Part – 1 :

Q(1):

I don't have the exact question, but it was something like this:

What makes airplanes go up (fly)?

Answer:

Due to the difference in the air speed above and below the wing of the airplane, where the speed above is higher than below, creating less pressure above the wing as compared to the pressure below. The difference in pressure creates uplift force.

Q(2):

What is the minimum runway blast pad width in meters for a design aircraft C-IV (answer format: one digit to the right of the decimal point, e.g. 255.0)

Answer: 60.0

Table 18-5 Runway Design and Separation Standards for Aircraft Approach Categories C & D

Item	Airplane Design Group					
	I	II	III	IV	V	VI
Runway Width	100 ft 30 m	100 ft 30 m	100 ft 30 m	150 ft 45 m	150 ft 45 m	200 ft 60 m
Runway Shoulder Width	10 ft 3 m	10 ft 3 m	20 ft 6 m	25 ft 7.5 m	35 ft 10.5 m	40 ft 12 m
Runway Blast Pad Width	120 ft 36 m	120 ft 36 m	140 ft 42 m	200 ft 60 m	220 ft 66 m	280 ft 84 m
Runway Blast Pad Length	100 ft 30 m	150 ft 45 m	200 ft 60 m	200 ft 60 m	400 ft 120 m	400 ft 120 m
Runway Safety Area Width	500 ft 150 m	500 ft 150 m	500 ft 150 m	500 ft 150 m	500 ft 150 m	500 ft 150 m
Runway Safety Area Length Beyond RW End	1,000 ft 300 m	1,000 ft 300 m	1,000 ft 300 m	1,000 ft 300 m	1,000 ft 300 m	1,000 ft 300 m
Runway Object Free Area	800 ft	800 ft	800 ft	800 ft	800 ft	800 ft

Q(3):

What is the minimum length of vertical curve in meters for a design aircraft D-IV given the tangents at the PVI are minus 0.75% and plus 0.75% (answer format: whole numbers without decimal point and rounded to a whole number, e.g. 175)

Answer: 450

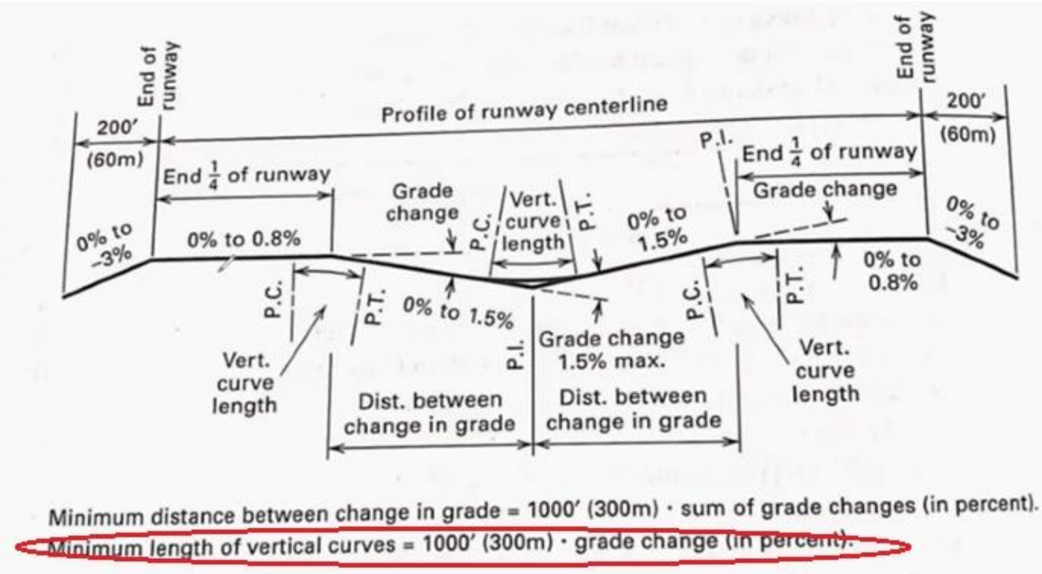


Figure 18-3b Longitudinal grade limitations for aircraft approach categories C and D. (Source: *Airport Design,* FAA Advisory Circular 150/5300-13, Changes 1–4, September 29, 1989.)

$$\min Length\ of\ Vertical\ Curve = 300(0.75 + 0.75) = 450\ m$$

Q(4):

Give the magnetic azimuth of single runway is 76, what are runway numbers of this runway for each of the two ends of runway (answer format: whole numbers with no decimal point and symbol and "&" between the two numbers with no spaces before or after the "&", e.g., 2&13)

Answer: 8 & 26

$76 \approx 80\ (Rounded\ to\ nearest\ 10)$

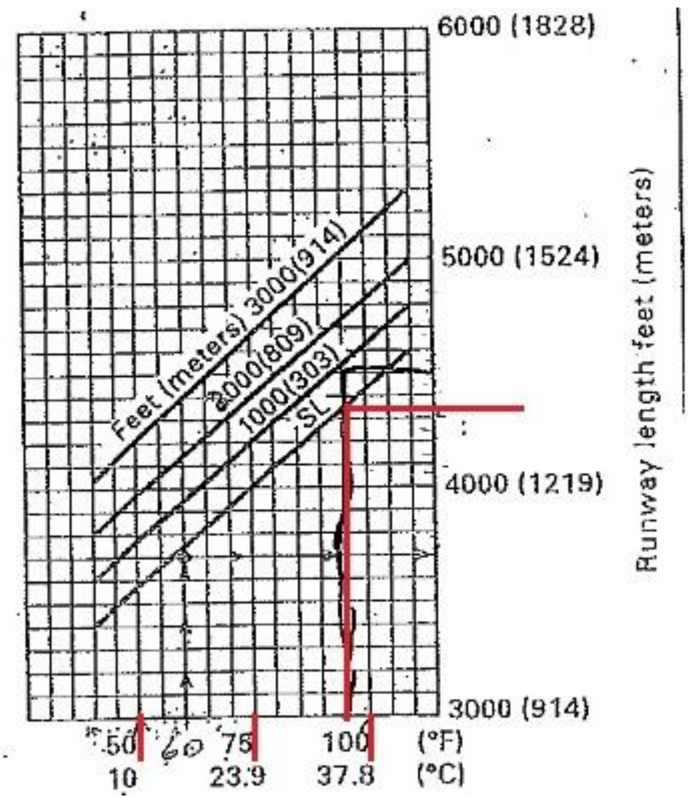
$First\ Number = \frac{80}{10} = 8$

$Second\ Number = 8 + 18 = 26$

Q(5):

What is the required runway length of a design aircraft of Beech B99 at location with elevation at sea level and mean daily maximum temperature of the hottest month of the year is 95 degree Fahrenheit (answer in whole numbers without decimal point and rounded to upper/higher 100ft, e.g. 2200)

Answer: 4300



Q(6):

Given expected daily traffic in the table below, determine the IFR hourly capacity for runway configuration number 4 in table 16.3, p. 519 in the textbook (answer format: whole number without decimal point, e.g., 98)

Air craft type	Expected typical daily number of aircrafts
Class A: Small single –engine aircrafts 12,500lb or less	40
Class B: Small multiengine aircrafts, 12,500lb or less and learjets	60
Class C: large aircrafts, 12,500lb an up to 300,000lb	80
Class D: heavy aircraft, more than 300,000lb	20

Answer: 56

$$\%C = \frac{80}{40+60+80+20} * 100\% = 40\%$$

$$\%D = \frac{20}{40+60+80+20} * 100\% = 10\%$$

$$\text{Mix Index} = \%C + 3(\%D) = 40 + 3(10) = 70$$

Table 16-3 Airport Capacities for Long-Range Planning Purpose

Runway Use Configuration	Mix Index (Percent) (C + 3D)	Hourly (hr) Capacity (Operations) VFR	Hourly (hr) Capacity (Operations) IFR	Annual Service Volume (Operations/yr)
1.	0–20	98	59	230,000
	21–50	74	57	195,000
	51–80	63	56	205,000
	81–120	55	53	210,000
	121–180	51	50	240,000
2. 700 to 2499 ft	0–20	197	59	355,000
	21–50	145	57	275,000
	51–80	121	56	260,000
	81–120	105	59	285,000
	121–180	94	60	340,000
3. 700 to 2499 ft, 2500 to 3499 ft	0–20	295	62	385,000
	21–50	219	63	310,000
	51–80	184	65	290,000
	81–120	161	70	315,000
	121–180	146	75	385,000
4.	0–20	98	59	230,000
	21–50	77	57	200,000
	51–80	77	56	215,000
	81–120	76	59	225,000
	121–180	72	60	265,000

Q(7):

Airport demand for passenger transfers depends mainly on

- ○ a. Population and level of education
- ○ b. Population and production of goods
- ○ c. Population and being a hub airport
- ◉ d. Using the airport as a hub airport by airlines
- ○ e. Population and economic character

But not sure, it might be (c) though!! You will have to ask Dr. Faisal.

Q(8):

In table 16.2, p.511 of the textbook, the percentage of wind in the study period in the range of 3.500 to 6.499 knots in the direction of between azimuths of 315 and 325 is (answer format: two digits to the right of the decimal point with no "%" sign, e.g., 1.42)

Answer: 0.97

16-6. Runway Orientation 511

Table 16-2 Typical Wind Data

Hourly Observations of Wind Speed (Knots)

Direction	0–3	4–6	7–10	11–16	17–21	22–27	28–33	34–40	41 Over	Total
1	469	842	568	212	0	0	0	0	0	2091
2	568	1263	820	169	0	0	0	0	0	2820
3	294	775	519	73	9	0	0	0	0	1670
4	317	872	509	62	11	0	0	0	0	1771
5	268	861	437	106	0	0	0	0	0	1672
6	357	534	151	42	8	0	0	0	0	1092
7	369	403	273	84	36	10	0	0	0	1175
8	158	261	138	69	73	52	41	22	0	814
9	167	352	176	128	68	59	21	0	0	971
10	119	303	127	180	98	41	9	0	0	877
11	323	586	268	312	111	23	28	0	0	1651
12	618	1397	624	779	271	69	21	0	0	3779
13	472	1375	674	531	452	67	0	0	0	3571
14	647	1377	574	281	129	0	0	0	0	3008
15	338	1093	348	135	27	0	0	0	0	1941
16	560	1399	523	121	19	0	0	0	0	2622
17	587	883	469	128	12	0	0	0	0	2079
18	1046	1984	1068	297	83	18	0	0	0	4496
19	499	793	586	241	92	0	0	0	0	2211
20	371	946	615	243	64	0	0	0	0	2239
21	340	732	528	323	147	8	0	0	0	2078
22	479	768	603	231	115	38	19	0	0	2253
23	187	1008	915	413	192	0	0	0	0	2715
24	458	943	800	453	96	11	18	0	0	2779
25	351	899	752	297	102	21	9	0	0	2431
26	368	731	379	208	53	0	0	0	0	1739
27	411	748	469	232	118	19	0	0	0	1997
28	191	554	276	287	118	0	0	0	0	1426
29	271	642	548	479	143	17	0	0	0	2100
30	379	873	526	543	208	34	0	0	0	2563
31	299	643	597	618	222	19	0	0	0	2398
32	397	852	521	559	158	23	0	0	0	2510
33	236	721	324	238	48	0	0	0	0	1567
34	280	916	845	307	24	0	0	0	0	2372
35	252	931	918	487	23	0	0	0	0	2611
36	501	1568	1381	569	27	0	0	0	0	4046
0	7729	0	0	0	0	0	0	0	0	7729
TOTAL:	21676	31828	19849	10437	3357	529	166	22	0	87864

Source: *Airport Design*, FAA Advisory Circular 150/5300-13, including Changes 1–4, Federal Aviation Administration, Washington, DC, September 29, 1989.

$$\text{Wind}(\%) = \frac{852}{87864} * 100\% = 0.97\%$$

Q(9): Don't have it, couldn't even open it, ITC crashed back then!!.

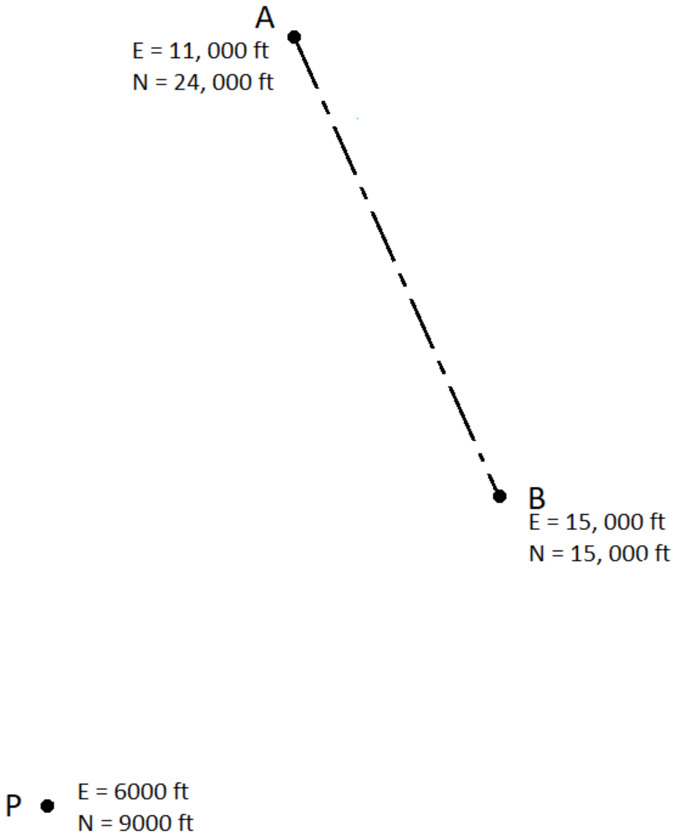
Part – 2

Question 1: (30 marks) – No groups for this question, entire class one group

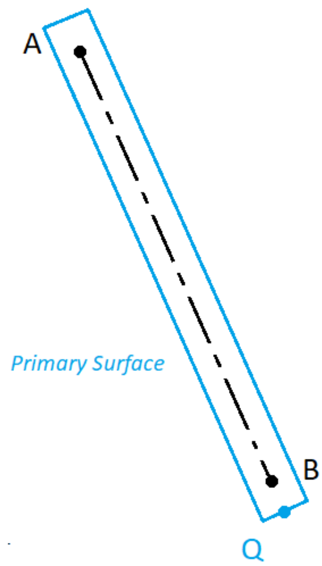
Given an airport with one precision instrument runway. The ends of the runway centerline have the following coordinates (N: 15000′, E: 15000′) and (N: 24000′, E: 11000′). The airport-established elevation is 760′ above msl.

Determine the maximum height of a structure at a proposed construction site with the following coordinates (N: 9000′, E: 6000′, Z: 730′ above msl) according to the FAA imaginary surfaces standards

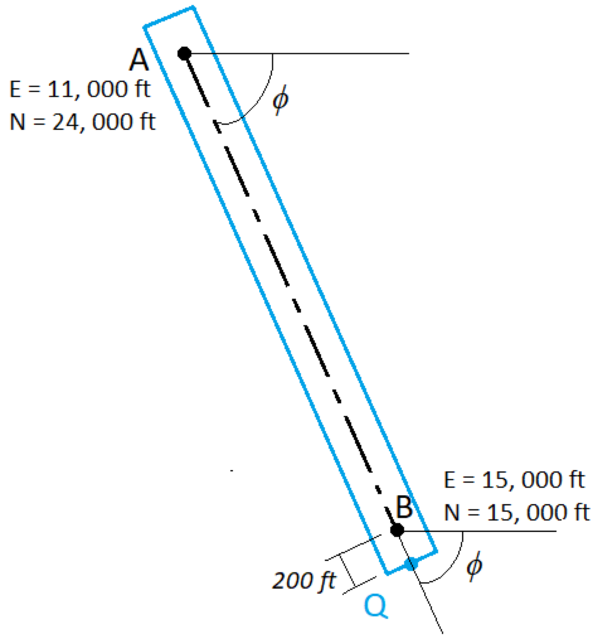
Note: all coordinates in feet



For Group 1:



We must find the coordinates of point (Q) to do this we first must find the angle ϕ:

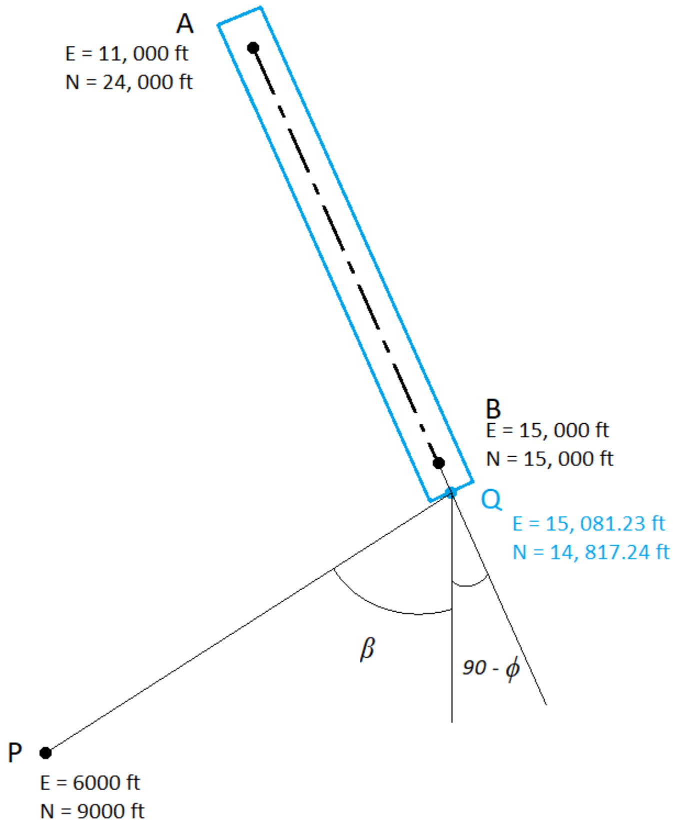


$$\phi = \tan^{-1}\left(\frac{24,000 - 15,000}{15,000 - 11,000}\right) = 66.0375^o$$

$$E_Q = E_B + 200\cos(\phi) = 15,000 + 200\cos(66.0375) = 15,081.23\ ft$$

$$N_Q = N_B - 200\sin(\phi) = 15,000 - 200\sin(66.0375) = 14,817.24\ ft$$

We must check the angle between the Runway CL and the line QP (to know if more or less than 90^o):

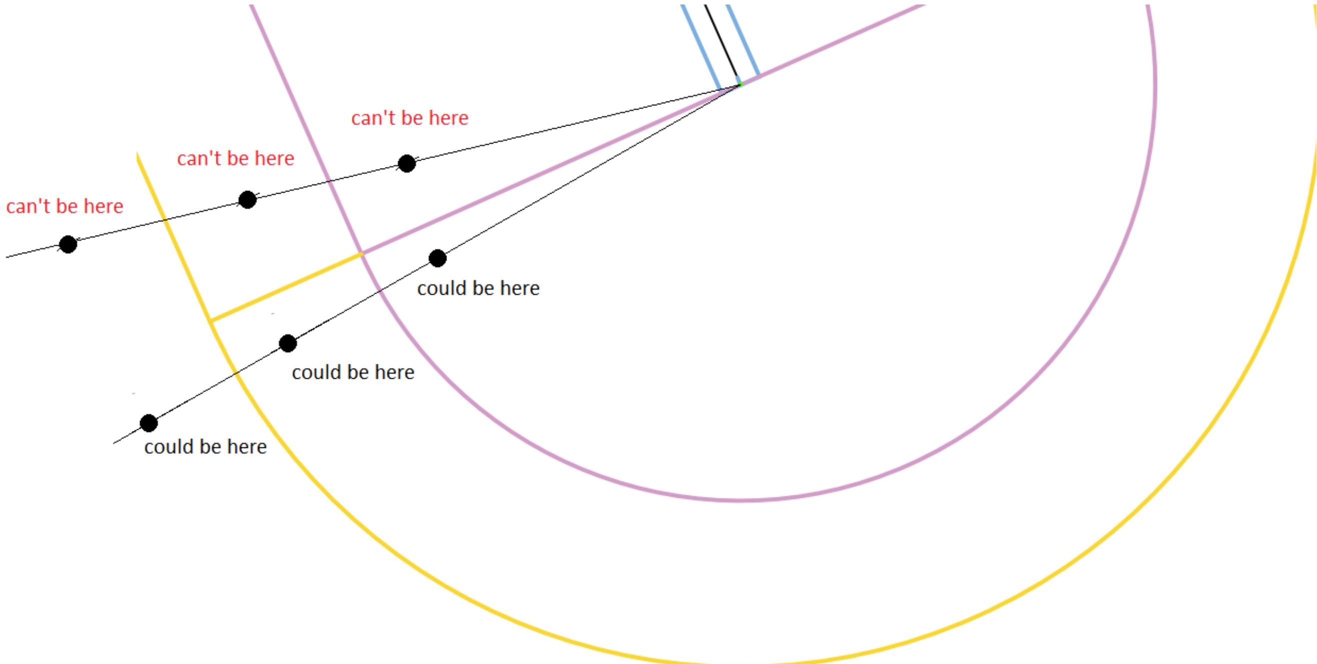


$90^o - \phi = 90^o - 66.0375^o = 23.9625^o$

$\beta = \tan^{-1}\left(\frac{15,081.23 - 6000}{14,817.24 - 9000}\right) = 57.3573^0$

$\beta + (90 - \phi) = 57.3573 + 23.9625 = 81.32^o < 90$

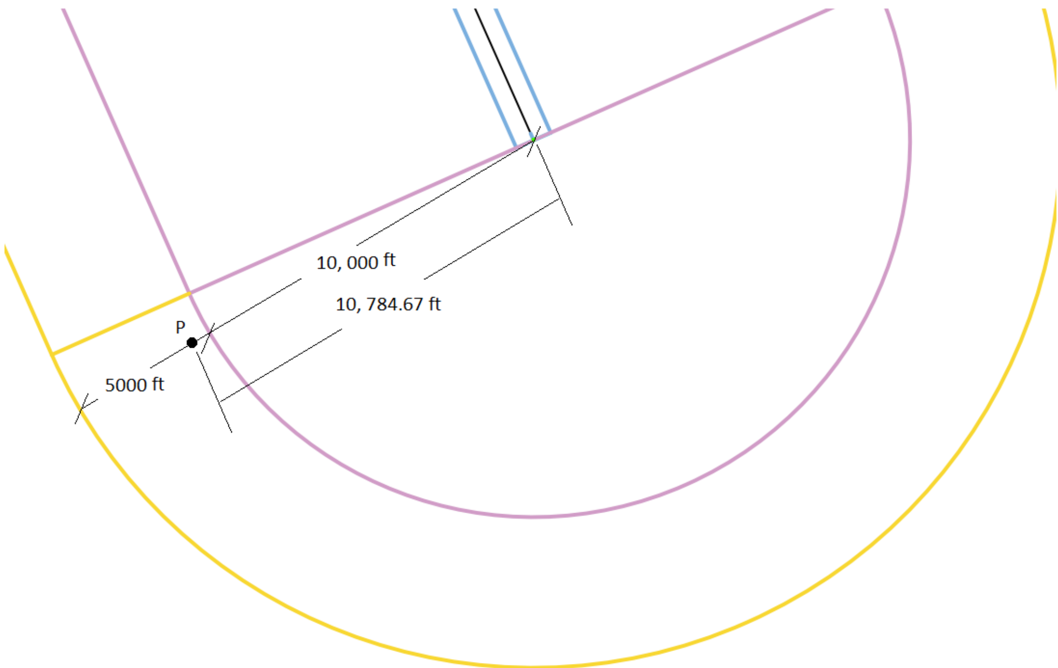
Since the angle is $< 90^o$ the site point (P) might be in one of the following positions:



To determine which position, we must find the radius (R') which is the line QP:

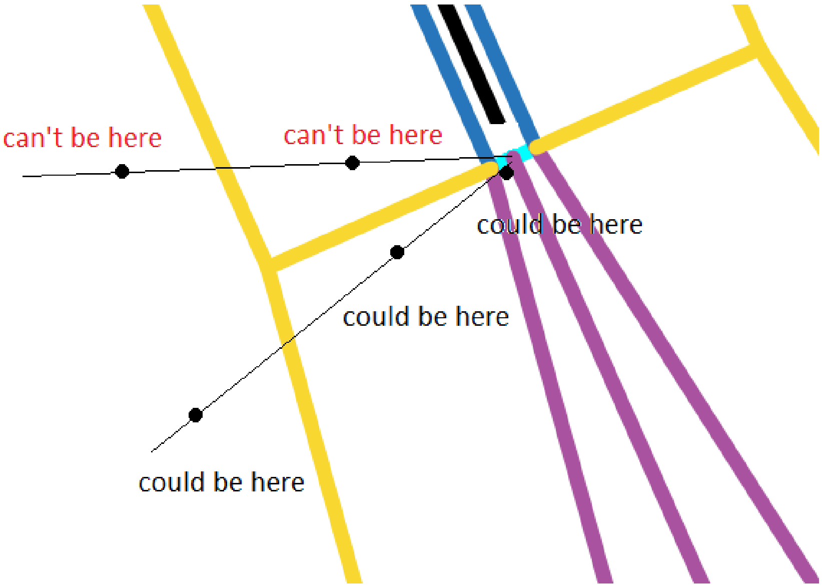
$R' = \sqrt{(15,081.23 - 6000)^2 + (14,817.24 - 9000)^2} = 10,784.67\ ft$

$10,000 < R' < 15,000 \Longrightarrow \textit{The site Point (P) is within the } \boldsymbol{Conical\ Surface} \textit{ for group } 1$



Group 2:

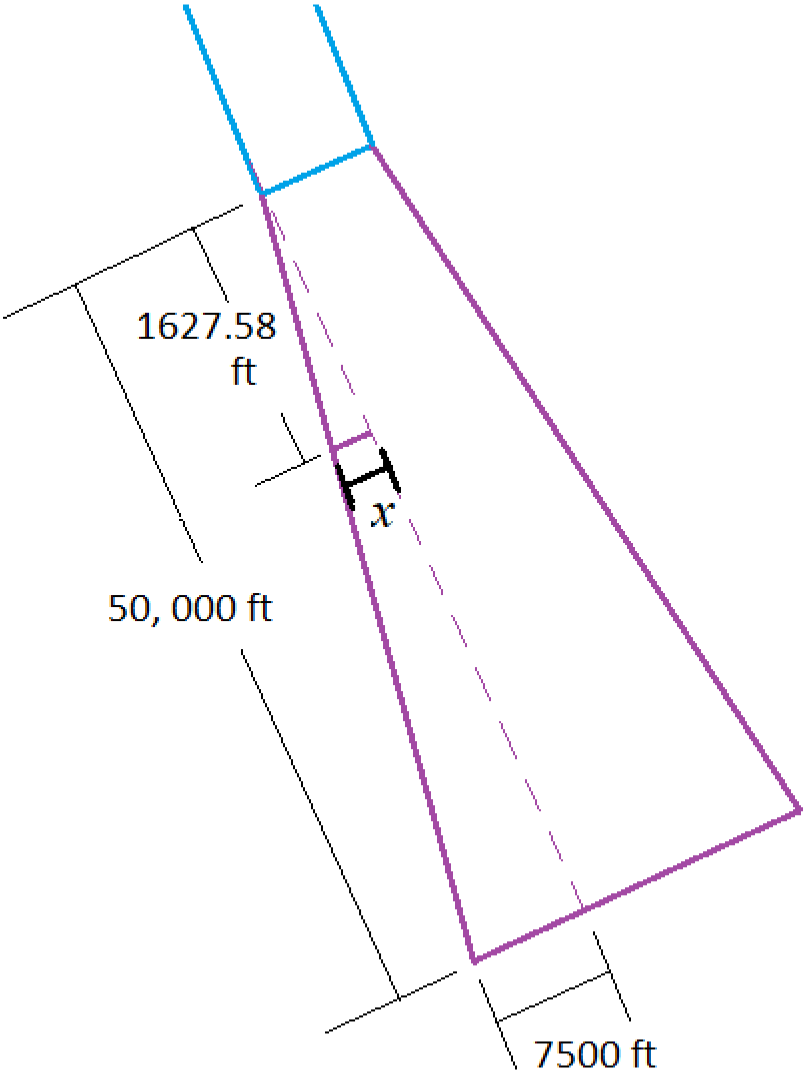
Since the angle between CL & QP < 90° the point might be in one of these positions:



In order to determine the exact position, we must find the component of QP parallel to CL and the component of QP perpendicular to CL:

$$QP_{\perp} = R' \sin\left(\beta + (90^o - \phi)\right) = 10{,}784.67 \sin(81.32^o) = 10{,}661.15\ ft$$

$$QP_{\parallel} = R' \cos\left(\beta + (90^o - \phi)\right) = 10{,}784.67 \cos(81.32^o) = 1627.58\ ft$$



by similar triangles:

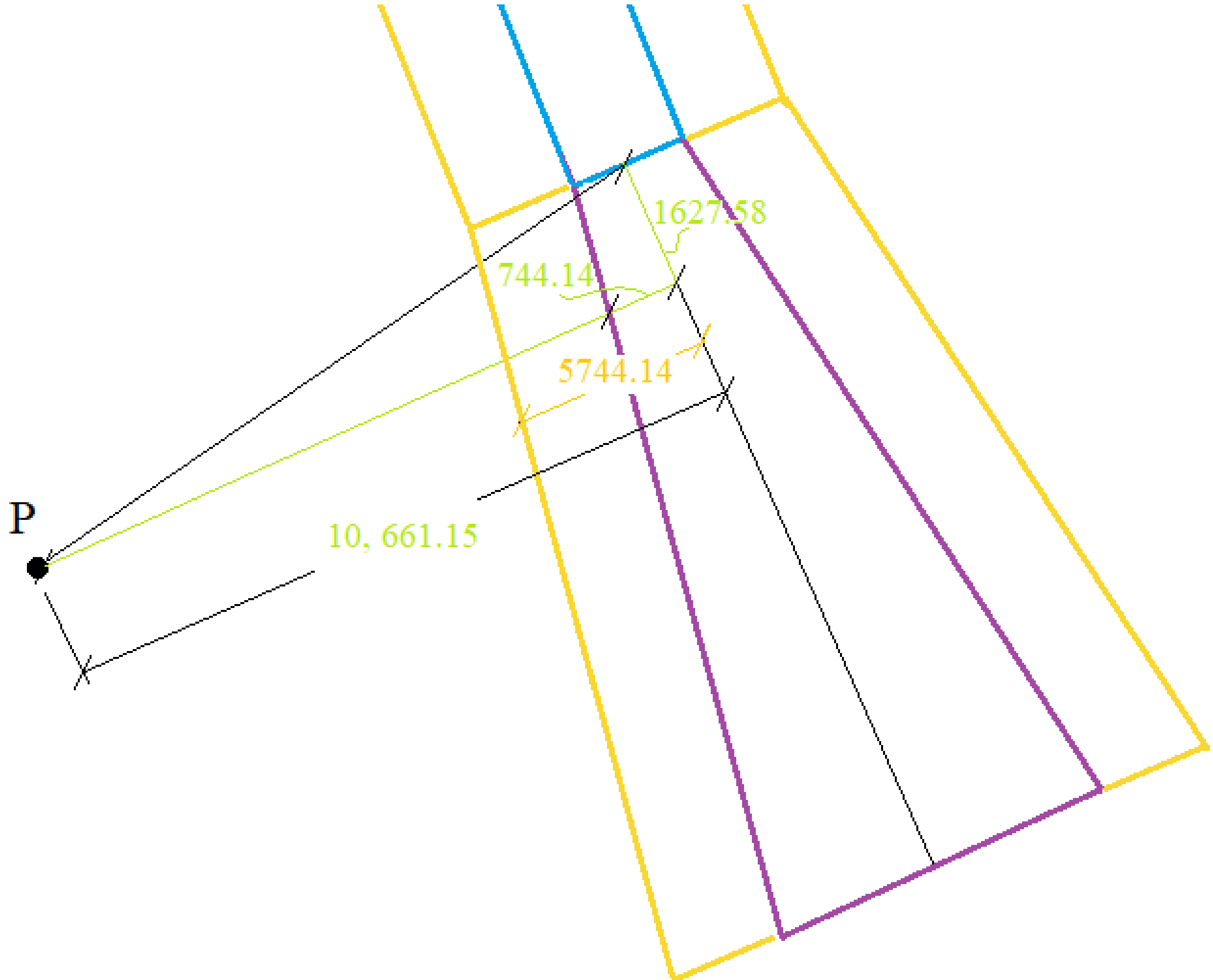
$$x = 1627.58\left(\frac{7500}{50,000}\right) = 244.1365\ ft$$

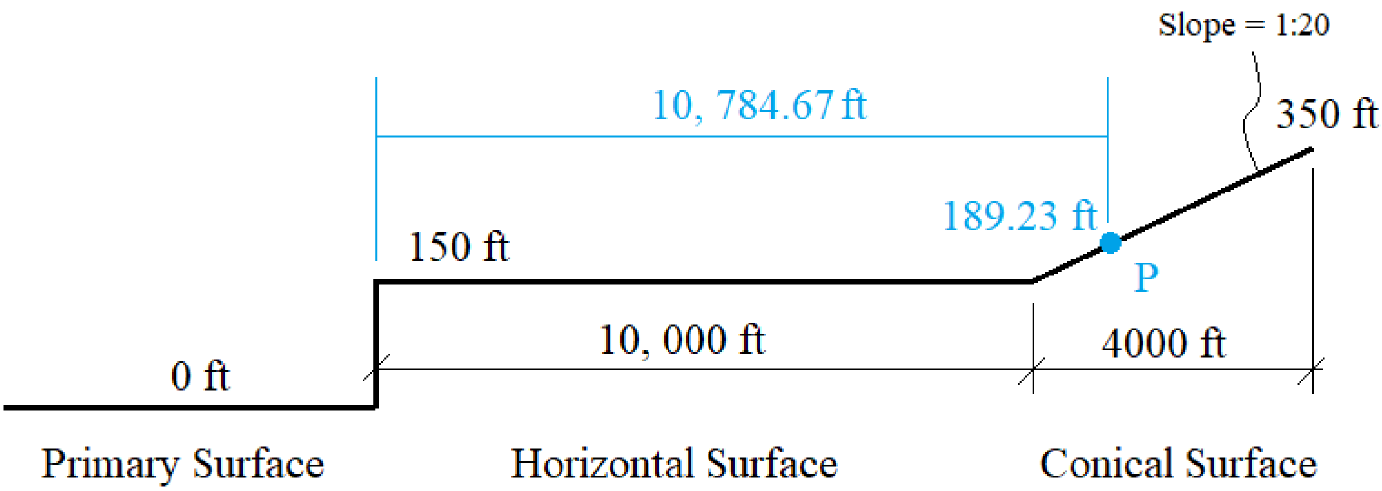
$$distance\ to\ boundary\ of\ Approach\ Surface = 244.1365 + 500 = 744.1365\ ft$$

$$distance\ to\ boundary\ of\ Transitional\ Surface = 744.1365 + 5000 = 5744.1365\ ft$$

$$744.1365\ ft < 5744.1365\ ft < (QP_{\perp} = 10,661.15\ ft) \Longrightarrow P, is\ not\ within\ group\ 2$$

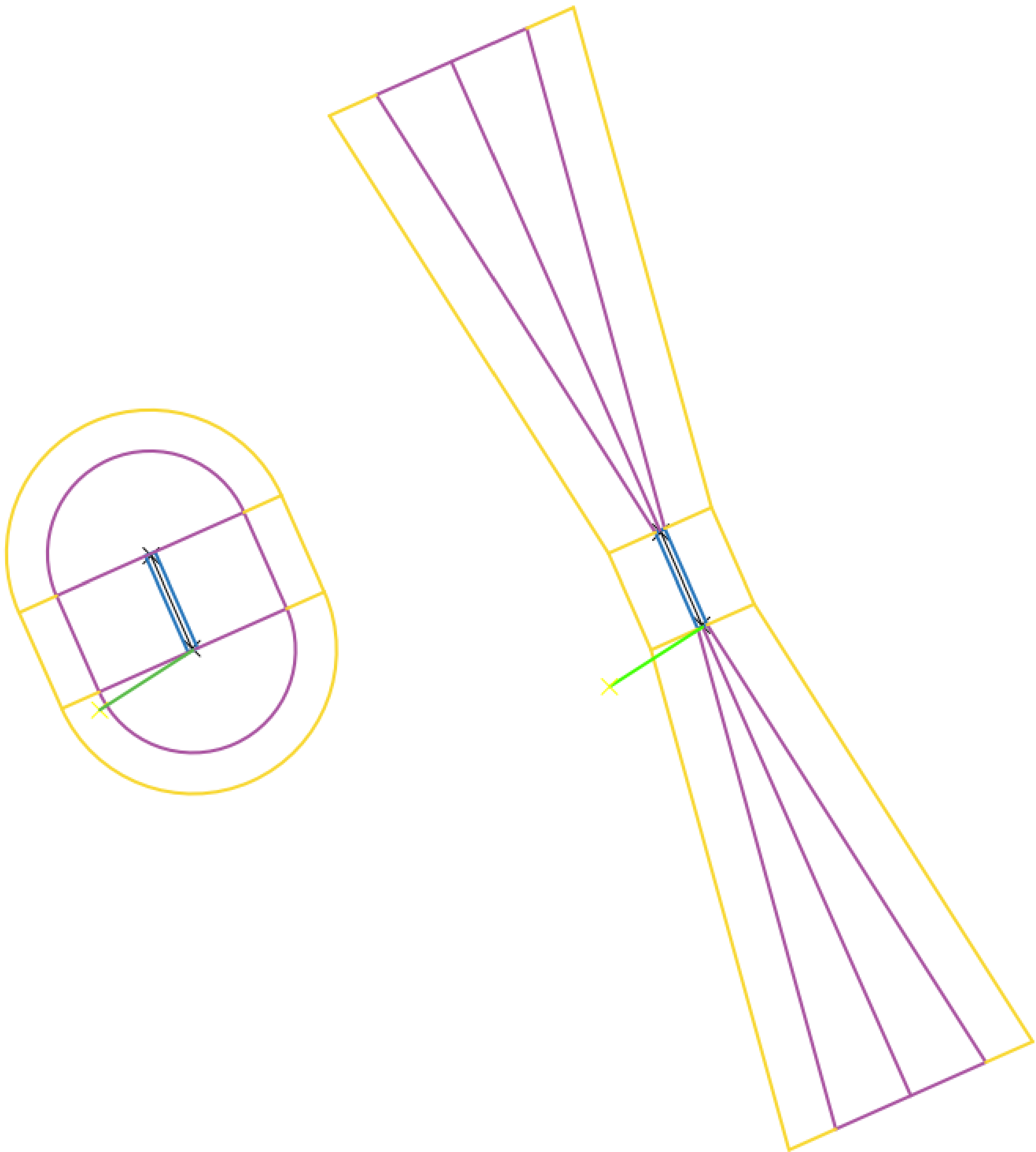
So, the site point (P) is only controlled by the conical surface of group1, and not limited by group 2:





$$Max\ Elev.Difference = 150 + \frac{10,784.67 - 10,000}{4000} = 189.23\ ft$$

$$Max\ height\ of\ structure = Max\ Elev.diff + Elev_{R.W} - Elev_P = 189.23 + 760 - 730 = 219.23\ ft$$



Question 2: (10 marks)

Group D: Digit 5 and 6 from the left of students numbers 75 - 99 inclusive (e.g., 1171879)

Table below provides the expected average number of aircrafts arrival per day for four category of aircrafts with expected mean time gate occupancy for each category; estimate the number of required gates according to European traffic.

Aircraft category	Average number of aircraft arrivals per hour	Mean time gate occupancy in minutes
A	3	45
B	17	55
C	20	65
C	25	75

$$n = m\left(\frac{Aircrafts}{hr}\right).q.t(hr)$$

$$q = \frac{3 + 17 + 20 + 25}{m} = \frac{65}{m}$$

$$t = \frac{(3)(45) + (17)(55) + (20)(65) + (25)(75)}{(3) + (17) + (20) + (25)} = 65.308\ min = 1.088\ hr$$

$$n = m\left(\frac{65}{m}\right)(1.088) = 70.75 = 71\ gates\ required$$

Question 3: (20 marks)

Group C: Digit 5 and 6 from the left of students numbers 75 - 99 and 00-09 inclusive (e.g., 1171099)

Given a design B757 aircraft for runway length requirement (similar to table 18.1 & 18.2). The airport is at an elevation of 1000 meters and normal maximum temperature of the hottest month of the year is 28 degrees. Maximum operational take-off weight is 95000kg, and maximum operational landing weight is 195000lb. Determine the required runway length assuming the difference between the highest and lowest points on the runway centerline is 4.5 meters.

For Landing:

$Max\ allowable\ landing\ weight = 89,800\ kg$

$Available\ Landing\ weight = 195,000\ lb = 88,450\ Kg$

$$W_{Avail} < W_{Max} \Longrightarrow (OK)$$

Table 18-1 Runway Length Table: Aircraft Performance, Landing (Boeing 757-232 Series) PW 2037 Engine, 25° Flaps

Temperature (°C)	By Airport Elevation in Meters: 0 m	500 m	1000 m	1500 m	2000 m	2500 m
	Maximum Allowable Landing Weight (1000 kg)					
10	89.8	89.8	89.8	89.8	89.8	89.8
12	89.8	89.8	89.8	89.8	89.8	89.8
14	89.8	89.8	89.8	89.8	89.8	89.8
16	89.8	89.8	89.8	89.8	89.8	89.8
18	89.8	89.8	89.8	89.8	89.8	89.8
20	89.8	89.8	89.8	89.8	89.8	89.8
22	89.8	89.8	89.8	89.8	89.8	89.8
24	89.8	89.8	89.8	89.8	89.8	89.8
26	89.8	89.8	89.8	89.8	89.8	89.8
28	89.8	89.8	89.8	89.8	89.8	89.8
30	89.8	89.8	89.8	89.8	89.8	89.8
32	89.8	89.8	89.8	89.8	89.8	89.8
34	89.8	89.8	89.8	89.8	89.8	89.8
36	89.8	89.8	89.8	89.8	89.8	89.0
38	89.8	89.8	89.8	89.8	89.8	86.9
40	89.8	89.8	89.8	89.8	89.8	84.9
42	89.8	89.8	89.8	89.8	87.5	82.9
44	89.8	89.8	89.8	89.8	85.2	81.0

Runway Length for landing:

$Airport\ Elev. = 1000\ m = 3280 ft$

$3000\ ft \Longrightarrow 6.28$

$4000\ ft \Longrightarrow 6.45$

$3280\ ft \Longrightarrow ??$

Weight (1000 lb)	By Airport Elevation in Feet								
	0 ft	1000 ft	2000 ft	3000 ft	4000 ft	5000 ft	6000 ft	7000 ft	8000 ft
	Runway Length (1000 ft)								
125	3.65	3.72	3.79	3.85	3.92	3.98	4.05	4.11	4.18
130	3.89	3.96	4.04	4.12	4.21	4.30	4.39	4.49	4.60
135	4.08	4.17	4.26	4.35	4.45	4.56	4.67	4.80	4.94
140	4.24	4.33	4.43	4.54	4.65	4.77	4.90	5.04	5.20
145	4.37	4.48	4.58	4.69	4.81	4.94	5.08	5.24	5.41
150	4.49	4.60	4.71	4.83	4.95	5.09	5.23	5.39	5.56
155	4.60	4.71	4.82	4.95	5.08	5.22	5.36	5.52	5.69
160	4.70	4.81	4.93	5.06	5.19	5.33	5.48	5.64	5.81
165	4.80	4.92	5.04	5.17	5.30	5.45	5.60	5.76	5.92
170	4.92	5.03	5.16	5.29	5.43	5.57	5.72	5.88	6.04
175	5.04	5.16	5.29	5.42	5.57	5.71	5.87	6.03	6.20
180	5.19	5.32	5.44	5.58	5.73	5.88	6.04	6.22	6.39
185	5.37	5.50	5.63	5.77	5.92	6.09	6.26	6.45	6.65
190	5.59	5.72	5.86	6.00	6.16	6.33	6.53	6.74	6.97
195	5.85	5.98	6.13	6.28	6.45	6.64	6.85	7.10	7.38
200	6.15	6.30	6.45	6.61	6.79	7.00	7.25	7.54	7.89

Interpolate

By interpolation:

R.W Length (Landing) = 6.33 (1000) = 6330 ft

For Take-off:

$Max\ allowable\ Take - off\ weight = 108,900\ kg$

$Available\ Take - off\ weight = 95,000\ \ Kg$

$$W_{Avail} < W_{Max} \Longrightarrow (OK)$$

Table 18-2 Runway Length Table: Aircraft Performance, Takeoff (Boeing 757-232 Series) PW 2037 Engine, 5° Flaps

Temperature (°C)	By Airport Elevation in Meters					
	0 m	500 m	1000 m	1500 m	2000 m	2500 m
	Maximum Allowable Takeoff Weight (1000 kg)					
10	108.9	108.9	108.9	108.9	108.9	106.4
12	108.9	108.9	108.9	108.9	108.9	104.9
14	108.9	108.9	108.9	108.9	108.8	103.4
16	108.9	108.9	108.9	108.9	107.7	101.9
18	108.9	108.9	108.9	108.9	106.4	100.3
20	108.9	108.9	108.9	108.9	105.0	98.6
22	108.9	108.9	108.9	108.9	103.4	97.0
24	108.9	108.9	108.9	107.9	101.7	95.3
26	108.9	108.9	108.9	106.0	100.0	93.5
28	108.9	108.9	108.9	104.1	98.1	91.7
30	108.9	108.9	107.5	102.1	96.1	89.9
32	108.9	108.9	105.5	100.0	94.1	88.0
34	108.9	108.4	103.4	97.8	91.9	86.1
36	108.9	106.5	101.3	95.6	89.7	84.1
38	108.9	104.5	99.0	93.2	87.4	82.1
40	104.5	106.5	96.7	90.8	85.1	80.0
42	105.3	99.9	94.1	88.3	82.7	77.8
44	103.0	97.3	91.4	85.7	80.3	75.6

Reference Factor (R):

$R = 63.8$

Temperature (°C)	0 m	500 m	1000 m	1500 m	2000 m	2500 m
	By Airport Elevation in Meters					
	Reference Factor *R*					
10	52.1	54.8	58.2	62.7	68.5	76.1
12	52.2	54.7	58.2	62.9	69.1	77.0
14	52.3	54.8	58.3	63.2	69.8	78.2
16	52.4	54.9	58.6	63.7	70.6	79.6
18	52.6	55.2	59.0	64.4	71.7	81.2
20	52.8	55.6	59.6	65.3	72.9	82.9
22	53.1	56.2	60.4	66.3	74.4	84.9
24	53.5	56.8	61.4	67.6	76.0	87.2
26	53.9	57.6	62.5	69.1	78.0	89.6
28	54.5	58.6	63.8	70.8	80.1	92.4
30	55.1	59.7	65.4	72.8	82.6	95.3
32	56.0	61.0	67.1	75.0	85.3	98.5
34	56.9	62.4	69.0	77.5	88.3	102.0
36	58.0	64.0	71.2	80.2	91.6	105.8
38	59.3	65.7	73.6	83.3	95.2	109.9
40	60.7	67.7	76.2	86.6	99.1	114.2
42	62.4	69.8	79.0	90.2	103.4	118.8
44	64.2	72.1	82.1	94.1	108.1	123.8

Runway Length for Take-off:

$60 \Longrightarrow 2205\ m$

$70 \Longrightarrow 2599\ m$

$63.8 \Longrightarrow ??$

18-3. The FAA Airport Reference Code 551

Table 18-2 Runway Length Table: Aircraft Performance, Takeoff (Boeing 757-232 Series) PW 2037 Engine, 5° Flaps *(Continued)*

Weight (1000 kg)	60	70	80	90	100	110	120	130	140
	Runway Length in Meters								
	Reference Factor *R*								
70	1247	1438	1617	1786	1951	2114	2279	2451	2632
75	1409	1630	1843	2048	2249	2448	2646	2846	3051
80	1581	1838	2096	2350	2599	2837	3062	3271	3460
85	1769	2067	2377	2688	2990	3271	3522	3731	3888
90	1975	2319	2685	3056	3414	3742	4021	4234	4364
95	2205	2599	3022	3451	3864	4239	4554	4788	4917
100	2462	2912	3388	3868	4330	4754	5117		
105	2750	3261	3782	4301	4804	5276			
110	3074	3650	4207	4748					

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(2551 m)

By interpolation

R.W Length (Take-off) = 2355 m = 7725 ft (Controls)

Since the Take-off R.W Length controls, we must take the gradient effect into consideration:

$Max\ difference\ in\ CL\ Elev = 4.5\ m = 14.76\ ft$

$R.W\ Length\ =\ 7725\ + 10(14.76) = 7873\ ft$

Question 4: (5 marks)

Group E: Last two digits of students numbers 80 - 99 inclusive (e.g., 1171290)

Given the fetch of 21km, wind velocity 80km/h and mean water depth of 6 meters at an inland lake, determine the maximum wave height

$$H_{max}(ft) = 0.17\sqrt{U(mph)F(miles)}$$

$$U = 80\frac{km}{hr} = 49.71\ mph$$

$$F = 21\ km = 13.049\ statute\ miles$$

$$H_{max} = 0.17\sqrt{(49.71)(13.049)} = 4.33\ ft$$