CEE 4674 Homework 6 Solution

Problem 1.

a) Use the Boeing 777-300ER (see Figure 1) as the critical aircraft to determine the following dimensions at a new airport. The airport will have two parallel runways with Instrument Landing System Category 2 (visibility below 1/2 mile). The airport will be located at 2,340 feet above sea level.

- Instrument Landing System Category 2 (Visibility below ½ mile)
- Elevation: 2,340 feet
- AAC: D, ADG: V, TDG: 6 Wingspan: 212.6 feet

Item	Dimensions
Approach RPZ	• Length: 2500ft • Inner width: 1000ft • Outer width: 1750ft • Area: 78.914Acres
Departure RPZ	• Length: 1700ft • Inner width: 500ft • Outer width: 1010ft • Area: 29.465Acres
Runway Safety Area	• Length beyond departure end: 1000ft • Length prior to threshold: 600ft • Width: 500ft
Runway OFA	• Length beyond runway end: 1000ft • Length prior to threshold: 600ft • Width: 800ft
Distance between runway to parallel taxiway	• 500 feet (with lower than ½ mile visibility)
Distance between runway centerline and runway exit hold line	• 303.4ft (280ft + 2340/100)
Distance between two parallel taxiways	• 267ft
Distance between a taxiway and a taxi lane	• 267ft
Distance between a taxi lane and a fixed or movable object	• 138ft
Distance between a runway centerline and parking area	• 500ft
Runway width	• 150ft
Runway shoulder width	• 35ft
Taxiway width	• 75ft
Taxiway shoulder width	• 35ft
Taxiway safety area	• 214ft
Taxiway safety distance (half of Taxiway OFA)	• 15 ft
Runway blast pad area	• Width: 220ft • Length: 400ft

Precision obstacle free zone (POFZ)	• Width: 800ft • Length: 200ft

Problem 2.

a) Assume the same critical aircraft and airport used in Problem 1. Find the closest distance from the runway that a Fixed-Based Operator could build a 60-foot tall hangar. Explain the controlling surfaces and dimensions considered in your analysis. Consider both Part 77 and inner transitional OFZ surfaces to answer this question.

Assume the hangar is located perpendicular to the runway. We need to consider inner transitional OFZ from AC150/5300-13A and Transitional surface from FAR 77.

Inner transitional OFZ

- ROFZ width: 400 ft.
- H=53-0.13(212.58)-0.0022(2340)=20.22 ft.
- Y=440+1.08(212.58)-0.024(2340)=613.4 ft.
- Large aircraft, the width of OFZ is 400 ft.
- H1=20.22+(613.4-200)/5=102.9ft > 60 ft.
- Distance from runway centerline to 60ft of OFZ height = (60-20.22)*5+200=398.9 ft.

Transitional surface

- Width of primary surface: 1,000ft
- Distance from runway centerline to 60ft of transitional surface height=920 ft.

Therefore, the 60-foot tall hangar can be installed at least 920 ft. away from the runway centerline.

Problem 3.

a) Design a 135 degree taxiway-taxiway connector for a new airport using the Airbus A350-900 as the critical aircraft (see Figure 2). In your design use the latest FAA criteria for taxiway-taxiway intersections considering the aircraft TDG group.

- AAC: C, ADG: V, TDG: 5

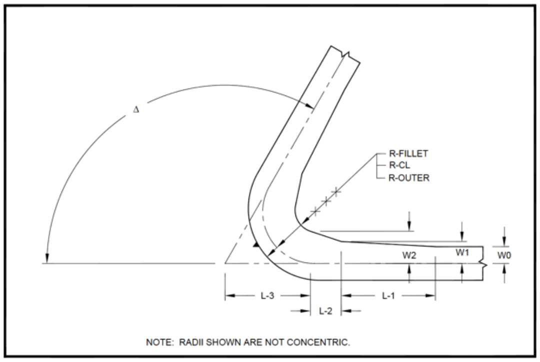


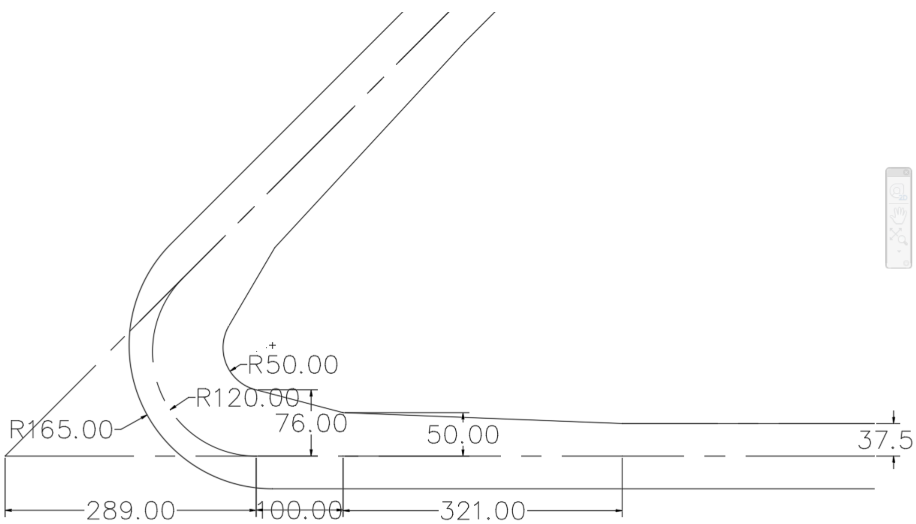
Figure 4-15. Taxiway turn - greater than 90 degree delta

Table 4-8. Standard intersection details for TDG 5

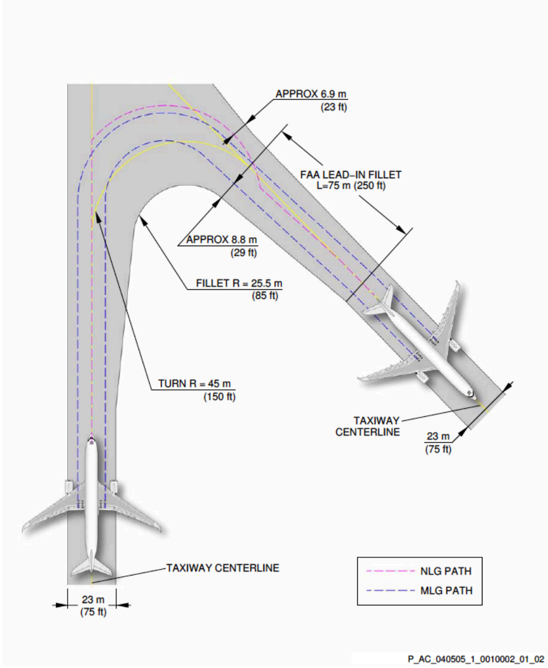
Dimension (See Figure 4-13, Figure 4-14, and Figure 4-15)	TDG 5						
Δ (degrees)	30	45	60	90	120	135	150
W-0 (ft)	37.5	37.5	37.5	37.5	37.5	37.5	37.5
W-1 (ft)	44	47	48	49	50	50	50
W-2 (ft)	55	63	71	82	75	76	76
L-1 (ft)	254	287	300	310	317	321	320
L-2 (ft)	100	100	110	125	100	100	100
L-3 (ft)	15	26	41	82	201	289	451
R-Fillet (ft)	0	0	0	0	50	50	50
R-CL (ft)	110	110	110	95	115	120	120
R-Outer (ft)	350	285	195	162	160	165	160

Note: Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.

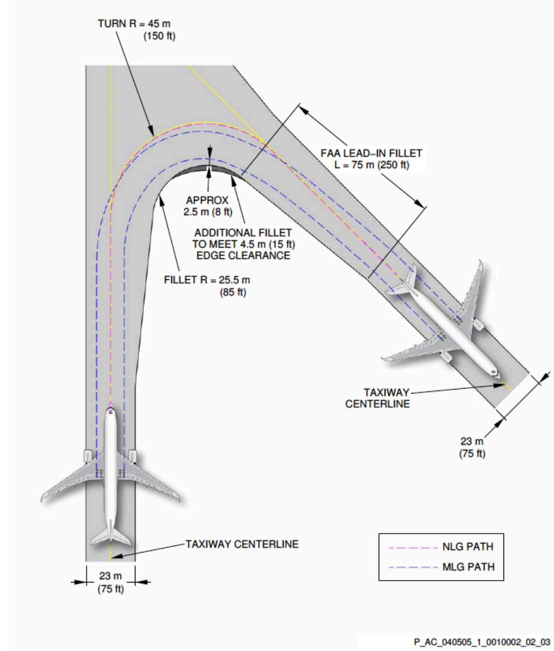
b) Draw your solution using the CAD program of your choice. Label the main dimensions of the geometric design dimensions



c) Compare your design with the dimensions offered by Airbus in the Airport Compatibility Document (see Figure 4.5.5 in the Airbus A350 planning document).



135° Turn - Taxiway to Taxiway
Oversteering Method (Sheet 1 of 2)
FIGURE-4-5-5-991-001-B01



135° Turn - Taxiway to Taxiway
Cockpit over Centerline Method (Sheet 2 of 2)
FIGURE-4-5-5-991-001-B01

Parameter	AC150/5300-13A	Airbus
W-0	37.5 ft	37.5 ft
W-1	50 ft	N/A
W-2	76 ft	N/A
L-1	321 ft	250 ft
L-2	100 ft	N/A
L-3	289 ft	N/A
R-Fillet	50 ft	85 ft
R-CL	120 ft	150 ft
R-Outer	165 ft	N/A

According to the Airbus document, the taxiway-taxiway connector recommended has a single 250 ft. fillet whereas the FAA recommends two fillets. Note: Old FAA standard had one fillet (250 ft. for this class of aircraft). Also, the fillet length of Airbus recommendation is shorter than FAA and there is no outer radius in the Airbus recommendation.

Problem 4.

A 3,050 meter long runway at an airport has three longitudinal grades (from left to right): at -0.32%, 0.51% and 0.43% with the points of intersection located at metric stations 1235 and 2006 from the left threshold. Assume the left threshold is located at station 0.

a) Test the suitability of this runway to be used at airport with Airbus A350-900 operations. Comment on your answers.

Since the AAC of A350-900 is C, we need to check following criteria.

(1) The maximum longitudinal grade is ±1.50 percent; however, longitudinal grades may not exceed ±0.80 percent in the first and last quarter, or first and last 2,500 feet (762 m), whichever is less, of the runway length.

- **Meets standard**

(2) The maximum allowable grade change is ±1.50 percent; however, no grade changes are allowed in the first and last quarter, or first and last 2,500 feet (762 m), whichever is less, of the runway length.

(3) Meets standard

(4) The minimum allowable distance between the points of intersection of vertical curves is 1,000 feet (305 m) multiplied by the sum of the grade changes (in percent) associated with the two vertical curves.

(5) Meets standard

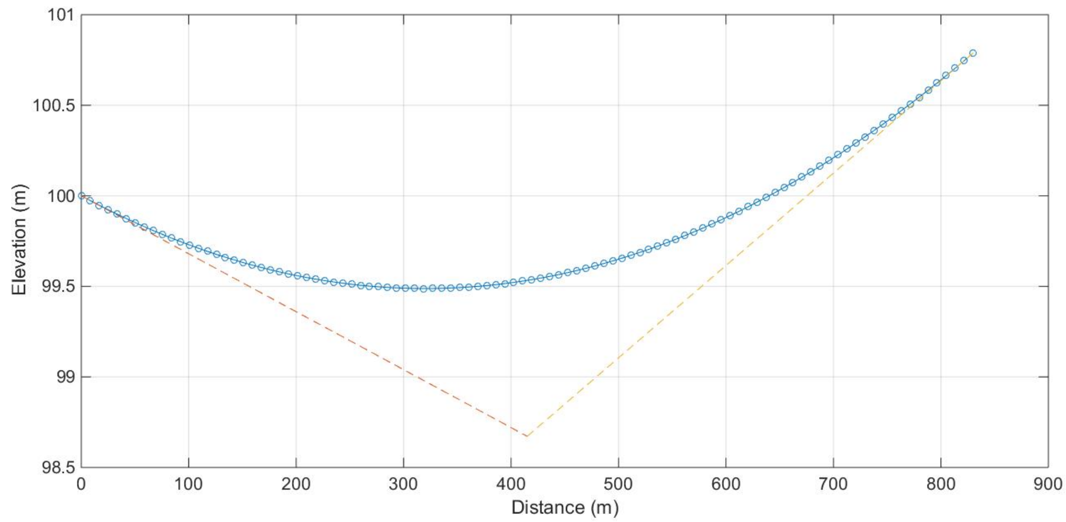
According to the criteria and the information what we have, the runway satisfy is suitable for operating the Airbus A350-900.

b) Design the first transition curve for this runway using a symmetric parabola. Specify the elevations (every 20 meters) as a function of the station (in meters). Refer to the formulas in the handout Geometric Design to create a symmetrical parabola. Use Excel or Matlab to simplify your work. You are allowed to use the Matlab script provided in class.

- Length for vertical curve 1: 0.83*1000=830 meter (apply minimum vertical curve length)
- Assume the elevation at the beginning point is 100 meters
- Use the equation of the parabola

$$elev = \frac{g_2 - g_1}{2L} x^2 + g_1 x + elev_{init}$$

- The profile of the vertical curve is shown below:



Problem 5.

A new airport is expected to have commercial airline operations using aircraft such as the Boeing 737-700 aircraft (see Figure 3). The longest runway length needed has been set to be 2,300 meters. The airport is located at an elevation 345 feet above mean sea level conditions. The airport will have a precision runway and serve approaches with visibility minima down to 1/2 mile. Determine the following dimensions for your design:

a) The length and width of the approach and departure surfaces for the airport

- AAC: C, ADG: III, TDG: 3
- Visibility minimums: Lower than ¾ mile
- Approach Surface Width: 16,000ft
- Approach Surface Length: 10,000ft (50:1) + 40,000ft (40:1)
- Departure RPZ Width: 500ft (Inner), 1,010ft (Outer)
- Departure RPZ Length: 1,700ft

b) The elevation of the horizontal surface above mean sea level conditions

- 345 ft. (airport elevation) + 150 ft. (Horizontal surface elevation) = 495 ft. (Horizontal surface elevation above mean sea level conditions)

c) The slope of the Obstacle Clearance Surface (OCS)

Table 3-2. Approach/departure standards table

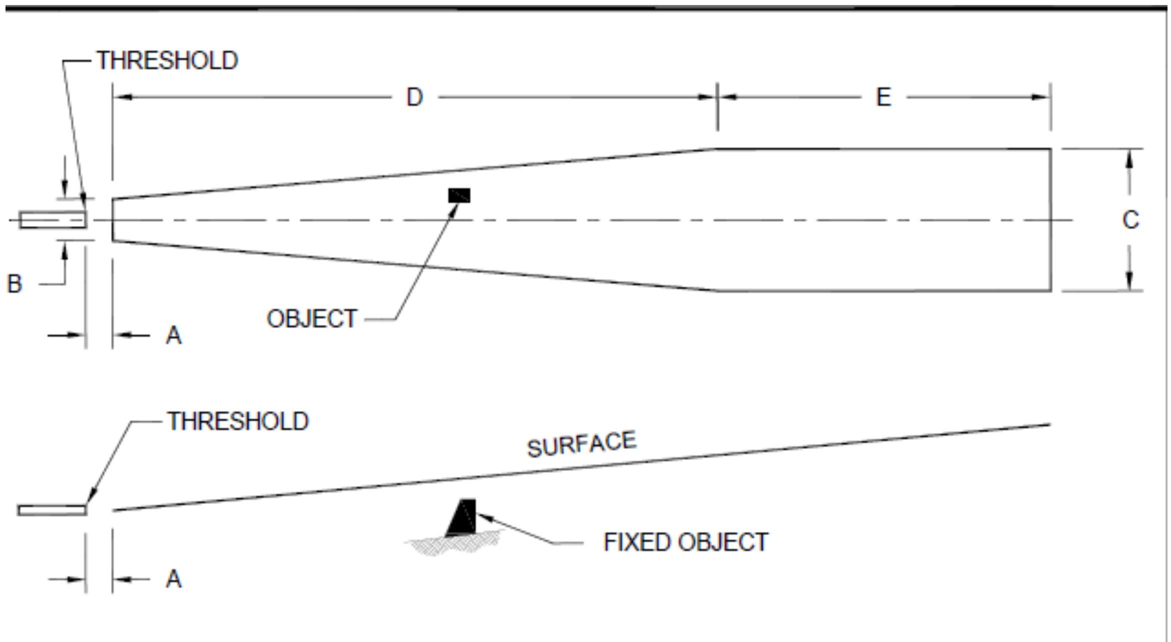
	Runway Type	DIMENSIONAL STANDARDS* Feet (Meters) A	B	C	D	E	Slope/ OCS
1	Approach end of runways expected to serve small airplanes with approach speeds less than 50 knots. (Visual runways only, day/night)	0 (0)	120 (37)	300 (91)	500 (152)	2,500 (762)	15:1
2	Approach end of runways expected to serve small airplanes with approach speeds of 50 knots or more. (Visual runways only, day/night)	0 (0)	250 (76)	700 (213)	2,250 (686)	2,750 (838)	20:1
3	Approach end of runways expected to serve large airplanes (Visual day/night); or instrument minimums ≥ 1 statute mile (1.6 km) (day only).	0 (0)	400 (122)	1000 (305)	1,500 (457)	8,500 (2591)	20:1
4	Approach end of runways expected to support instrument night operations, serving approach Category A and B aircraft only. [1]	200 (61)	400 (122)	3,800 (1158)	10,000 [2] (3048)	0 (0)	20:1
5	Approach end of runways expected to support instrument night operations serving greater than approach Category B aircraft. [1]	200 (61)	800 (244)	3,800 (1158)	10,000 [2] (3048)	0 (0)	20:1
6	Approach end of runways expected to accommodate instrument approaches having visibility minimums ≥ 3/4 but <1 statute mile (≥ 1.2 km but < 1.6 km), day or night.	200 (61)	800 (244)	3,800 (1158)	10,000 [2] (3048)	0 (0)	20:1
7	Approach end of runways expected to accommodate instrument approaches having visibility minimums < 3/4 statute mile (1.2 km).	200 (61)	800 (244)	3,800 (1158)	10,000 [2] (3048)	0 (0)	34:1
8[3,5,6,7]	Approach end of runways expected to accommodate approaches with vertical guidance (Glide Path Qualification Surface [GQS]).	0 (0)	Runway width + 200 (61)	1520 (463)	10,000 [2] (3048)	0 (0)	30:1
9	Departure runway ends for all instrument operations.	0 [4] (0)	See Figure 3-4.				40:1

* The letters are keyed to those shown in Figure 3-2.

The OCS slope is 40:1

d) The town company proposes building a 69 foot parking deck to be located 3,800 feet from the approach end of the precision runway. Determine if the proposed parking deck is an obstruction to navigation. Does the tank violates the OCS surface?

If the OCS starts at the end of the runway, the height of the OCS at 3,800ft away from the approach end is (3,800-200)/40=90 ft. Thus, the parking deck does not violate the OCS surface.


THRESHOLD
D
E
C
B
A
OBJECT
THRESHOLD
SURFACE
FIXED OBJECT
A