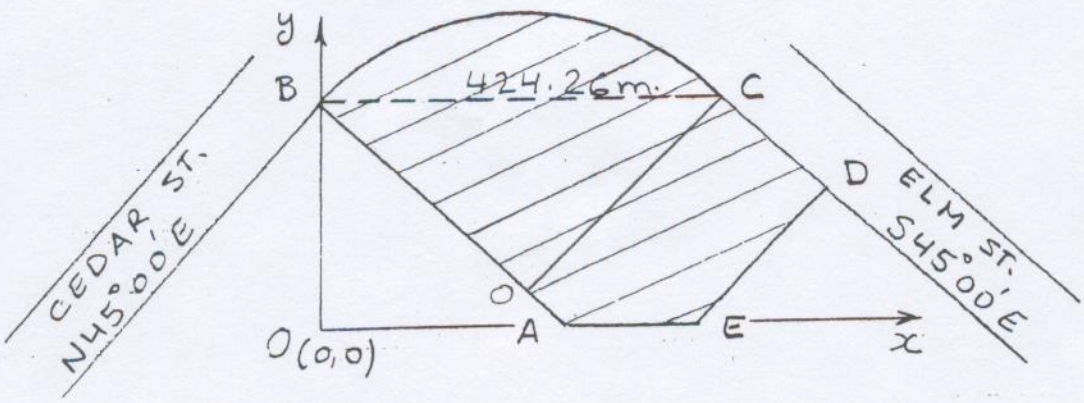
FINAL EXAM

SOLUTIONS

1-

a)



Line	Length (m)	Bearing	Departure (m)	Latitude (m)
AB	350.00	N45°00'W	-247.49	+247.49
BC	424.26	East	+424.26	00.00
CD	150.00	S45°00'E	+106.07	-106.07
DE	200.00	S45°00'W	-141.42	-141.42
EA	141.42	West	-141.42	00.00

Point	x	y
A	247.49	0.00
B	0.00	247.49
C	424.26	247.49
D	530.33	141.42
E	388.91	0.00

b) Area of traverse ABCDEA:

$$\text{Area} = \frac{1}{2}\Big[(247.49\times247.49 + 0.00 + 424.26\times141.42 + 0.00 + 0.00 - (0.00 + 247.49\times424.26 + 247.49\times530.33 + 141.42\times388.91 + 0.00)\Big]$$

	x's	y's
A	247.49	0.00
B	0.00	247.49
C	424.26	247.49
D	530.33	141.42
E	388.91	0.00
A	247.49	0.00

$$= \frac{1}{2}(61251.30 + 59998.85) - (105000.11 + 131251.37 + 54999.65)$$

$$= \frac{1}{2}(-170000.98) = -85000.49$$

$\therefore$ Area of ABCDEA = 85000.49 m²

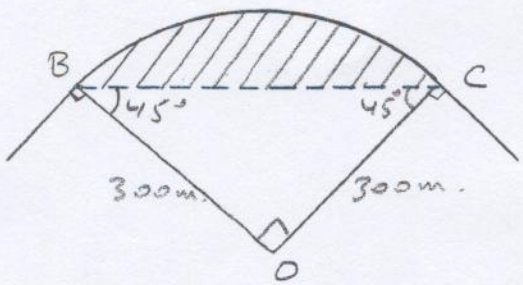
Cont'd ↑

1. b) Cont'd

Area of sector OBC:

$\pi r^2 \times \frac{\theta}{360} =$

$\pi \times (300)^2 \times \frac{90}{360} = 70686\ m^2$



Area of $\triangle$ OBC:

$\frac{300 \times 300}{2} = 45000\ m^2$

∴ Area between chord BC and arc BC:

$70686 - 45000 = 25686\ m^2$

Hence, area of the piece of land:

$85000.49 + 25686 = \underline{\underline{110686.49\ m^2}} = \underline{\underline{11.07\ \text{hectares}}}$ ANS.

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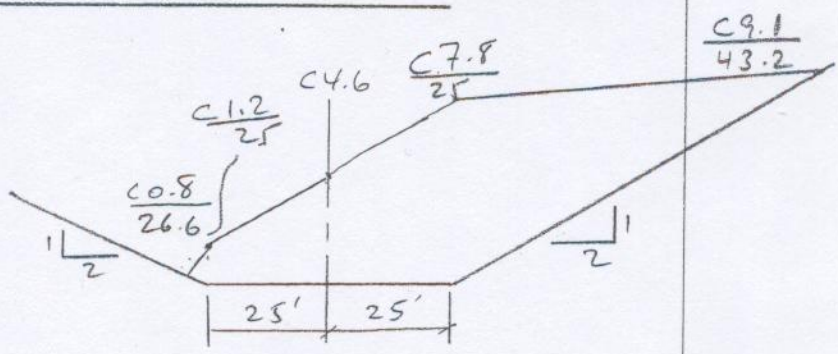
2. a)



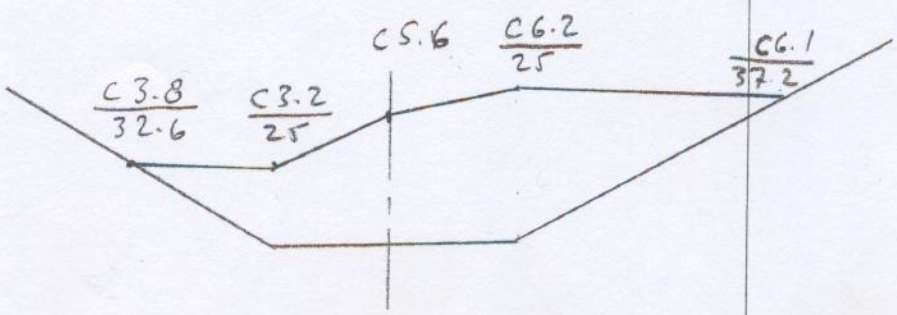
Station 65+00

$(0.8 \times 2) + 25 = 26.6$

$(9.1 \times 2) + 25 = 43.2$

$\text{Area} = \left(\frac{1.2 \times 1.6}{2}\right) + \left(\frac{1.2 + 4.6}{2}\right) \times 25 + \left(\frac{4.6 + 7.8}{2}\right) \times 25 + \left(\frac{7.8 \times 18.2}{2}\right)$

$= 0.96 + 72.5 + 155 + 70.98 = \underline{299.44\ ft^2}$



Station 66+00

$(3.8 \times 2) + 25 = 32.6'$

$(6.1 \times 2) + 25 = 37.2'$

$$\text{Area} = \left(\frac{3.2\times 7.6}{2}\right) + \left(\frac{3.2+5.6}{2}\right)\times 25 + \left(\frac{5.6+6.2}{2}\right)\times 25 + \left(\frac{6.2\times 12.2}{2}\right)$$

$$= 12.16 + 110 + 147.5 + 37.82 = \underline{307.48\ ft^2}$$

b) Volume by Average-END-Area Formula:

$$V_e = \frac{A_1+A_2}{2} \times \frac{L}{27}\ yd^3$$

$$= \frac{299.44+307.48}{2} \times \frac{100}{27} = \underline{1123.93\ yd^3}$$ ANS.

C) Volume by prismoidal Formula:

$$C_p = \frac{L}{12\times 27}(C_1-C_2)(W_1-W_2);$$

$C_1 = 4.6$ ft., $C_2 = 5.6$ ft.

$W_1 = 26.6+43.2 = 69.8$ ft

$W_2 = 32.6+37.2 = 69.8$ ft

$$\therefore C_p = \frac{100}{12\times 27}(4.6-5.6)(69.8-69.8)$$

$$C_p = 0$$

$$\therefore V_p = 1123.93 - 0 = \underline{1123.93\ yd^3}$$ ANS.

3.

a) $M = R\left(1-\cos\frac{I}{2}\right)$

$15 = R\left(1-\cos\frac{11^\circ}{2}\right)$; $\therefore R = \underline{3258\ ft.}$

$$D = \frac{5729.58}{R} = \frac{5729.58}{3258} = \underline{1.75862^\circ} = \underline{1^\circ 45.517'} = \underline{1^\circ 45' 31''}$$ ANS.

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

$$\frac{3258}{3258+E} = \cos\frac{11^\circ}{2};$$

$3258 = 3243 + 0.995E$; $\therefore E = \underline{15.07\ ft.}$ ANS.

3 a) Cont'd.

$$T = R \tan \frac{I}{2} = 3258 \tan 5^\circ 30' = 313.71 \text{ ft} = \underline{3+13.7 \text{ sta.}}$$

$$L = 100 \frac{I}{D} = 100 \times \frac{11^\circ}{1.75862} = 625.50 \text{ ft} = \underline{6+25.5 \text{ sta.}}$$

$\therefore BC = PI - T = (71+00) - (3+13.7) = \underline{67+86.3}$ sta. ANS.

& $EC = (67+86.3) + (6+25.5) = \underline{74+11.8}$ sta. ANS.

b)

$\delta\alpha_1 = 0.3\, C_{a_1} D$; $C_{a_1} = (68+00) - (67+86.3) = 13.7$ ft.

$= 0.3 \times 13.7 \times 1.75862 = 7.228$ min.

$\delta\alpha_2 = 0.3\, C_{a_2} D$; $C_{a_2} = (74+11.8) - (74+00) = 11.8$ ft.

$= 0.3 \times 11.8 \times 1.75862 = 6.226$ min.

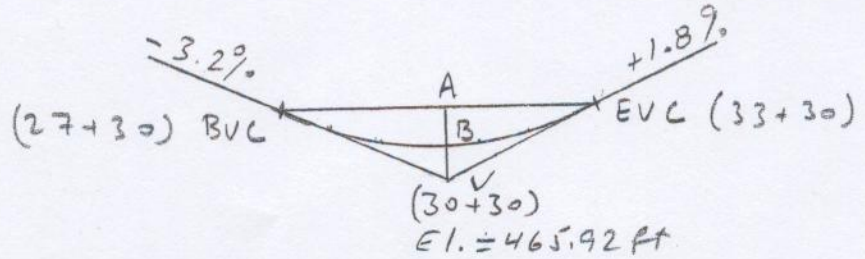
	Station	Chord	Deflection Angle
BC	67+86.3		0° 00′
	68+00	13.7 ft.	0° 7.228′ (0° 07′ 13.7″)
	69+00	100.0 ft	0° 59.987′ (0° 59′ 59.2″)
	70+00	100.0 ft	1° 52.746′ (1° 52′ 44.7″)
	71+00	100.0 ft	2° 45.505′ (2° 45′ 30.3″)
	72+00	100.0 ft	3° 38.264′ (3° 38′ 15.8″)
	73+00	100.0 ft	4° 31.023′ (4° 31′ 01.4″)
	74+00	100.0 ft	5° 23.782′ (5° 23′ 46.9″)
EC	74+11.8	11.8 ft.	5° 30.008′ (5° 30′ 00.5″)

Last deflection angle must be equal to $\frac{I}{2}$

$\frac{I}{2} = \frac{11}{2} = 5^\circ 30' \cong 5^\circ 30.008'$ ✓ Checks

4.

a) Rate of change in grade per sta $= \frac{1.8 - -3.2}{6} = 0.833$ ANS.



El. of BVC $= 465.92 + (3 \times 3.2) = 475.52$ ft.

El. of EVC $= 465.92 + (3 \times 1.8) = 471.32$ ft.

El. of A $= \frac{475.52 + 471.32}{2} = 473.42$ ft.

$\therefore$ VB $= \frac{473.42 - 465.92}{2} = 3.75$ ft. = offset at V.

Station	tan Elev. (ft)	offset (ft)	Curve Elev. (ft)	1st. diff.	2nd diff.
BVC 27+30	475.52	0.00	475.52		
				2.78	
28+30	472.32	0.42	472.74		0.83
				1.95	
29+30	469.12	1.67	470.79		0.83
				1.12	
30+30	465.92	3.75	469.67		0.84 ✓ Checks
				0.28	
31+30	467.72	1.67	469.39		0.83
				-0.55	
32+30	469.52	0.42	469.94		0.83
				-1.38	
EVC 33+30	471.32	0.00	471.32		

offset at $a = \left[\frac{x_a}{L/2}\right]^2 \times$ offset at V.

offset at (28+30) & (32+30) $= \left[\frac{1}{3}\right]^2 \times 3.75 = 0.42$ ft.

offset at (29+30) & (31+30) $= \left[\frac{2}{3}\right]^2 \times 3.75 = 1.67$ ft.

The second difference is equal to the rate of change in grade per station = 0.83.

$\therefore$ The calculations are correct.

Cont'd.

4) a) Another Method

Hence, $VB = BA = \frac{473.42 - 465.92}{2} = 3.75$ ft.

Offset at $a = \left[\frac{x_a}{L/2}\right]^2 \times$ offset at V

∴ Offset at 28+00: $\left(\frac{0.70}{3}\right)^2 \times 3.75 = 0.20$ ft.

Offset at 29+00: $\left(\frac{1.70}{3}\right)^2 \times 3.75 = 1.20$ ft.

Offset at 30+00: $\left(\frac{2.70}{3}\right)^2 \times 3.75 = 3.04$ ft.

Offset at 31+00: $\left(\frac{2.30}{3}\right)^2 \times 3.75 = 2.20$ ft.

Offset at 32+00: $\left(\frac{1.30}{3}\right)^2 \times 3.75 = 0.70$ ft.

Offset at 33+00: $\left(\frac{0.30}{3}\right)^2 \times 3.75 = 0.04$ ft.

Station	tan. elev. (ft)	offset (ft)	Curve elev. (ft)	1st diff.	2nd diff
BVC 27+30	475.52	0.00	475.52		
28+00	473.28	0.20	473.48	2.04	-0.16
29+00	470.08	1.20	471.28	2.20	0.84
30+00	466.88	3.04	469.92	1.36	1.11
V 30+30	465.92	3.75	469.67	0.25	-0.04
31+00	467.18	2.20	469.38	0.29	0.59
32+00	468.98	0.70	469.68	-0.30	0.84
33+00	470.78	0.04	470.82	-1.14	0.64
EVC 33+30	471.32	0.00	471.32	-0.50	

Check: The 2nd difference between sta 29+00 & 30+00 and between 32+00 and 33+00 is equal to 0.84 which is equal to the rate of change in grade per station. The others are different because the lengths of the stations are not the same.

4. c) Cont'd.

Location of the low point of the curve.

$$x = \frac{g_2 L}{g_2 - g_1} = \frac{1.8 \times 600}{1.8 - -3.2} = 216 \text{ ft from EVC.}$$
$$= (2+16) \text{ sta. from EVC.}$$

∴ Location of low point: $(33+30) - (2+16) = \underline{31+14}$ sta.

Tangent elev. at Low point:

$$465.92 + \left[(31+14) - 30+30)\right] \times 1.8\% = 467.43 \text{ ft.}$$
(84)

tangent offset at low point (31+14):

$$\left(\frac{2.16}{3}\right)^2 \times 3.75 = 1.94 \text{ ft.}$$

∴ Elev. at Low point = $467.43 + 1.94 = \underline{469.37 \text{ ft}}$

Hence, Low point is at sta. (31+14), elev. 469.37 ft. ANS.

5.

a) Difference in standard time between Ottawa and Paris is 5 hrs. (75th. Zone and Zero Zone).

∴ Standard time in Paris:

$22^h 30^m + 5^h = 27^h 30^m = \underline{3^h 30^m \text{ on May 1st, 2005}}$ ANS.

b) $d = \frac{rh}{H}$, $d = 79.8 - 70.5 = 9.3 \text{ mm}$,

$r = 79.8 \text{ mm.}$,

$H = \frac{f}{s} = \frac{152.4}{1/10,000} \div 1000 = 1524 \text{ m.}$

$$h = \frac{dH}{r} = \frac{9.3 \times 1524}{79.8} = 177.61 \text{ m.}$$

∴ Height of the tower is 177.61 m. ANS.

5. Cont'd

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

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

$= \sqrt{285.95 + 267.32}$

$= 23.52$ mm.

$\therefore$ Scale of photography $= \frac{23.52}{1240.08} \times \frac{1}{1000} = \frac{1}{52725}$

$S_{av.} = \frac{f}{H - h_{av.}}$; $\frac{1}{52725} = \frac{152.4}{H - \frac{122+178}{2}} = \frac{152.4 \div 1000}{H - 150}$

$\therefore$ Flying height: $H = 8035.29 + 150 = \underline{\underline{8185 \text{ m.}}}$ ANS.

d) Scale of photography $= \frac{2.40/12}{2000} = \frac{1}{10,000}$; 1: 10,000

No. of photographs per flight line $= 120 \div 6 = 20$ photos.

Distance between 2 photographs $= 0.40 \times 9 \times \frac{10,000}{12} = 3000$ ft.

$\therefore$ Length of the island:

$L = 3000 \times (20 - 1) = 5700$ ft $= 10.80$ miles.

Distance between flight lines $= 0.75 \times 9 \times \frac{10,000}{12} = 5625$ ft.

$\therefore$ Width of the island:

$W = 5625 \times (6 - 1) = 28125$ ft. $= 5.33$ miles.

$S_{av.} = \frac{f}{H - h_{av.}}$

$\frac{1}{10,000} = \frac{6/12}{7000 - h_{av.}}$

$\therefore h_{av.} = 7000 - 5000 = 2000$ ft. above Mean-Sea-Level

$\therefore$ The Island is 10.80×5.33 miles and has a average elevation of 2000 ft. above Mean-Sea-Level.

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