



MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN
BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 401: HIGHWAY ENGINEERING I

DATE: 16TH JANUARY, 2025

TIME: 11.00 AM – 1.00 AM

INSTRUCTIONS:

*Answer question **ONE (Compulsory)** and **any other TWO** questions*

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) When locating a highway route, several key factors are considered to balance engineering, environmental, social, and economic needs. These factors ensure the route is efficient, cost-effective, and sustainable. Discuss **six major factors** that are considered. (6 Marks)
- b) A Road located in Nyeri county has a vertical curve alignment whose first tangent is +3.5% and second tangent as +1.8%. The elevation of the point of intersection is 206.8m, the chainage of end of vertical curve (EVC) is 1034.53m and desirable stopping sight distance is 2316m. Determine the elevation of;
- i) BVC (4 Marks)
 - ii) Chainage 908m (4 Marks)
 - iii) EVC (4 Marks)
- (Use $h_1 = 1.05$ and $h_2 = 0.26$ m)
- c) Ngong road in Kajiado county has a horizontal curve. The curve has a diameter of 980m and balances 45% centrifugal force,
- i) Calculate super elevation for a velocity of 85km/h. (2 Marks)
 - ii) If the above super elevation and curve radius balances the hand off speed, estimate the design speed. (2 Marks)
- d) There are 3 main road classification in Kenya. Briefly discuss **Four** factional classifications of roads. (8 Marks)

QUESTION TWO (20 MARKS)

- a) Eldoret road is a two-lane single carriage with lane width of 5.55m, cross fall on tangent of 2.5 percent and super elevation on circular curve of 6 percent, determine
- Length of the transition curve
 - Radius of the circular curve

Take speed=85km/h and rate of gain of radial acceleration = 0.45m/s^3 .

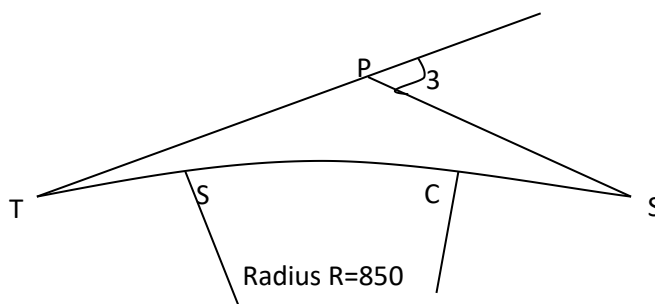
<u>Speed</u>	<u>Max Slope (Longitudinal)</u>
50	0.66%
85	0.50%
100	0.40%
140	0.36%

(10 Marks)

- b) With illustrative diagram(s), define Passing Sight Distance (PSD), safe PSD, Preliminary delay distance, Overtaking distance and Safety distance. (5 Marks)
- c) Briefly discuss five factors affecting the traffic speed. (5 Marks)

QUESTION THREE (20 MARKS)

- a) B42 has a horizontal alignment as shown in figure 1. It 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 chain age at the end of the alignment is 1185.45m, estimate the;
- Length of spiral curve. (3 Marks)
 - Chain age of beginning of curve (3 Marks)
 - Tangent length (3 Marks)
 - Chain age of point of intersection (3 Marks)



Figure

- b) State four advantage of a super elevation on a horizontal curve. (4 Marks)
- c) State four factors that determine the Maximum super elevation to be used on a horizontal curve. (4 Marks)

QUESTION FOUR (20 MARKS)

- a) Majaja road is a two-lane with a 310m horizontal curve, 3.5m lanes and deflection angle of 30° defines the line of sight for a vehicle on the curve. For the standard stopping conditions (1.08m observer and 0.15m object). Determine the slope of the line of sight.
Take the grade to be level.
(4 Marks)
- b) The stopping distance along a two-lane Jogoo road, 3.6m lanes is 140m. Calculate the required clear distance between the drivers' location and the edge of estate on level terrain and no back slope given the radius to the centerline is 305m.
(8 Marks)
- c) Horizontal curve on C91, two lanes (3.6 m per lane) level graded road has a radius of 500 to the centerline. Determine the distance of the line of sight when an obstruction is located 10m from the centerline of the road.
(8 Marks)

QUESTION FIVE (20 MARKS)

- a) A 1.8T vehicle moving at 85km/h on a road with coefficient of friction of 0.4 and grade of 1:45. Determine the braking distances for a perception time of 2.8 sec.
(5 Marks)
- b) During a survey, it was determined that slope of the outside edge of pavement on a super elevation transition should be 0.5% for a two-lane road (4m lanes) and $e_{\max} = 6\%$,
i) Determine the length of the super elevation runoff.
ii) Draw a sketch for the relationship between the centerline and the outside edge of pavement (the centerline is at a constant elevation of 35m).
(5 Marks)
- c) The line of sight from an observer to an object along a crest vertical curve is tangent at the high point of the curve. If the length of the curve is 350m and the observer's eye height is 1m ft above the pavement, what is the Station of the observer if the Station of the PIVC is 10+00.00.
(10 Marks)