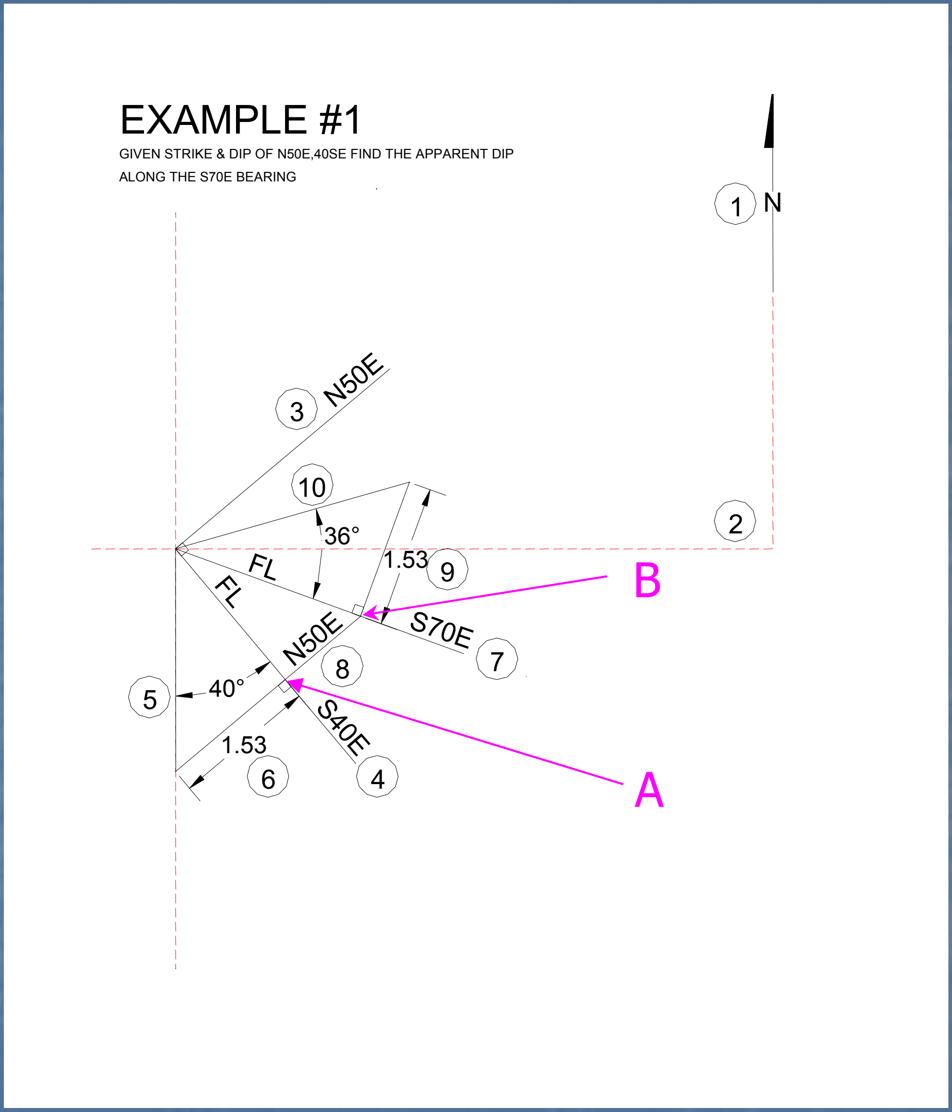
GY403 Structural Geology Laboratory

Example Apparent Dip & 3-Point Problems

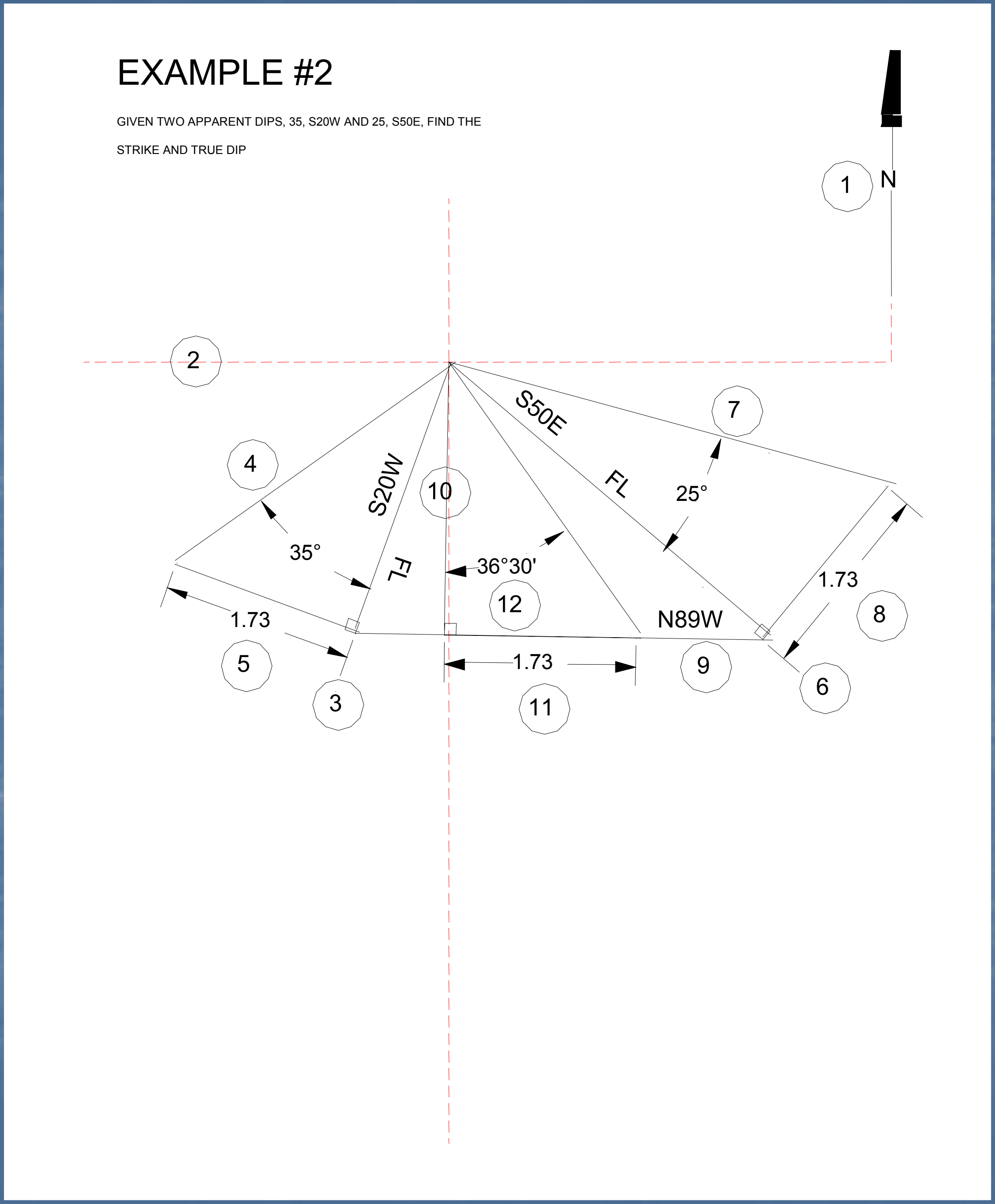
Given: Strike and dip of N50E, 40SE
Find: Apparent dip angle in a vertical section trending S70E

Step 1: construct north arrow.
Step 2: construct E-W and N-S construction lines. Origin is located where these lines intersect.
Step 3: construct strike line from origin to NE.
Step 4: construct fold line along true dip direction (S40E).
Step 5: construct true dip angle (40°).
Step 6: construct a perpendicular to the true dip fold line at arbitrary distance from origin.
Step 7: construct a line from origin trending in apparent dip direction (S70E).
Step 8: construct a line from point A parallel to strike (N50E) until it intersects apparent dip trend line (point B)
Step 9: construct a perpendicular from S70E line from point B that is the same length as Step 6 line (1.53 units).
Step 10: construct a line from the origin to the end of the line constructed in previous step. Angle from fold line to this line is apparent dip.

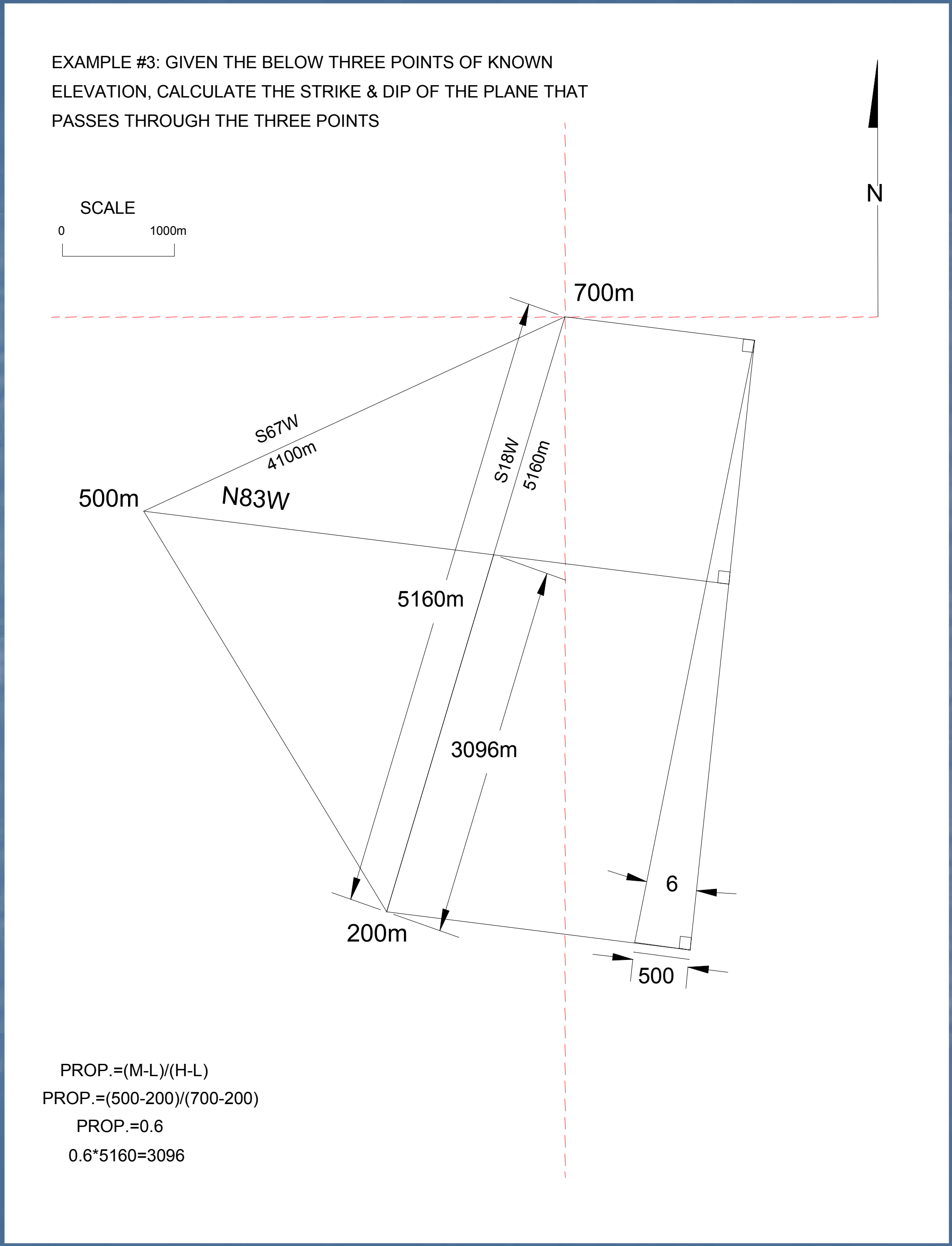


NOTE: sequential problem steps are indicated by circled number.

Given: 2 apparent dip angles and trends of 25, S50E, and 35, S20W, formed by excavating vertical cuts on the upper contact of a planar coal seam. Find: Strike and true dip of coal seam.



Given: 3 geographic points that are in the same geological plane and that have known elevations.
Find: Strike and true dip of the structural plane that passes through the 3 points.



Mathematical Example: Given Strike and True Dip find Apparent Dip angle

φ = true dip angle
δ = apparent dip angle
β = angle between true dip bearing and apparent dip bearing

$\delta = \text{ArcTan}\,[\text{Tan}\,\varphi\ \text{Cos}\,\beta]$

Example Problem 1: Given strike and true dip of N50E, 40SE, find the apparent dip in vertical section trending S70E.

$\varphi = 40$
$\beta = 30$
$\delta = \text{ArcTan}\,[(\text{Tan}\,40)(\text{Cos}\,30)]$
$\delta = \text{ArcTan}\,[(0.839)(0.866)]$
$\delta = \text{ArcTan}\,[0.726]$
$\delta = 36$

Mathematical Example: Given 2 Apparent Dips find Strike and Dip

Let α, β, γ represent directional angles of a linear vector. Because apparent dips are equivalent to linear vectors their plunge and azimuth (trend) can be directly converted to directional cosines:
Cos (α) = Sin (azimuth) * Sin (90-plunge)
Cos (β) = Cos (azimuth) * Sin (90-plunge)
Cos (γ) = Cos (90-plunge)

The angle between 2 non-parallel vectors can be calculated by:
Cos (θ) = Cos(α1)*Cos(α2)+Cos(β1)*Cos(β2)+Cos(γ1)*Cos(γ2)

The normal to the plane containing 2 non-parallel vectors is calculated by the cross-product equations:

$$\cos\alpha_P = \frac{\cos\beta_1\cos\gamma_2 - \cos\gamma_1\cos\beta_2}{\sin\theta}$$

$$\cos\gamma_P = \frac{\cos\alpha_1\cos\beta_2 - \cos\beta_1\cos\alpha_2}{\sin\theta}$$

$$\cos\beta_P = \frac{-\left[\cos\alpha_1\cos\gamma_2 - \cos\gamma_1\cos\alpha_2\right]}{\sin\theta}$$

Mathematical Solution cont.

Problem 2: given two apparent dips:
(1) 35, S20W
(2) 25, S50E

Find the strike and true dip of the plane from which the above two apparent dips were measured. The directional cosines are calculated as below:

Vector (1)
Azimuth1 = 200; Plunge1 = 35
$Cos(\alpha 1) = Sin(200)*Sin(90-35) = (-0.342)*(0.819) = -0.280$
$Cos(\beta 1) = Cos(200)*Sin(90-35) = (-0.940)*(0.819) = -0.770$
$Cos(\gamma 1) = Cos(90-35) = 0.574$
Vector (2)
Azimuth2 = 130; Plunge2 = 25
$Cos(\alpha 2) = Sin(130)*Sin(90-25) = (0.766)*(0.906) = 0.694$
$Cos(\beta 2) = Cos(130)*Sin(90-25) = (-0.643)*(0.906) = -0.582$
$Cos(\gamma 2) = Cos(90-25) = 0.423$

Mathematical Solution cont.

$\text{Cos}(\theta) = (-0.280)(0.694)+(-0.770)(-0.582)+(0.574)(0.423)$
$\theta = \text{ArcCos}[-0.194+0.448+0.243]$
$\theta = \text{ArcCos}(0.497)$
$\theta = 60.2$

Now all necessary values are known for extracting the cross-product:

$\text{Cos}(\alpha_P) = [(-0.770)*(0.423)-(0.574)*(-0.582)]/\text{Sin}(60.2) = 0.010$
$\text{Cos}(\beta_P) = -[(-0.280)*(0.423)-(0.574)*(0.694)]/\text{Sin}(60.2) = 0.596$
$\text{Cos}(\gamma_P) = [(-0.280)*(-0.582)-(-0.770)*(0.694)]/\text{Sin}(60.2) = 0.804$

$\text{Azimuth}_P = \text{ArcTan}(0.010/0.596) = 0.96$
$\text{Plunge}_P = 90 - \text{ArcCos}(0.804) = 53.5$

Strike = 0.96 + 90 = 90.96 = N89W
True dip = 90 - 53.5 = 36.5SW