangents at 25m intervals including full stations for a 350m vertical curve joining a + 2.7% grade with a – 1.50% grade. Assume PI is at station 150 + 00 and elevation 25.00m

**(8 marks)**

### **Question Three**

The allowable side friction factor for horizontal curves with a design speed of 100km/h is O.R.

- a) Determine super elevation rate that would be used for curve with a design speed of 100km/h and a radius of 420m.
- b) A spiral transition curve is used to go from a normal crown slope with 2% cross-slopes grade between the centerline and the edge is 1/200 and the roadway consists of the 3.6m lanes. Determine the length of the spiral.

**(20 marks)**

### **Question Four**

- a) In the design of Highways, outline any **SIX** elements that are influenced by the performance characteristics of vehicles.
- b) A circular curve with a radius of 350m is connected by 60m spiral transition curves to tangents with deflection angle of 0.349 rad. If the station of the TS is 105 + 40, determine the station of SI.

**(14 marks)**

### **Question Five**

A vertical curve joins a -2.0% grade to a + 0.5% grade. The PI of the vertical curve is at station 100 + 100 and elevation 69.50m above sea level. The centerline of the roadway must clear an overhead structure located at station 99 + 20 by 5.67m. The elevation of bottom of the structure is 77.45m above sea level. Determine the maximum length of vertical curve that can be used.

**(20 marks)**