FE Civil Review – Surveying
Spring 2012

Snyder

FE Civil –Surveying Afternoon Session

I. Surveying (11% of 60 problems - PM Test Content)

A. Angles, distances, and trigonometry

B. Area Computations

C. Closure

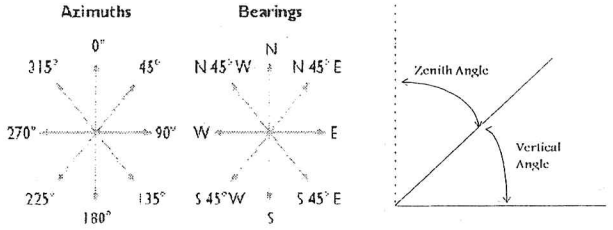
D. Coordinate Systems (e.g., GPS, state plane)

E. Curves (vertical and horizontal)

F. Earthwork and volume computations

G. Leveling (e.g., differential, elevations, percent grades)

Angles, Distances and Trigonometry



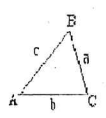
Angles, Distances and Trigonometry

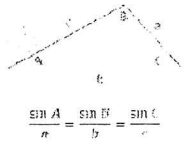
Law of Cosines (3 versions)

$c^2 = a^2 + b^2 - 2ab\cos C$

$b^2 = a^2 + c^2 - 2ac\cos B$

$a^2 = b^2 + c^2 - 2bc\cos A$





$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$\text{area} = \frac{1}{2}(\text{base}) \times (\text{height})$

$= \frac{1}{2}(c)(b\sin A)$

$= \frac{1}{2}cb\sin A$

$= \frac{1}{2}bc\sin A$

Examples (1/8)

1. Two sides of a triangular shaped property are 83.40 ft. and 95.20 ft. respectively. The angle between the two sides is 51°15'00". Which values represent the remaining elements of the property?

   a. 77.97 ft, 56°31'56", 72°13'05"
   b. 77.97 ft, 56°31'56", 72°15'07"
   c. 77.93 ft, 56°31'56", 72°13'04"
   d. 85.46 ft, 55°31'15", 79°09'45"

Examples (2/8)

2. A triangular shaped property is 1.5 acres. The 3 angles are 102°03'50", 47°56'10" and 30°00'00". What is the length of the side opposite angle 30°00'00"?

   a. 250.00 ft^2
   b. 350.34 ft^2
   c. 300.00 ft^2
   d. 375.89 ft^2

Examples (3/8)

3. The mean direction between two azimuths AB 289°30'50" and AC 15°16'20" expressed as a bearing is:

   a. N27°36'25"W
   b. N27°36'20"E
   c. S27°35'25"W
   d. N27°35'20"E

Examples (4/8)

4. A line is measured to have a slope distance of 257.56 ft. with a slope of 4°0'0". If the actual slope is 3°0'0", the error introduced as a result of the incorrect slope is?

   a. 0.10 ft.
   b. 0.14 ft.
   c. 0.28 ft.
   d. 0.34 ft.

Examples (5/8)

5. Determine the vertical distance to the top of a tower with respect to a total station. The height of the tower is 157.00 ft. and the vertical angle to the base of the tower is 1°46'52" and the vertical angle to the top of the tower is 9°50'33". What is the distance from the total station to the top of the tower?

   a. 159.89 ft.
   b. 179.09 ft.
   c. 191.48 ft.
   d. 199.35 ft.

Examples (6/8)

6. A slope distance and zenith angle of 123.456 m and 102°54'00", respectively, are measured using a total station. The horizontal distance (m) is most nearly:

   a. 123.335
   b. 123.298
   c. 120.511
   d. 120.340

Examples (7/8)

7. The following azimuths are from the north: 329°20', 183°35', 48°32' 170°30', 145°25' and 95°49'. Express these directions as (1) azimuths from the south, (2) back azimuths, (3) bearings.

   answers:
   (1) 149°20', 3°35', 228°32',350°30',325°25',275°49'
   (2) same as (1)
   (3) N30°40'W, S3°35'W, N48°32'E, S9°30'E, S34°35'E, S84°11'E

Examples (8/8)

8. In downtown Corbin, the 1990 isogonic map shows a magnetic declination of 23°31'W with an annual shift of 2' westward. A 2000 ft. property line had a magnetic bearing in 1990 of N 60°10'W . What is the magnetic and true bearing of this line in 2006? A pipeline was constructed carrying a magnetite slurry that crossed the property line just prior to the original magnetic bearing measurement, what was the true bearing in 1990?

   a. 59°38 W , 83°41' W, 83°41' W
   b. 59°35 W , 82°41' W, 82°41' W
   c. 59°28 W , 83°41' E, 83°44' E
   d. 59°37 W , 84°41' W, 83°41' W

Areas

Area by Coordinates:

$$2 \times Area = [+X_1Y_n + X_nY_{n-1} + X_{n-1}Y_{n-2} + X_{n-2}Y_{n-3} + X_3Y_2 + X_2Y_1 - X_nY_{n-1} - X_{n-1}Y_{n-2} - X_{n-2}Y_{n-3} - X_3Y_2 - X_2Y_1 - X_1Y_n]$$

$$area = \frac{1}{2}(base) \times (height)$$

$$= \frac{1}{2}(c) \times (b \sin A)$$

$$= \frac{1}{2}bc \sin A$$

Simpson's 1/3 Rule Area:

$$= \frac{h}{3}\left[f(x_0) + 4 \sum_{\substack{i=1 \\ i=odd}}^{n-1} f(x_i) + 2 \sum_{\substack{i=2 \\ i=even}}^{n-2} f(x_i) + f(x_n) \right]$$

Trapezoidal Area - regularly spaced offsets:

$$Area = w\left(\frac{h_o}{2} + h_1 + h_2 + \ldots + \frac{h_n}{2}\right)$$

Irregularly spaced offsets:

$$Area = \frac{1}{2}[d(h_0 + h_1) + d(h_1 + h_2) + d(h_2 + h_3) + \ldots + (h_{n-1} + h_n)]$$

Examples (1/5)

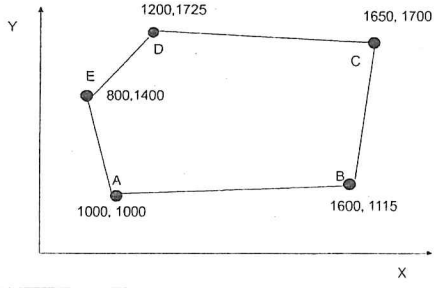
9. Calculate the area of a triangle with x-y coordinates of its corners given as (3,1), (5,1), and (5,7).

   a. 5
   b. 6.0
   c. 6
   d. 5.5

Examples (2/5)

10. Given the following traverse (units = feet), compute the area of the parcel (ABCDEA) in acres:

    a. 9.534
    b. 10.3478
    c. 10.3633
    d. 10.5322



Examples (3/5)

11. The balanced latitude and departure of the legs of a closed traverse were determined as shown. What is the traverse area?

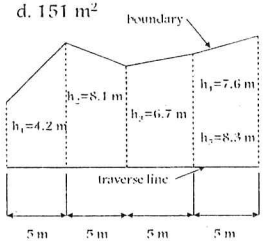
    a. 2,065,000
    b. 1,800,100
    c. 2,000,000
    d. 3,005,000

Leg	Latitude	Departure
AB	N 350	E 0
BC	N 550	E 600
CD	S 250	E 1200
DE	S 750	E 200
EF	S 550	W 1100
FA	N 650	W 900

Examples (4/5)

12. A boundary and traverse line bordering an irregular area are shown. Using Simpson's 1/3 rule, the total area between the boundary and traverse is most nearly:

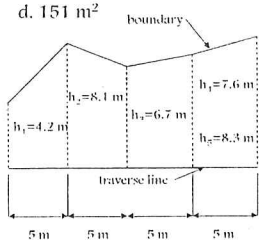
a. 141 m^2
b. 143 m^2
c. 148 m^2
d. 151 m^2



Examples (5/5)

13. A boundary and traverse line bordering an irregular area are shown. Using the trapezoidal rule, the total area between the boundary and traverse is most nearly:

a. 141 m^2
b. 143 m^2
c. 148 m^2
d. 151 m^2

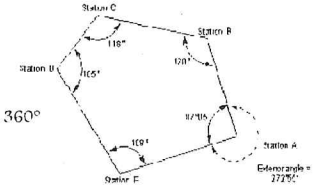


Closure

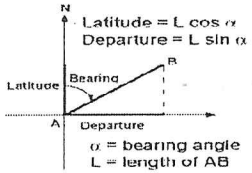
•Angular Closure (balance angles)

$$\sum_{i=1}^{n} 180(n-2)$$

Sum deflection Angles = 360°
A_1 + Sum(Angles right) – Sum(Angles left) = A_2 + 360°



•Traverse Closure (coordinates)



•Compass Rule
(Error Lat./Perimeter length) X Leg Distance = Latitude Correction
(Error Dept./Perimeter length) X Leg Distance = Departure Correction

Examples (1/5)

14. The interior angles of a five-sided closed -loop traverse are as follows: 124°34', 93°30', 139°50' 130°20'. The fifth and remaining angle is not measured. Compute this angle, assuming the given angles to have no error.

a. 51°47'
b. 51°45'
c. 51°46'
d. 47°51'

Examples (2/5)

15. The deflection angles of a closed traverse are as follows: 85°20' R, 10°04' L, 83°32' R, 63°27' R, 34°18'R, 72°56' R, 30°45' R. Compute the error of closure. Adjust the angular values on the assumption that the error is the same for each.

    a. 14'
    b. 13'
    c. -13'
    d. -10'

Examples (3/5)

16. A closed traverse consists of seven legs, the total of whose length is 2705.13 ft. Leg CD has a departure of 443.56 ft. and a latitude of 219.87 ft. The total closure in departure for the traverse was 0.41 ft.; the total closure in latitude was -0.29 ft. Using the compass rule, the corrected latitude and departure for leg CD are:

    a. 219.82, 443.64
    b. 218.92, 444.48
    c. 219.92, 444.48
    d. 211.52, 460.51

Examples (4/5)

17. A five-leg closed traverse is taped and scoped in the field, but obstructions make it impossible to collect all readings. It is known that the general direction of leg EA is east west. Complete the field notes.

Leg	N. Azimuth	Distance
AB	106.22	1081.3
BC	195.23	1589.5
CD	247.12	1293.7
DE	332.37	
EA		1737.9

Examples (5/5)

18. Calculate the closure, latitude and departures and the corrected latitude and departures for the closed-loop traverse shown.

COURSE	BEARING	LENGTH	AZIMUTH	LAT. (y)	DEP. (x)
A - B	N 26° 10' 00"E	28.510			
B - C	S 75° 25' 00"E	61.045			
C - D	S 15° 30' 00"W	72.048			
D - E	N 01° 42' 00"W	20.300			
E - A	N 53° 06' 00"W	64.702			

latitude (A-B) = L sin θ= 28.510 sin (63.833)= 25.588
departure (A-B) = L cos θ = 28.510 cos (63.833)= 12.572

$$z = \sqrt{(\Sigma X)^2 + (\Sigma Y)^2}$$
$$= \sqrt{(0.053)^2 + (-0.070)^2}$$
$$= 0.088$$

Examples (5/5)

COURSE	BEARING	LENGTH	AZIMUTH	LAT (y)	DEP (x)
A - B	N 26° 10' 00"E	28.510	26.167	+ 25.588	+ 12.572
B - C	S 75° 25' 00"E	61.045	345.417	- 15.370	+ 59.078
C - D	S 15° 30' 00"W	72.048	254.500	- 69.427	- 19.254
D - E	N 01° 42' 00"W	20.300	91.700	+ 20.291	- 0.602
E - A	N 53° 06' 00"W	64.702	143.100	+ 38.848	- 51.741
				Σ = -0.070	Σ = +0.053

LEG	Uncorrected Latitudes (ΔY)	Correction in Latitude	Corrected Latitudes (ΔY)	Uncorrected Departures (ΔX)	Correction in Departure	Corrected Departure
A B	+ 25.588	-0.008	+ 25.596	+ 12.572	0.006	+ 12.566
B - C	- 15.370	-0.017	- 15.353	+ 59.078	0.0131	+ 59.0649
C - D	- 69.427	-0.020	- 69.407	- 19.254	0.0155	- 19.2695
D - E	+ 20.291	-0.0058	+ 20.2968	- 0.602	0.0044	- 0.6064
E - A	+ 38.848	-0.018	+ 38.866	- 51.741	0.0139	- 51.7569
	Σ = -0.070		Σ = 0	Σ = +0.053		Σ = 0

Coordinate Systems

Coordinate system- a system that uses one or more numbers to uniquely determine the location of a point or other geometric element.

Two general types – rectangular (e.g., Cartesian, Northing and Eastings) or angular (e.g., latitude and longitude, Universal Transverse Mercator) coordinates.

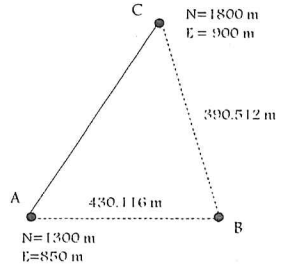
GPS: Triangulates position by sending signals to a satellite array. Time to receive signals from different satellites allows calculation of position.

Strengths: gives latitude/longitude readings anywhere in the world. No drifting of measurement.

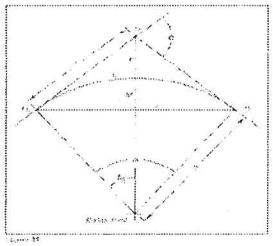
Weaknesses: inaccuracies, outages

Examples (1/1)

19. The north and east coordinates of point B for the situation shown are most nearly:
    a. 250 m, 350 m
    b. 350 m, 250 m
    c. 1200 m, 1550 m
    d. 1550 m, 1200 m



Curves



$$R = \frac{5729.578}{D} \qquad D = \frac{5729.578}{R}$$

$$T = R \tan\frac{\Delta}{2} \qquad C = 2R \sin\frac{\Delta}{2}$$

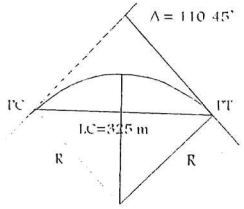
$$M = R\left(1 - \cos\frac{\Delta}{2}\right) \qquad L = \frac{100\Delta}{D} = \frac{\pi R\Delta}{180}$$

$$E = \left(\frac{R}{\cos\frac{\Delta}{2}}\right) - R$$

Examples (1/5)

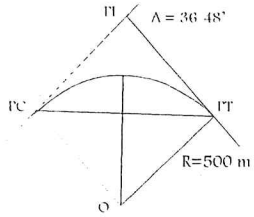
20. What is the tangent distance and the length of the curve for a curve with an intersection angle of 110°45' and a LC of 325 m?

    a. 195 m, 295 m
    b. 197 m, 284 m
    c. 284 m, 390 m
    d. 286 m, 380 m



Examples (2/5)

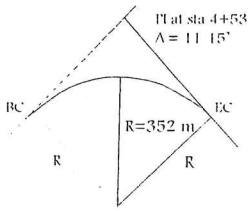
21. The area inside the quadrilateral PC, PI, PT, and O below equals 83, 164 m². The area (m²) between the circular curve and the tangents is most nearly?
    a. 2,879
    b. 3,577
    c. 3,601
    d. 3,700



Examples (3/5)

22. What is the length of the curve with an intersection angle of 11°15' and a radius of 352 m? What is the station for BC?

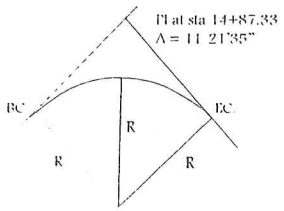
    a. 69 m, 4 +20
    b. 69 m, 4 + 21
    c. 69 m, 4 + 18
    d. 72 m, 4 + 25



Examples (4/5)

23. A 6° curve has forward and back tangents that intersect at sta 14+87.33. The station of the point of tangent is most nearly:

    a. sta 11 + 15.4
    b. sta 17 + 86
    c. sta 17 + 80
    d. sta 17 + 90



Examples (5/5)

24. A total station is set up over the PC, backsighting the back tangent (looking back along the route). Find the deflection angle and distance to place a hub at the location where a storm line will cross the curve at Sta 2+94.25. Given R=200 ft. and PC= Sta 1+53.26.

    a. 20°11'43", 138.09 ft.
    b. 20°11'43", 138.50 ft.
    c. 20°11'40", 138.50 ft.
    d. 20°11'40", 138.09 ft.

Earthwork and Volume Calculations

$V = L(A_1 + A_2)/2$ Average Area End Formula

$V = L(A_1 + 4A_m + A_2)/6$ Prismoidal Formula

$V = h(\text{Area of Base})/3$ Pyramid or Cone

Examples (1/1)

25. The cross-sectional areas to be excavated (cut) at certain sections of a road project are given below. Using the prismoidal method, the earth to be excavated (yd^3) between Sections 4+35 and 5+65 is most nearly:

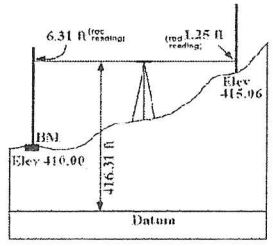
    a. 1,460
    b. 1,840
    c. 1,860
    d. 1,900

Station	Area (ft^2)
3+00	247
4+00	269
4+35	322
5+00	395
5+65	418
6+00	293
7+00	168

Leveling

$\Delta h = \Sigma BS - \Sigma FS$ Differential Leveling

$h_i = h_{i-1} + BS_{i-1} - FS_i$



Examples (1/3)

26. If a level rod is inclined 0.5 ft forward in a length of 12 ft., what error would be introduced in a rod reading of 6.0 ft.?

    a. 0.005 ft.
    b. 0.05 ft.
    c. 0.01 ft.
    d. 0.09

Examples (2/3)

27. A level survey was run from bench mark Point F to find the elevation of Point R. One foresight was not recorded. The level loop was repeated and the elevation of Point R was determined to be 719.43 ft. What is the value of the missing FS in the first run? BM F = 743.25 ft.

    a. 5.23 ft.
    b. 5.21 ft.
    c. 4.23 ft.
    d. 5.50 ft.

BS	FS
0.41'	6.22'
2.56'	9.85'
3.51'	2.83'
0.11'	NR
1.98'	8.28'

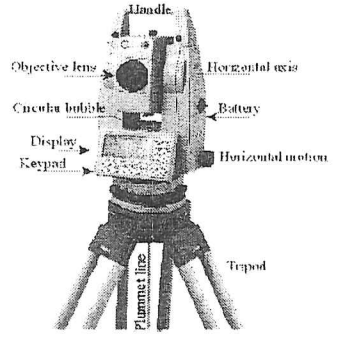
Examples (3/3)

28. The field data (e.g., BS, FS) for a differential leveling survey beginning on BM 1 and closing on BM 2 are as follows: 0.501, 3.525, 1.279, 3.218, 0.458, 1.789, 3.125, 0.345, 2.368, 0.356, 2.554, 0.125 m. Elevations of BM 1 and BM 2 are 219.561 and 220.500 m respectively. Put data in proper field note form, reduce data, determine the closure error, and calculate the adjusted elevation for TP 3.

    a. 0.012 m, 213.273 m
    b. -0.019 m, 213.288 m
    c. 0.012 m, 213.288 m
    d. 0.014 m, 213.273 m

Total Station

Total Station-measures slope distance, horizontal and vertical angles.



Examples (1/3)

29. A total station was used to determine the difference in elevation between two points. The following readings were recorded in the field book for the measurement: HI = 5.43 ft., HR = 5.23 ft., zenith angle = 12.45392°, station point elevation = 564.34 ft. MSL, slope distance = 212.491 ft. What is the elevation of the second point?

    a. 357.29 ft.
    b. 772.03 ft.
    c. 783.01 ft.
    d. 783.51 ft.

Examples (2/3)

30. A total station was used to determine the difference in elevation between two points. The following readings were recorded in the field book for the measurement: HI=5.13 ft., HR=5.65 ft., vertical angle = -11.35322°, prism point elevation = 514.32 ft. MSL, slope distance=112.491 ft. What is the elevation of the station point?

    a. 536.99 ft.
    b. 542.46 ft.
    c. 531.77 ft.
    d. 531.97 ft.

Examples (3/3)

31. Calculate the maximum error in degrees, minutes, and seconds in a horizontal angle measured by a total station to a prism pole held 0.1 ft. off-point a horizontal distance of 845.32 ft.?

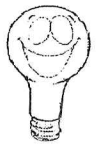
    a. 0°24'00"
    b. 0°1'5"
    c. 0°0'24"
    d. 0°0'2.4"

Answers:

1. a.	20. d.	25. c.
2. c.	21. a.	26. a.
3. a.	22. c.	27. b.
4. c.	23. b.	28. a.
5. c.	24. a.	29. b.
6. d.		30. a.
		31. c.

7. (1) 149°20', 3°35', 228°32',350°30',325°25',275°49'
   (2) same as (1)
   (3) N30°40'W, S3°35'W, N48°32'E, S9°30'E, S34°35'E, S84°11'E
8. a.
9. c.
10. b.
11. a.
12. c.
13. b.
14. b.
15. a.
16. a.
17. DE Dist.=1210.34
18. Solution given in problem.
19. d.

You R Bright



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#1!!!!

Good Luck on
your exam!!