

Ferris State University
Surveying Engineering
Surveying Computation - SURE 215
PROBLEM NUMBER 1
Designed by: S.R. Hashimi
Circle/Circle Intersection Problem

PROBLEM 1

<u>POINT NO.</u>	<u>NORTHING</u>	<u>EASTING</u>
PI #1	4419.696	5260.632

Forward Azimuth of The Back Tangent For Curve #1 = 334 4 36.1

Radius Of The Circular Curve #1 = 328.251

The Central Angle (Delta) For Curve #1 = 72 36 36.2

The Curve is Concaved Left

<u>POINT NO.</u>	<u>NORTHING</u>	<u>EASTING</u>
PT #2	4707.830	5587.996

Forward Azimuth of The Back Tangent For Curve #2 = 84 47 17.4

Tangent Distance For Curve #2 = 426.804

The Central Angle (Delta) For Curve #2 = 70 10 5.3

The Curve is Concaved Left

PROBLEM 2

<u>POINT NO.</u>	<u>NORTHING</u>	<u>EASTING</u>
PC #1	4703.713	5200.627

Forward Azimuth of The Back Tangent For Curve #1 = 199 36 39.7

Tangent Distance For Curve #1 = 465.608

The Central Angle (Delta) For Curve #1 = 70 8 57.2

The Curve is Concaved Left

<u>POINT NO.</u>	<u>NORTHING</u>	<u>EASTING</u>
PI #2	4638.306	4979.898

Forward Azimuth of The Back Tangent For Curve #2 = 208 44 59.7

Tangent Distance For Curve #2 = 414.585

The Central Angle (Delta) For Curve #2 = 70 3 31.0

The Curve is Concaved Left

Compute The Following For Each Of The Above Two Problems (Arrange And Underline Your Answers In The Order Shown Below)

1. The Coordinates Of the Point P (Intersection of the Two Circular Curves)
2. The Coordinates Of The Center (O1) Of The Circle #1
3. The Coordinates Of The Center (O2) Of The Circle #1
4. Arc Length From PC #1 To P
5. Central Angle From PC #1 To P
6. Arc Length From PC #2 To P
7. Central Angle From PC #2 To P
8. Distance And Azimuth From PC #1 To P
9. Distance And Azimuth From PC #2 To P

CIRCLE-CIRCLE INTERSECTION

PROBLEM #1

CURVE #1: $T_1 R_1 \sin \Delta_1/2 = 241.1687$

$$X_{PC_1} = X_{PI_1} + T_1 \sin \Delta_1/2 = 5,366.0631$$

$$Y_{PC_1} = Y_{PI_1} + T_1 \cos \Delta_1/2 = 4,202.7937$$

$$\Delta_{Z_{PC_1}O_1} = \Delta_{Z_{PC_1}PI_1} - 90^\circ = 244^\circ 04' 36.1''$$

$$X_{O_1} = X_{PC_1} + R_1 \sin \Delta_{Z_{PC_1}O_1} = 5,070.8407$$

$$Y_{O_1} = Y_{PC_1} + R_1 \cos \Delta_{Z_{PC_1}O_1} = 4,059.2930$$

$$\Delta_{Z_{PI_1}PT_1} = \Delta_{Z_{PC_1}PI_1} - \Delta_1 = 261^\circ 27' 59.9''$$

$$X_{PT_1} = X_{PI_1} + T_1 \sin \Delta_{Z_{PI_1}PT_1} = 5,022.1331$$

$$Y_{PT_1} = Y_{PI_1} + T_1 \cos \Delta_{Z_{PI_1}PT_1} = 4,383.9101$$

$$R_1 = [(X_{O_1} - X_{PT_1})^2 + (Y_{O_1} - Y_{PT_1})^2]^{1/2} = 328.2510 \checkmark$$

CURVE #2: $\Delta_{Z_{PI_2}PT_2} = \Delta_{Z_{PC_2}PI_2} - \Delta_2 = 14^\circ 37' 12.1''$

$$\Delta_{Z_{PT_2}O_2} = \Delta_{Z_{PT_2}PI_2} + 90^\circ = 284^\circ 37' 12.1''$$

$$T = R \tan \Delta/2 \Rightarrow R_2 = \frac{T_2}{\tan \Delta_2/2} = 607.6397$$

$$X_{O_2} = X_{PT_2} + R_2 \sin \Delta_{Z_{PT_2}O_2} = 5,000.0310$$

$$Y_{O_2} = Y_{PT_2} + R_2 \cos \Delta_{Z_{PT_2}O_2} = 4,861.2029$$

$$X_{PI_2} = X_{PT_2} + T_2 \sin \Delta_{Z_{PT_2}PI_2} = 5,480.2674$$

$$Y_{PI_2} = Y_{PT_2} + T_2 \cos \Delta_{Z_{PT_2}PI_2} = 4,294.8455$$

$$X_{PC_2} = X_{PI_2} + T_2 \sin \Delta_{Z_{PI_2}PC_2} = 5,055.2280$$

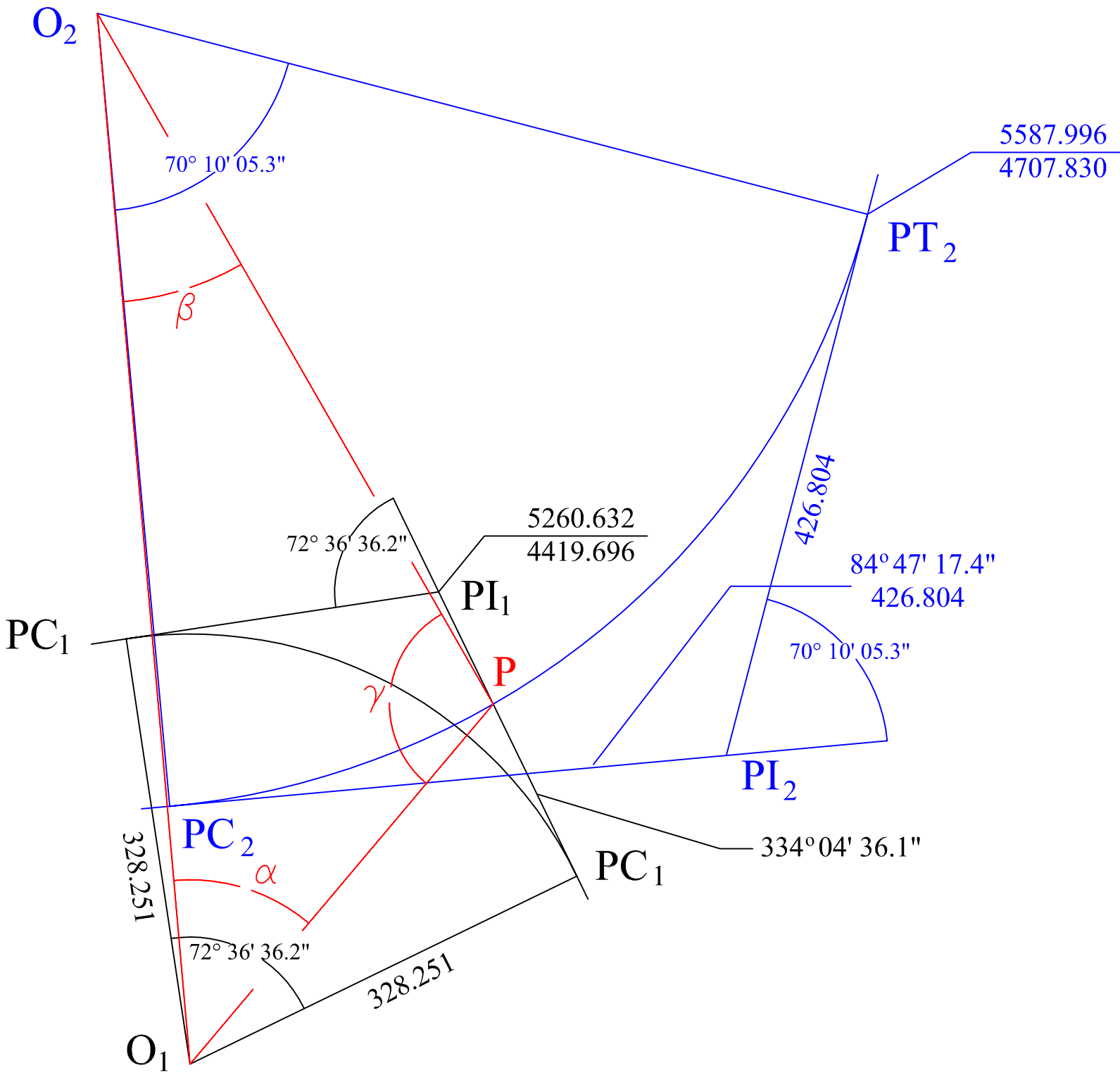
$$Y_{PC_2} = Y_{PI_2} + T_2 \cos \Delta_{Z_{PI_2}PC_2} = 4,256.0754$$

$$R_2 = [(X_{PC_2} - X_{O_2})^2 + (Y_{PC_2} - Y_{O_2})^2]^{1/2} = 607.6397 \checkmark$$

$$\Delta_{O_1O_2P}: D_{O_1O_2} = [(X_{O_2} - X_{O_1})^2 + (Y_{O_2} - Y_{O_1})^2]^{1/2} = 805.0301$$

$$\Delta_{Z_{O_1O_2}P} = \tan^{-1} \left[\frac{X_{O_2} - X_{O_1}}{Y_{O_2} - Y_{O_1}} \right] = 354^\circ 57' 13.7''$$

$$\alpha = \cos^{-1} \left[\frac{D_{O_1O_2}^2 + R_1^2 - R_2^2}{2 D_{O_1O_2} R_1} \right] = 42^\circ 59' 18.3''$$



$$\beta = \cos^{-1} \left[\frac{D_{0,02}^2 + R_2^2 - R_1^2}{2 D_{0,02} R_2} \right] = 21^\circ 36' 47.8''$$

$$AZ_{0,P} = AZ_{0,02} + \alpha = 37^\circ 56' 32''$$

$$X_P = X_{01} + R_1 \sin AZ_{0,P} = \underline{5,272.671}$$

$$Y_P = Y_{01} + R_1 \cos AZ_{0,P} = \underline{4,318.162}$$

$$AZ_{02,P} = AZ_{02,01} - \beta = 153^\circ 20' 25.9''$$

$$X_P = X_{02} + R_2 \sin AZ_{02,P} = \underline{5,272.671} \quad \checkmark$$

$$Y_P = Y_{02} + R_2 \cos AZ_{02,P} = \underline{4,318.162} \quad \checkmark$$

CURVE #1: $d_{PC_1,P} = AZ_{01,PC_1} - AZ_{01,P} = \underline{26^\circ 08' 04.1''}$ (CENTRAL Δ , $PC_1 \rightarrow P$)

$$D_1 = \left(\frac{360^\circ}{2\pi R_1} \right) 100 = 17^\circ 27' 17.5''$$

$$L_1 = (D_1 / D_1) 100 = 415.9874$$

$$ARC_{PC_1,P} = (L_1 / D_1) d_{PC_1,P} = \underline{149.7260}$$

$$K_{PC_1,P} = 2R_1 \sin(d_{PC_1,P}/2) = \underline{148.431}$$

$$AZ_{PC_1,P} = AZ_{PC_1,P_1} - (d_{PC_1,P}/2) = \underline{321^\circ 00' 34''}$$

$$X_P = X_{PC_1} + K_{PC_1,P} \sin AZ_{PC_1,P} = 5,272.671 \quad \checkmark$$

$$Y_P = Y_{PC_1} + K_{PC_1,P} \cos AZ_{PC_1,P} = 4,318.162 \quad \checkmark$$

CURVE #2: $AZ_{02,PC_2} = \tan^{-1} \left[\frac{X_{PC_2} - X_{02}}{Y_{PC_2} - Y_{02}} \right] = 174^\circ 47' 17.4''$

$$d_{PC_2,P} = AZ_{02,PC_2} - AZ_{02,P} = \underline{21^\circ 26' 51.5''}$$

$$D_2 = (360^\circ / 2\pi R_2) 100 = 9^\circ 25' 45.2''$$

$$L_2 = (D_2 / D_2) 100 = 744.1551$$

$$ARC_{PC_2,P} = (L_2 / D_2) d_{PC_2,P} = \underline{227.459}$$

$$K_{PC_2,P} = 2R_2 \sin(d_{PC_2,P}/2) = \underline{226.133}$$

$$AZ_{PC_2,P} = AZ_{PC_2,P_2} - (d_{PC_2,P}/2) = \underline{74^\circ 03' 51.7''}$$

$$X_P = X_{PC_2} + K_{PC_2,P} \sin AZ_{PC_2,P} = 5,272.671 \quad \checkmark$$

$$Y_P = Y_{PC_2} + K_{PC_2,P} \cos AZ_{PC_2,P} = 4,318.162 \quad \checkmark$$

PROBLEM #2

CURVE #1: $T = R \tan \Delta/2 \Rightarrow R_1 = T_1 / \tan \Delta/2 = 663.1176$

$X_{PI_1} = X_{PC_1} + T_1 \sin AZ_{PC_1, PI_1} = 5,044.3536$

$Y_{PI_1} = Y_{PC_1} + T_1 \cos AZ_{PC_1, PI_1} = 4,265.1136$

$AZ_{PI_1, PT_1} = AZ_{PC_1, PI_1} - \Delta_1 = 129^\circ 27' 42.5''$

$X_{PT_1} = X_{PI_1} + T_1 \sin AZ_{PI_1, PT_1} = 5,403.8256$

$Y_{PT_1} = Y_{PI_1} + T_1 \cos AZ_{PI_1, PT_1} = 3,969.1900$

$AZ_{PC_1, O_1} = AZ_{PC_1, PI_1} - 90^\circ = 109^\circ 36' 39.7''$

$X_{O_1} = X_{PC_1} + R_1 \sin AZ_{PC_1, O_1} = 5,825.2790$

$Y_{O_1} = Y_{PC_1} + R_1 \cos AZ_{PC_1, O_1} = 4,481.1489$

$R_1 = [(X_{O_1} - X_{PT_1})^2 + (Y_{O_1} - Y_{PT_1})^2]^{1/2} = 663.1176' \checkmark$

CURVE #2: $R_2 = T_2 / \tan \Delta/2 = 591.4447$

$X_{PC_2} = X_{PI_2} + T_2 \sin AZ_{PI_2, PC_2} = 5,179.3082$

$Y_{PC_2} = Y_{PI_2} + T_2 \cos AZ_{PI_2, PC_2} = 5,001.7841$

$AZ_{PC_2, O_2} = AZ_{PC_2, PI_2} - 90^\circ = 118^\circ 44' 59.7''$

$X_{O_2} = X_{PC_2} + R_2 \sin AZ_{PC_2, O_2} = 5,697.8440$

$Y_{O_2} = Y_{PC_2} + R_2 \cos AZ_{PC_2, O_2} = 4,717.3066$

$AZ_{O_2, PT_2} = AZ_{O_2, PC_2} - \Delta_2 = 228^\circ 41' 28.7''$

$X_{PT_2} = X_{O_2} + R_2 \sin AZ_{O_2, PT_2} = 5,253.5721$

$Y_{PT_2} = Y_{O_2} + R_2 \cos AZ_{O_2, PT_2} = 4,326.8847$

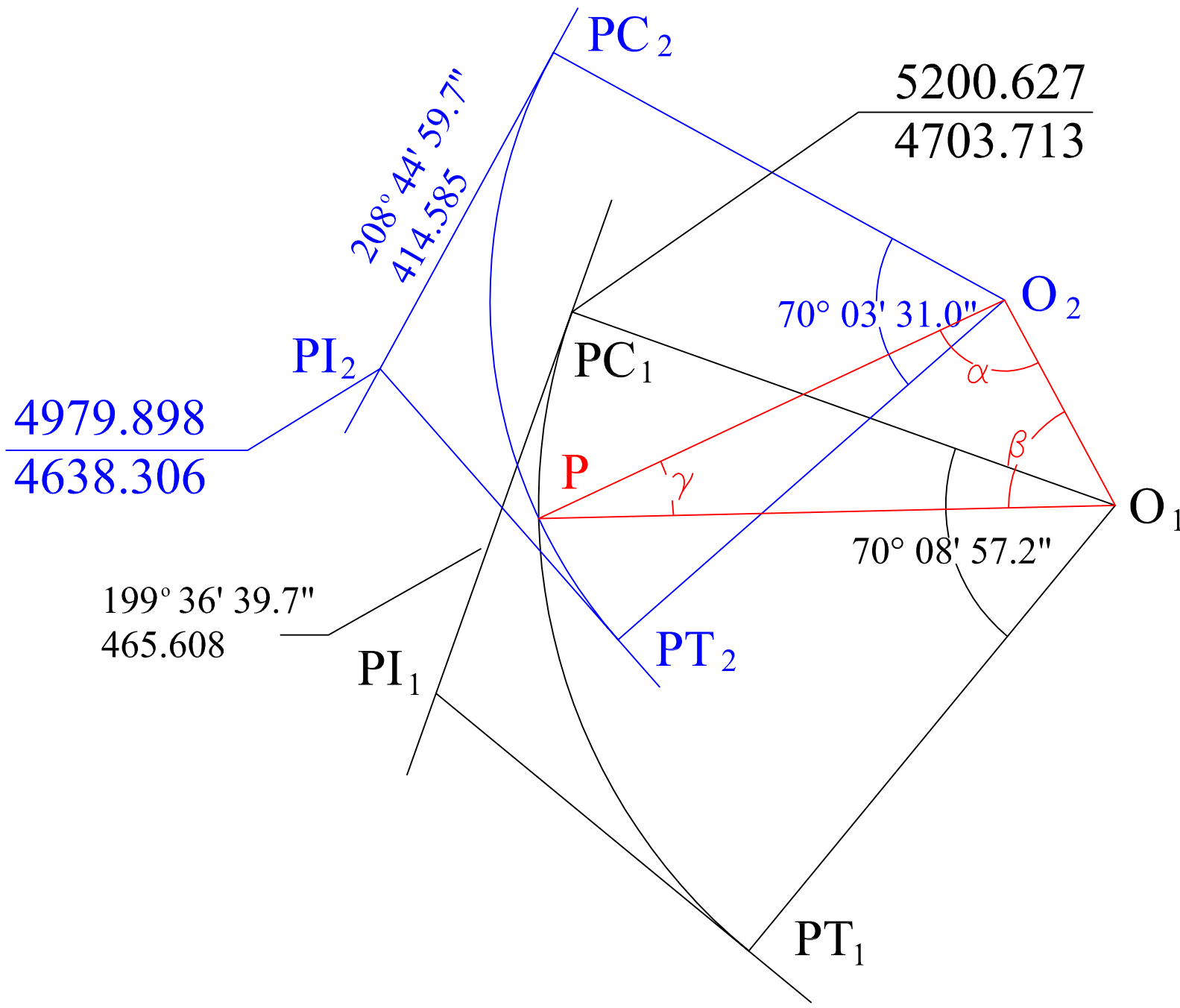
$T_2 = [(X_{PI_2} - X_{PT_2})^2 + (Y_{PI_2} - Y_{PT_2})^2]^{1/2} = 414.5850$

$\Delta_{O_1, O_2, P}$: $D_{O_1, O_2} = [(X_{O_2} - X_{O_1})^2 + (Y_{O_2} - Y_{O_1})^2]^{1/2} = 268.3470$

$AZ_{O_1, O_2} = \tan^{-1} \left[\frac{X_{O_2} - X_{O_1}}{Y_{O_2} - Y_{O_1}} \right] = 331^\circ 38' 52.4''$

$\alpha = \cos^{-1} \left[\frac{R_1^2 + D_{O_1, O_2}^2 - R_2^2}{2 R_1 D_{O_1, O_2}} \right] = 62^\circ 56' 07.7''$

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22-142 100 SHEETS
22-144 200 SHEETS
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$$\beta = \cos^{-1} \left[\frac{R_2^2 + D_{0,02}^2 - R_1^2}{2R_2 D_{0,02}} \right] = 93^\circ 14' 02.9''$$

$$AZ_{0,P} = AZ_{0,02} - \alpha = 268^\circ 42' 44.7''$$

$$X_P = X_{01} + R_1 \sin AZ_{0,P} = \underline{5,162.3288}$$

$$Y_P = Y_{01} + R_1 \cos AZ_{0,P} = \underline{4,466.2482}$$

$$AZ_{02P} = AZ_{02,01} + \beta = 244^\circ 52' 55.3''$$

$$X_P = X_{02} + R_2 \sin AZ_{02P} = \underline{5,162.3288} \checkmark$$

$$Y_P = Y_{02} + R_2 \cos AZ_{02P} = \underline{4,466.2481} \checkmark$$

CURVE #1: $d_{PC,P} = AZ_{0,PC} - AZ_{0,P} = \underline{20^\circ 53' 55''}$

$$D_1 = (360^\circ / 2\pi R_1) 100 = 8^\circ 38' 25.3''$$

$$L_1 = (D_1 / D_1) 100 = 811.8780$$

$$ARC_{PC,P} = (L_1 / D_1) d_{PC,P} = \underline{241.872}$$

$$R_{PC,P} = 2R_1 \sin(d_{PC,P}/2) = \underline{240.533}$$

$$AZ_{PC,P} = AZ_{PC,P1} - (d_{PC,P}/2) = \underline{189^\circ 09' 42''}$$

$$X_P = X_{PC} + R_{PC,P} \sin AZ_{PC,P} = 5,162.329 \checkmark$$

$$Y_P = Y_{PC} + R_{PC,P} \cos AZ_{PC,P} = 4,466.248 \checkmark$$

CURVE #2: $d_{PC2P} = AZ_{02,PC2} - AZ_{02,P} = \underline{53^\circ 52' 04''}$

$$D_2 = (360^\circ / 2\pi R_2) 100 = 9^\circ 41' 14.7''$$

$$L_2 = (D_2 / D_2) 100 = 723.191$$

$$ARC_{PC2P} = (L_2 / D_2) d_{PC2P} = \underline{556.060}$$

$$R_{PC2P} = 2R_2 \sin(d_{PC2P}/2) = \underline{535.805}$$

$$AZ_{PC2P} = AZ_{PC2,P2} - (d_{PC2P}/2) = \underline{181^\circ 48' 58''}$$

$$X_P = X_{PC2} + R_{PC2P} \sin AZ_{PC2P} = 5,167.329 \checkmark$$

$$Y_P = Y_{PC2} + R_{PC2P} \cos AZ_{PC2P} = 4,466.248 \checkmark$$