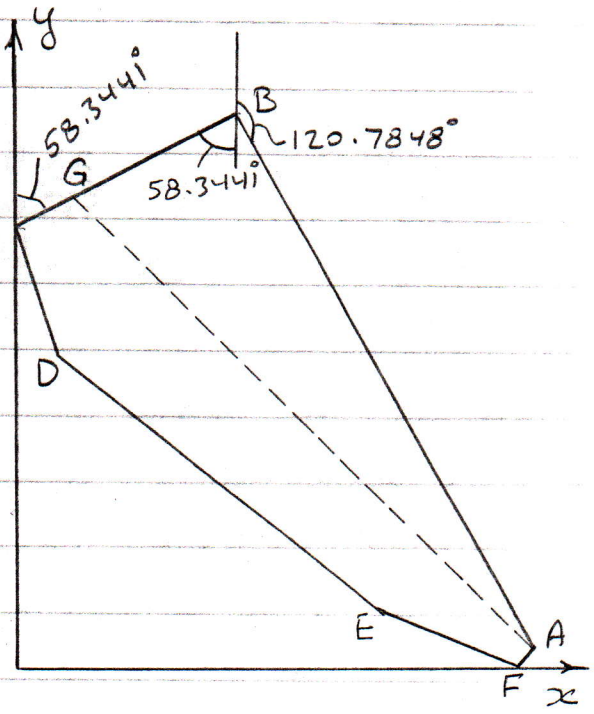
CVG 2171
FINAL EXAM
SOLUTIONS

April 12, 2014

1. a)

Point	E(X)	N(Y)
A	687.999	26.547
B	276.442	717.358
C	0.000	546.918
D	60.229	383.378
E	480.955	70.657
F	671.019	0.000
A	687.999	26.547



Double the Area of ABCDEFA $= [(687.999 \times 717.358) + (276.442 \times 546.918) + (0.000 \times 383.378) + (60.229 \times 70.657) + (480.955 \times 0.000) + (671.019 \times 26.547)]$
$- [(26.547 \times 276.442) + (717.358 \times 0.000) + (546.918 \times 60.229) + (383.378 \times 480.955) + (70.657 \times 671.019) + (0.000 \times 687.999)]$
$= [493541.587 + 151191.106 + 4255.600 + 17813.541]$
$- [7338.706 + 32940.324 + 184387.566 + 47412.189]$
$= 666801.834 - 272078.785$
$= 394723.049$

$\therefore$ Area of ABCDEFA $= 394723.049 \div 2 = \underline{197361.524\ m^2}$ ANS.

1. Cont'd

b) Azimuth of $CB = \tan^{-1}\frac{(276.442-0.000)}{(717.358-546.918)} = \tan^{-1}\frac{276.442}{170.440} = 58.3441^\circ$

Azimuth of $BA = \tan^{-1}\frac{(276.442-687.999)}{(717.358-26.547)} = \tan^{-1}\frac{-411.557}{690.811} = 120.7848^\circ$

$\therefore \angle CBA = (180.0000 - 120.7848) + 58.3441^\circ = 117.5593^\circ$ (See Diagram)

i.e. $\angle GBA = 117.5593^\circ$

Length of $BA = \sqrt{(687.999-276.442)^2+(26.547-717.358)^2}$

$= \sqrt{169379.1642+477219.8377} = 804.114\,m$

Area of $GBA = \frac{1}{2} GB \times BA \times \sin\angle GBA = \frac{197361.524}{2} = 98680.762\,m^2$

$\frac{1}{2} GB \times 804.114 \times \sin 117.5593^\circ = 98680.762$

$356.4366\,GB = 98680.72$

$\therefore GB = 276.853\,m.$

If Coordinates of G are x & y, then:

x of $G = 276.442 - 276.853 \times \sin 58.3441^\circ = \underline{40.780\,m.}$

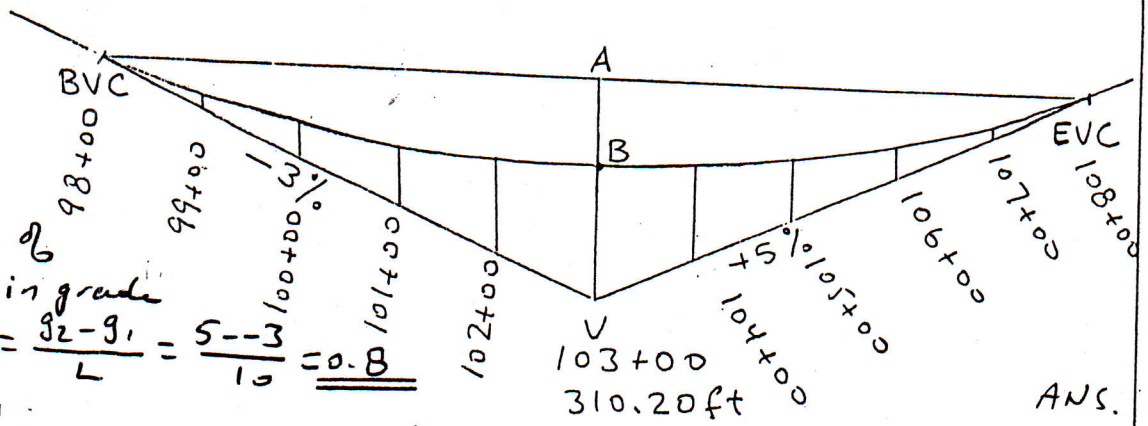
y of $G = 717.358 - 276.853 \times \cos 58.3441^\circ = \underline{572.061\,m.}$

Therefore Coordinates of G are $\underline{\underline{(40.780, 572.061)}}$ ANS.

If Somebody used the imperial units, Then the area will be in ft^2 and x & y in ft.

2.

a)



The rate of change in grade per sta. $= \frac{g_2 - g_1}{L} = \frac{5 - -3}{10} = 0.8$

2

ANS.

b) Elev. of BVC $= 310.20 + (3 \times 5) = 325.20$ ft.

Elev. of EVC $= 310.20 + (5 \times 5) = 335.20$ ft.

$\therefore$ Elev. of A $= \frac{325.20 + 335.20}{2} = 330.20$ ft.

$\therefore$ VB $=$ AB $= \frac{330.20 - 310.20}{2} = 10$ ft

$\frac{\text{offset a}}{\text{offset V}} = \left(\frac{x_a}{L/2}\right)^2$

Offset at 102+00 and 104+00 $= 10 \times \left(\frac{4}{5}\right)^2 = 6.4$ ft.

" " 101+00 " 105+00 $= 10 \times \left(\frac{3}{5}\right)^2 = 3.6$ ft.

" " 100+00 " 106+00 $= 10 \times \left(\frac{2}{5}\right)^2 = 1.6$ ft.

" " 99+00 " 107+00 $= 10 \times \left(\frac{1}{5}\right)^2 = 0.4$ ft.

Station	tangent (ft) elev.	offset	Curve Elev. (ft)	1st difference	2nd difference
98+00 BVC	325.20	0.00	325.20		
99+00	322.20	0.40	322.60	2.60	
100+00	319.20	1.60	320.80	1.80	0.80
101+00	316.20	3.60	319.80	1.00	0.80
102+00	313.20	6.40	319.60	0.20	0.80
103+00 V	310.20	10.00	320.20	−0.60	0.80
104+00	315.20	6.40	321.60	−1.40	0.80
105+00	320.20	3.60	323.80	−2.20	0.80
106+00	325.20	1.60	326.80	−3.00	0.80
107+00	330.20	0.40	330.60	−3.80	0.80
108+00 EVC	335.20	0.00	335.20	−4.60	

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✓ Checks

2. (Cont'd)

c) Low point of the curve.

$$x = \frac{g_1 L}{g_1 - g_2}, \text{ where } x \text{ is from BVC}$$

$$x = \frac{-3 \times 10}{-3-(+5)} = 3.75 \text{ stations from BVC.}$$

∴ Station of the lowest point:

$$98+00 + (3+75) = \underline{101+75}$$ ANS. 3

Offset at $101+75 = 10 \times \left(\frac{3.75}{5}\right)^2 = 5.625$ ft.

Elev. on tangent at $101+75 = 310.20 + (1.25 \times 3) = 313.95$ ft

∴ Elev. of the low point $= 313.95 + 5.625 = \underline{319.575 \text{ ft.}}$ ANS. 3

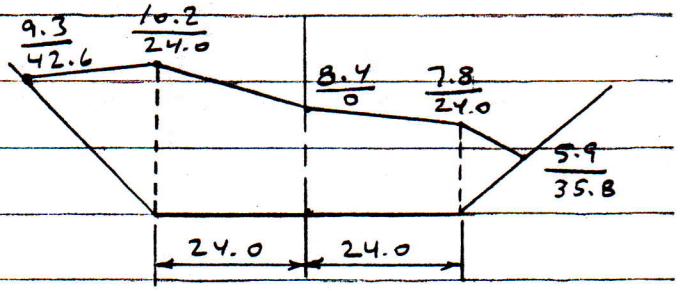
3. a)

Side slopes:

Sta. 95+00

$\frac{42.6 - 24.0}{9.3} = 2$

$\frac{35.8 - 24.0}{5.9} = 2$



Sta. 95+00

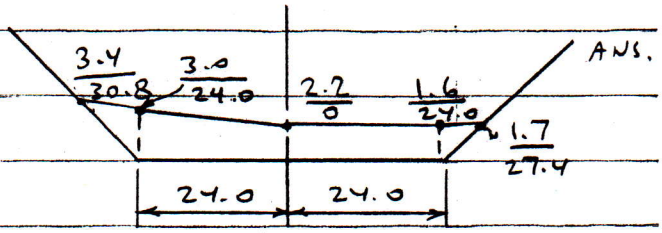
∴ Side slopes @ sta. 95+00 are:

2 <u>2 horiz. : 1 vertical</u>

Sta. 96+00

$\frac{30.8 - 24.0}{3.4} = 2$

$\frac{27.4 - 24.0}{1.7} = 2$



Sta. 96+00

2 ∴ Side slopes @ sta. 96+00 are: <u>2 horiz. : 1 vertical</u> ANS.

b) Area @ Section 95+00:

$\frac{10.2(42.6 - 24.0)}{2} + \frac{8.4 + 10.2}{2} \times 24.0 + \frac{8.4 + 7.8}{2} \times 24.0 + \frac{7.8(35.8 - 24.0)}{2} = \underline{558.48\ ft^2}$

Area @ Section 96+00:

$\frac{3.0(30.8 - 24.0)}{2} + \frac{3.0 + 2.2}{2} \times 24.0 + \frac{2.2 + 1.6}{2} \times 24.0 + \frac{1.6(27.4 - 24.0)}{2} = \underline{120.92\ ft^2}$

10 ∴ Volume $= \frac{558.48 + 120.92}{2} \times \frac{100}{27} = \underline{1258.15\ yd^3}$ ANS.

c) $C_p = \frac{L}{12 \times 27}(C_1 - C_2)(W_1 - W_2)$; $W_1 = 42.6 + 35.8 = 78.4\ ft.$

$W_2 = 30.8 + 27.4 = 58.2\ ft.$

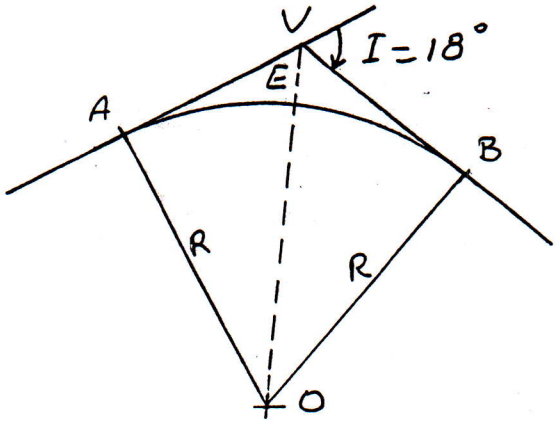
$= \frac{100}{12 \times 27}(8.4 - 2.2)(78.4 - 58.2)$

$= 38.65\ yd^3$

6 ∴ Volume $= 1258.15 - 38.65 = \underline{1219.50\ yd^3}$ ANS.

4. a)

$I = 18°$; $E = 20$ ft.



$$\cos\frac{I}{2} = \frac{R}{R+E}$$

$$\cos 9° = \frac{R}{R+20}$$

$$0.9877R + 19.7538 = R$$

4 $\therefore R = \underline{1606 \text{ ft}}$ ANS

$$D_a = \frac{5729.58}{R} = \frac{5729.58}{1606}. \quad \therefore D_a = \underline{3.5676°} = \underline{3°34'3.4''}$$ ANS

$$T = R\tan\frac{I}{2} = 1606\tan 9° = 254.365 \text{ ft} = 2+54.365 \text{ sta.}$$

$\therefore$ Sta. A $= (75+00) - (2+54.365) = \underline{72+45.635 \text{ sta.}}$ ANS

$$L = 100\frac{I}{D_a} = 100\frac{18°}{3.5676°} = 504.541 \text{ ft} = 5+04.541 \text{ sta.}$$

6 $\therefore$ Sta. B $= (72+45.635)+(5+04.541) = \underline{77+50.176 \text{ sta.}}$ ANS

b) $\frac{d}{2} = 0.3CD_a$; $\therefore$ At A: $\frac{d_1}{2} = 0.3 \times 54.365_{\times 3.5676°} = 58.19 \text{ min.}$

At B: $\frac{d_2}{2} = 0.3 \times 50.176_{\times 3.5676°} = 53.70 \text{ min.}$

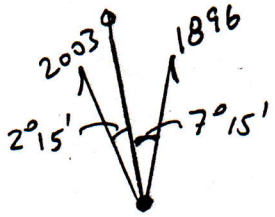
	Station	Chord (ft.)	Deflection Angle
A	72+45.635	0.000	00° 00.00' + $\frac{d_1}{2}$
	73+00	54.365	00° 58.19' + $\frac{D}{2}$
	74+00	100.000	02° 45.22' + $\frac{D}{2}$
V	75+00	100.000	04° 32.24' + $\frac{D}{2}$
	76+00	100.000	06° 19.27' + $\frac{D}{2}$
	77+00	100.000	08° 06.30' + $\frac{D}{2}$
B	77+50.176	50.176	09° 00.00' + $\frac{d_2}{2}$

10 $= \frac{I}{2}$ checks ✓

5. a)

Magnetic Declination :

$7°15' + 2°15' = \underline{\underline{9°30' \text{ W}}}$ ANS.



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b)

40mm x 2000 = 80,000 mm = 80m on the ground.

$\therefore$ Slope $= \frac{2}{80} \times 100 = \underline{\underline{2.5\%}}$ ANS.

If Contour interval was 5m.:

$\therefore$ Distance on ground $= \frac{5}{x} \times 100 = 2.5$; $\therefore x = 200$ m.

Hence, distance on map $= \frac{200 \times 1000}{2000} = \underline{\underline{100 \text{ mm}}}$ ANS.

4

c)

Difference in standard time between Ottawa and Paris is 5 hours.

$\therefore$ Standard time in Ottawa :

$3^h 45^m - 5^h = \underline{\underline{22^h 45^m \text{ on February 28, 2003}}}$ ANS.

4

d)

$d = \frac{rh}{H}$; $d = 0.30$ inches

$r = 3.20$ inches

$h = 375$ ft.

$0.30 = \frac{3.20 \times 375}{H}$; $\therefore H = \frac{3.2 \times 375}{0.3} = \underline{\underline{4000 \text{ ft}}}$ (flying Height) ANS.

$S = \frac{f}{H} = \frac{6/12}{4000} = 8000$; $\therefore$ Scale $= \underline{\underline{1:8000}}$ ANS.

4

e)

Length of ab $= \sqrt{(x_b - x_a)^2 + (y_b - y_a)^2}$

$= \sqrt{(23.59 - 40.50)^2 + (-59.15 - 42.80)^2} = 103.34 \text{mm}$

Photo scale $= \frac{\text{Photo dist.}}{\text{Ground dist.}} = \frac{103.34}{1240.08} \times \frac{1}{1000} = \frac{1}{12000}$; i.e. 1:12000

$S_{av.} = \frac{f}{H - h_{av.}}$; $\frac{1}{12000} = \frac{152.4}{H - \frac{122+178}{2}} = \frac{152.4}{H - 150}$

$\therefore$ H - Flying height $= 1979$ m. // ANS.

4

END