



KIMATHI UNIVERSITY COLLEGE OF TECHNOLOGY

UNIVERSITY EXAMINATION 2012/2013

**FORTH YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE
OF BACHELOR OF SCIENCE IN CIVIL ENGINEERING**

ECE 2404 – HIGHWAY ENGINEERING 1

DATE: AUGUST 2012

TIME: 2 HOURS

INSTRUCTIONS:

- (a) This paper contains FOUR (4) questions.
 - (b) You are required to answer THREE (3) questions only.
 - (c) Question ONE is compulsory.
 - (d) Attempt any other TWO questions.
 - (e) Question ONE carries 30 marks and the others carry 20 marks each.
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QUESTION ONE

- (a) (i) Define stopping sight distance (SDD) as applied in highway engineering. (2 Marks)
- (ii) Calculate the down slope and upslope braking distance for a 1.5 tonne vehicle moving at 80km/h on a road with coefficient of 0.4 and friction grade of 1:40 for a perception time of 2.5 sec. (4 Marks)
- (b) (i) State four resistances that come into place on a moving vehicle. (2 Marks)
- (ii) Show, with illustrative diagram(s), that the traction forces on a vehicle travelling on a section of road of grade G is:
$$T=P (f\pm G)$$
 (4 Marks)
- (c) A vehicle moving at 30km/h on a level road suddenly joins a graded section and continues moving without changing the traction force until it stops after moving 23.6m in 5.7sec.
 - (i) Estimate the grade of the road if the coefficient of friction is 0.02. (4 Marks)
 - (ii) What would be the traction force (T') in terms of vehicle weight (W) to maintain the speed of the vehicle? (2 Marks)
 - (iii) What would be the traction force (T') in terms of initial traction force (T) to maintain the speed of the vehicle? (2 Marks)
- (d) (i) State four factors that determine the highway capacity. (2 Marks)
- (ii) Briefly discuss four major factors controlling road design (8 Marks)

QUESTION TWO

- (a)(i) Define super elevation and state its advantages on road design. (2 Marks)
- (ii) Calculate the speed at which a vehicle should traverse a circular curve of radius 750m having maximum super elevation of 5% such that no steering effort is required to balance the forces acting on the vehicle. What is this speed called? (4 Marks)
- (b)(i) A horizontal alignment in figure 1 consists of a circular curve of radius 850 m and spirals on either end. The tangents meet at an angle of 38° . If the length of the circular curve is 76.5m and the chainage at the end of the alignment is 1185.45m, estimate the
- a) Length of spiral curve. (2 Marks)
 - b) Chainage of beginning of curve (2 Marks)
 - c) Tangent length (2 Marks)
 - d) Chainage of point of intersection (2 Marks)

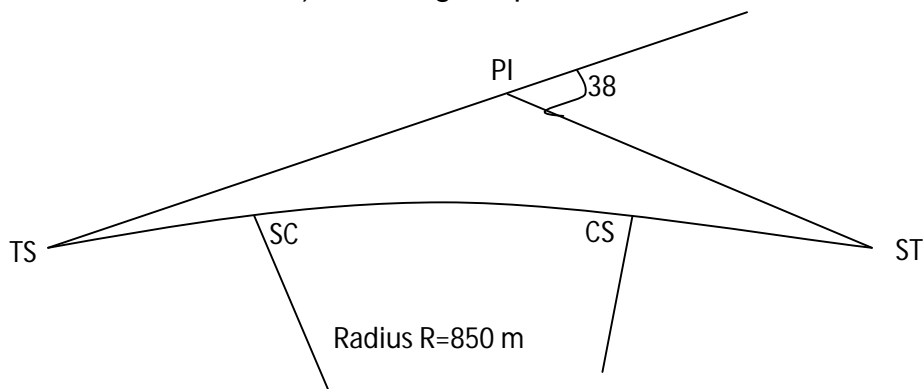


Figure 1

- (ii) Briefly discuss five major cross sectional elements of a road. (6 Marks)

QUESTION THREE

- (a) A horizontal curve whose diameter is 900m balances 45% centrifugal force,
- (i) Calculate super elevation for a velocity of 85km/h. (1 Marks)
 - (ii) If the above super elevation and curve radius balances the hand off speed, estimate the design speed. (1 Marks)

- (b) A vertical curve alignment has the first tangent as +4% and second tangent as +1%.if the elevation of the point of intersection is 203.25m, the chainage of end of vertical curve (EVC) is 1024.05m and desirable stopping sight distance is 225m, estimate the elevation of

- a) Beginning of curve (2 Marks)
- b) Point of chainage 898m (2 Marks)
- c) EVC (2 Marks)

(Use $h_1 = 1.05$ and $h_2 = 0.26$ m)

- (c)(i) Show, with illustrative diagram(s) that a driver moving on a curved section of a carriageway with the outer front wheel defining a path of radius R needs an extra width w such that:

$$w = R - \sqrt{R^2 - l^2}$$

Where l = length between front and rear axles to safely negotiate the bend.

(3 Marks)

- (ii) If the curve is designed for a two-axled truck for extra width w of 0.6, lateral width between the wheels of 1.3m and length between front and rear axles of 7m, estimate the radius of the inner rear wheel in the curve. (3 Marks)

- (d)(i) State four factors to consider when designing a roundabout.

(2 Marks)

- (ii) State four advantages and four disadvantages of rotary roundabouts.

(4 Marks)

QUESTION FOUR

- (a)(i) With illustrative diagram(s), differentiate between acceleration and deceleration lanes. (2 Marks)
- (iii) Discuss the four factors to consider when designing an at-grade intersection on a highway. (4 Marks)
- (b) (i) With illustrative diagram(s), define Passing Sight Distance (PSD), safe PSD, Preliminary delay distance, Overtaking distance and Safety distance. (5 Marks)
- (ii) Briefly discuss five factors affecting the traffic speed. (5 Marks)
- (iii) Show, with illustrative diagram(s), the basic equation of super elevation on a circular curve of radius R meters, transverse coefficient of friction μ and a road design speed of V kph is given by

$$e = \frac{V^2}{127R} + \mu \quad (4 \text{ Marks})$$