# MACHAKOS UNIVERSITY

**University Examinations for 2022/2023**

**SCHOOL OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF BUILDING AND CIVIL ENGINEERING**

**THIRD YEAR FIRST SEMESTER EXAMINATION FOR**

**BACHELOR OF SCIENCE (CIVIL ENGINEERING)**

**ECV 304 SURVEYING III**

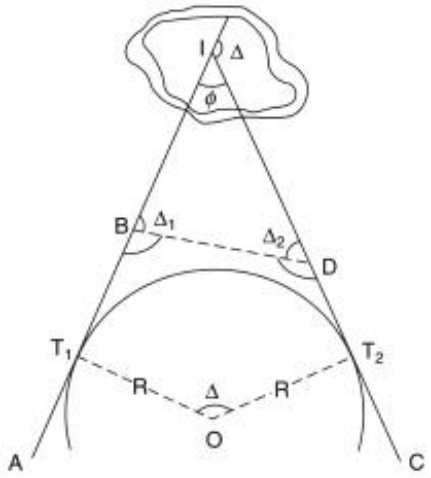
**DATE:** **TIME:**

---

**INSTRUCTIONS:** Attempt questions **ONE** and any other **TWO** questions

**QUESTION ONE (COMPULSORY) (30 MARKS)**

a) The straight lines ABI and CDI are tangents to a proposed circular curve of radius 1600 m. The lengths AB and CD are each 1200 m.




The intersection point is inaccessible so that it is not possible directly to measure the deflection angle; but the angles at B and D are measured as:

ABD = 123° 48', BDC = 126° 12' and the length BD is 1485 m

i) Calculate the distances from A and C of the tangent points on their respective straights. (3 marks)

ii) Calculate the deflection angles for setting out 30-m chords from one of the tangent points. (3 marks)

b) While observing angles at a station, the horizon was closed. The observations in Table I and their standard deviations were obtained:

Table 1

| No. | Angle | S (’’) |
|---|---|---|
| $a_1$ | 134°38’56’’ | ±6.7 |
| $a_2$ | 83°17’35’’ | ±9.9 |
| $a_3$ | 142°03’17’’ | ±4.3 |

What are the most probable values for these observations? (5 marks)

c) Outline the principle behind the rate of approach stating its application in route location (4 marks)

d) Part of a motorway scheme involves the design and setting out of a simple curve with cubic spiral transitions at each end. The transitions are to be designed such that the centrifugal ratio is 0.197, whilst the rate of change of centripetal acceleration is 0.45m/s$^3$ at a design speed of 100 km/h. If the chainage of the intersection to the straights is 2154.22m and the angle of deflection 50°, calculate: *(9 marks)*

i. The length of transition to the nearest 10 m.

ii. The chainage at the beginning and the end of the total composite curve.

iii. The setting-out angles for the first three 10-m chords on a through chainage basis.

e) The Volumes in cubic meters of excavation (+) and fill (−) between successive sections 100 m apart on a 1300-m length of a proposed railway are given.

| *Section* | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Volume (m$^3$) | | −1000 | −2200 | −1600 | −500 | +200 | +1300 | +2100 |
| *Section* | 7 | 8 | 9 | 10 | 11 | 12 | 13 | |
| Volume (m$^3$) | | +1800 | +1100 | +300 | −400 | −1200 | −1900 | |

i. Draw a mass haul diagram for this length.

ii. If earth may be borrowed at either end, which alternative would give the least haul? (6 marks)

**QUESTION TWO (20 MARKS)**

a) With the aid of a clearly labelled diagram, derive the formula for the Apex distance in curves. (4 marks)

b) Describe the approximations used in vertical curve computations (5 marks)

c) Two straights, with a deflection angle of 36°, are to be joined with a circular curve of 500m radius. The forward chainage of the Intersection Point is 6051.35m. Compute the setting-out data required for chords of 20m length. (11 marks)

**QUESTION THREE (20 MARKS)**

An existing length of road consists of a rising gradient of 1 in 20, followed by a vertical parabolic crest curve 100 m long, and then a falling gradient of 1 in 40. The curve joins both gradients tangentially and the reduced level of the highest point on the curve is 173.07 m above datum. Visibility is to be improved over this stretch of road by replacing this curve with another parabolic curve 200 m long.

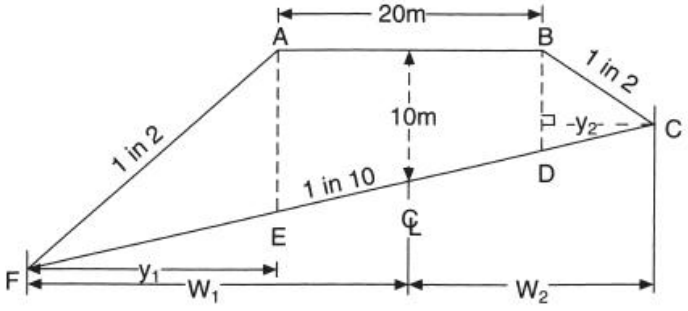
i. Find the depth of excavation required at the mid-point of the curve.

ii. Tabulate the reduced levels of points at 30-m intervals on the new curve.

iii. What will be the minimum visibility on the new curve for a driver whose eyes are 1.05 m above the road surface?

**QUESTION FOUR (20 MARKS)**

In the figure below, the line AB defines the road formation level to be attained and the line FC defines the existing ground level.



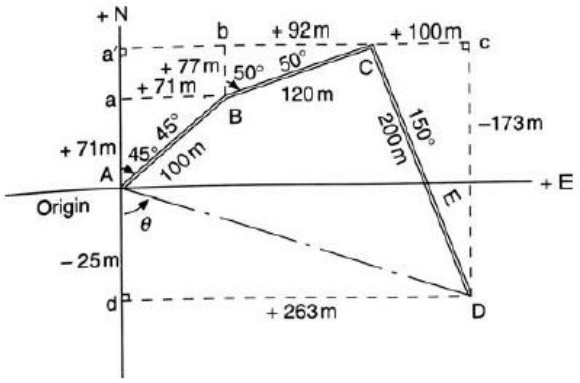
a) Compute the area of the fill and the side widths $W_1$ and $W_2$ (6 marks)

b) Outline two major needs of providing curves (2 marks)

c) Describe the properties of a mass haul diagram (12 marks)

**QUESTION FIVE (20 MARKS)**

a) Compute the area of the polygon ABCD by coordinates. Then carry out a check of the area by using the geometric shapes. (6 marks)




| *Stns* | *E* | *N* |
|---|---|---|
| *A* | 0.0 | 0.0 |
| *B* | 71 | 71 |
| *C* | 163 | 148 |
| *D* | 263 | −25 |
| *A* | 0.0 | 0.0 |

b) Derive Simpson's Rule method of area estimation (7 marks)

c) Outline the procedure of running a traverse (7 marks)