MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 401: HIGHWAY ENGINEERING I

DATE:26/8/2022 **TIME: 11.00-1.00 PM**

INSTRUCTIONS:

- *This paper comprises of FIVE questions. Answer **THREE** questions*
- *Question one is **compulsory** and carry 30 marks*
- *Answer any other **TWO** questions*

QUESTION ONE (30 MARKS)

a) i. Define stopping sight distance (SDD) as applied in highway engineering. (2 marks)

ii. 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

I. Beginning of curve (4 marks)

II. Point of chainage 898m (4 marks)

III. EVC (4 marks)

(Use h_1 = 1.05 and h2 = 0.26 m)

b) 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±G) (6 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? (3 marks)

iii. What would be the traction force (T') in terms of initial traction force (T) to maintain the speed of the vehicle? (3 marks)

QUESTION TWO (20 MARKS)

a) i. Define super elevation and state its advantages on road design. (4 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? (6 marks)

b) i. State four resistances that come into place on a moving vehicle. (2 marks)

ii. Briefly discuss four major cross sectional elements of a road. (8 marks)

QUESTION THREE (20 MARKS)

a) i. 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. (6 marks)

ii. 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.(4 marks)

b) i. 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. (4 marks)

ii. State four factors to consider when designing a roundabout. (2 marks)

iii. State four advantages and four disadvantages of rotary roundabouts. (4 marks)

QUESTION FOUR (20 MARKS)

a) i. Discuss the four factors to consider when designing an at-grade intersection on a highway. (6 marks)

ii. With illustrative diagram(s), define Passing Sight Distance (PSD), safe PSD, Preliminary delay distance, Overtaking distance and Safety distance. (5 marks)

b) i. Briefly discuss five factors affecting the traffic speed. (5 marks)

ii. 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

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

QUESTION FIVE (20 MARKS)

a) i. Briefly discuss four major factors controlling road design (8 marks)

ii. State four factors that determine the highway capacity. (4 marks)

b) 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^o. If the length of the circular curve is 76.5m and the chainage at the end of the alignment is 1185.45m, estimate the

i. Length of spiral curve. (2 marks)

ii. Chainage of beginning of curve (2 marks)

iii. Tangent length (2 marks)

iv. Chainage of point of intersection (2 marks)

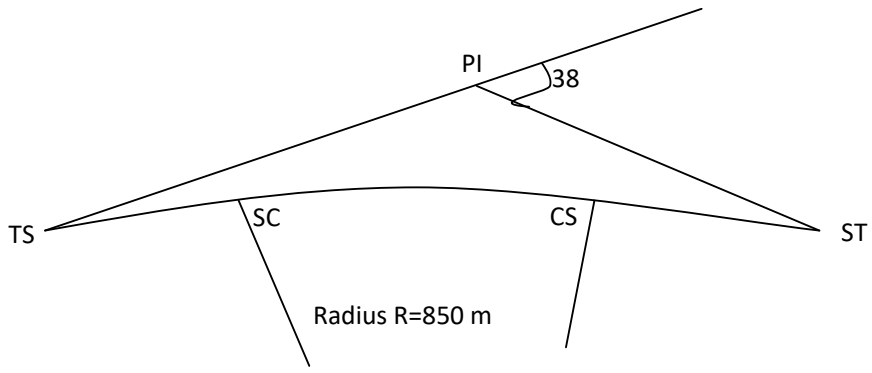

Figure 1