

Quiz 1 Solution

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Instructor: Trani

Problem #1 (40 points)

The Fort Lauderdale Airport Authority would like to request your services to study runway length improvements to runway 10R/28L at the airport. The airport authority wants to improve this runway allowing airlines to conduct takeoffs supporting international services to Germany (Frankfurt). Estimate the runway length needed for runway 10R/28L if the critical stage length services have been identified at this airport in Table 1.

In your analysis use the latest version of the Boeing documents for airport design. Add 5% to the distance calculated to account for real Air Traffic route conditions and to account for possible weather deviations from the shortest flight path.

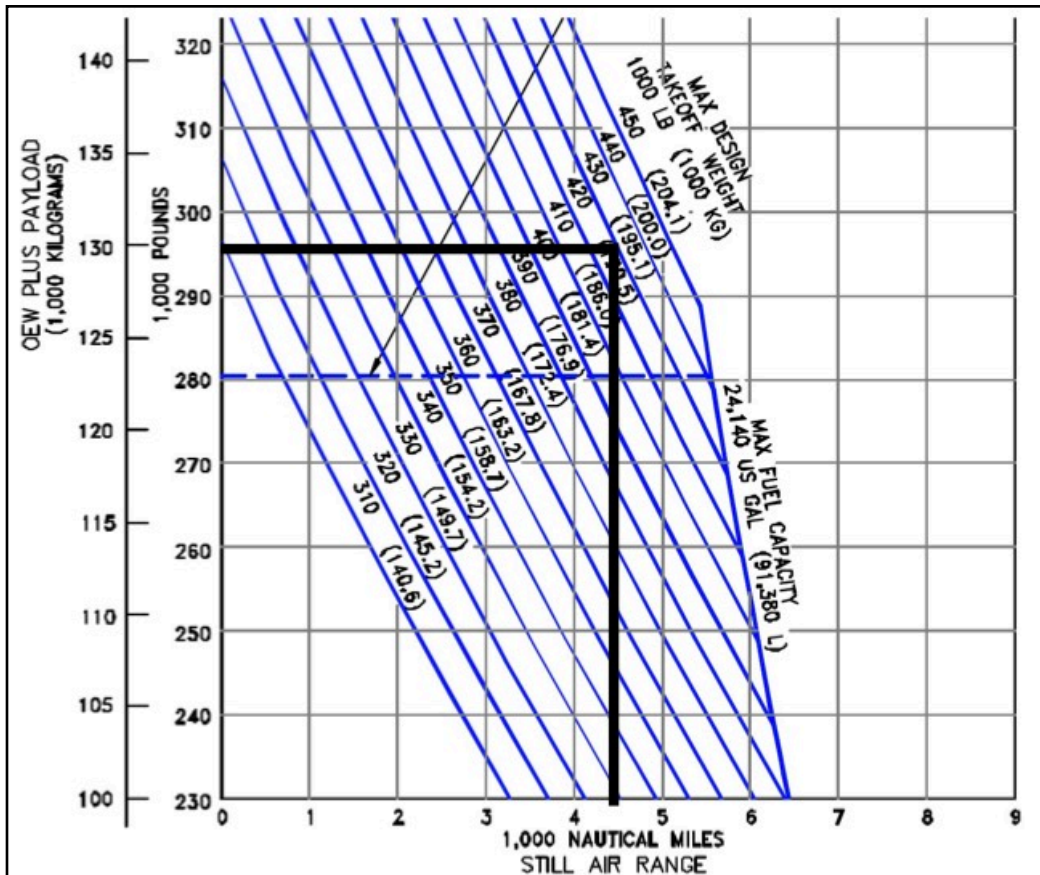
Table 1. Critical Aircraft Used in the Evaluation of Fort Lauderdale Runway 10R/28L.

CHARACTERISTICS	UNITS	767-400ER (1)	
		GE ENGINES	PW ENGINES
MAX DESIGN TAXI WEIGHT	POUNDS	451,000	451,000
	KILOGRAMS	204,570	204,570
MAX DESIGN TAKEOFF WEIGHT	POUNDS	450,000	450,000
	KILOGRAMS	204,116	204,116
MAX DESIGN LANDING WEIGHT	POUNDS	350,000	350,000
	KILOGRAMS	158,757	158,757
MAX DESIGN ZERO FUEL WEIGHT	POUNDS	330,000	330,000
	KILOGRAMS	149,685	149,685
SPEC OPERATING EMPTY WEIGHT (1)	POUNDS	227,400	229,000
	KILOGRAMS	103,147	103,872
MAX STRUCTURAL PAYLOAD	POUNDS	102,600	101,000
	KILOGRAMS	46,538	45,813
SEATING CAPACITY (1)	ONE-CLASS	409 ALL ECONOMY	
	TWO-CLASS	296 - 24 FIRST + 272 ECONOMY	
	THREE-CLASS	243 - 16 FIRST + 36 BUSINESS + 189 ECONOMY	
MAX CARGO - LOWER DECK (2)	CUBIC FEET	4,905	4,905
	CUBIC METERS	138.9	138.9
USABLE FUEL	US GALLONS	24,140	24,140
	LITERS	91,370	91,370
	POUNDS	161,738	161,738
	KILOGRAMS	73,363	73,363

Origin-Destination Airport Pair	Aircraft Flying the Route
Fort Lauderdale to Frankfurt (Germany)	Boeing 767-400ER with PW4062 engines. Aircraft maximum design takeoff weight is 450,000 lb. Aircraft has a typical three-class configuration (243 seats).



Boeing 767-400 Taxiing in Atlanta Airport (A. Trani).



Boeing 767-400ER Payload-Range Diagram. Solution Shown to Fly 4,391 nm.

The distance to be flown is 4391 nm. This includes 5% additional distance.

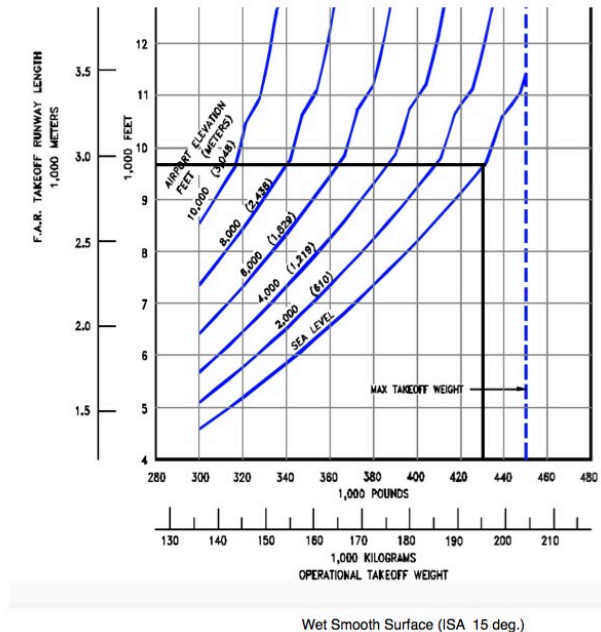
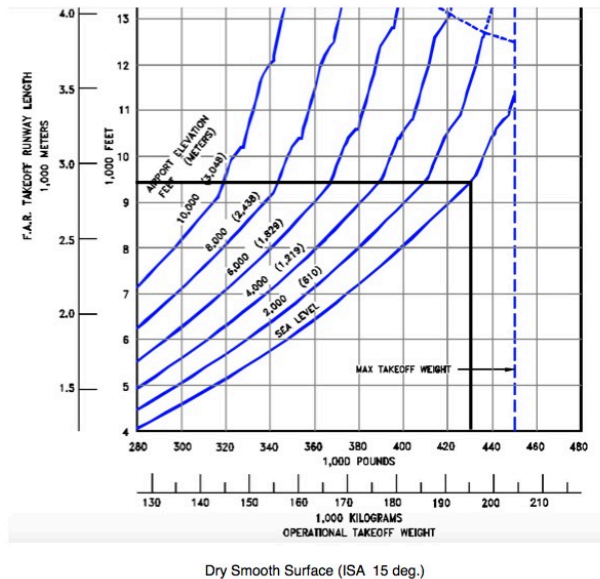
OEW + PYL = 294,460 lb

DTW obtained from the payload-range diagram.

DTW ≈ 430,000 lb

FW = 135,540 lb

- a) Find the runway length needed to satisfy the proposed route with a full passenger load and additionally, carrying three 4,000 lb. LD3 containers. State the airport design temperature, airport elevation and other environmental conditions and assumptions used in your calculations. Indicate the figure(s) used in the aircraft manufacturer documents.



Runway Length Solutions for Boeing 767-400ER with Dry and Wet Smooth Surfaces Under ISA + 15 degrees Conditions.

Dry runway runway length = 9,400 feet

Wet Smooth surface runway length = 9,700 feet

The landing distance is not critical.

- b) Do you need a runway extension? State the extension needed (if any).

Yes, the runway 10R/28L is 8,000 feet. A 1,700 foot extension is needed if wet surface conditions are used. A 1,400 foot extension is needed if dry runway conditions are used.

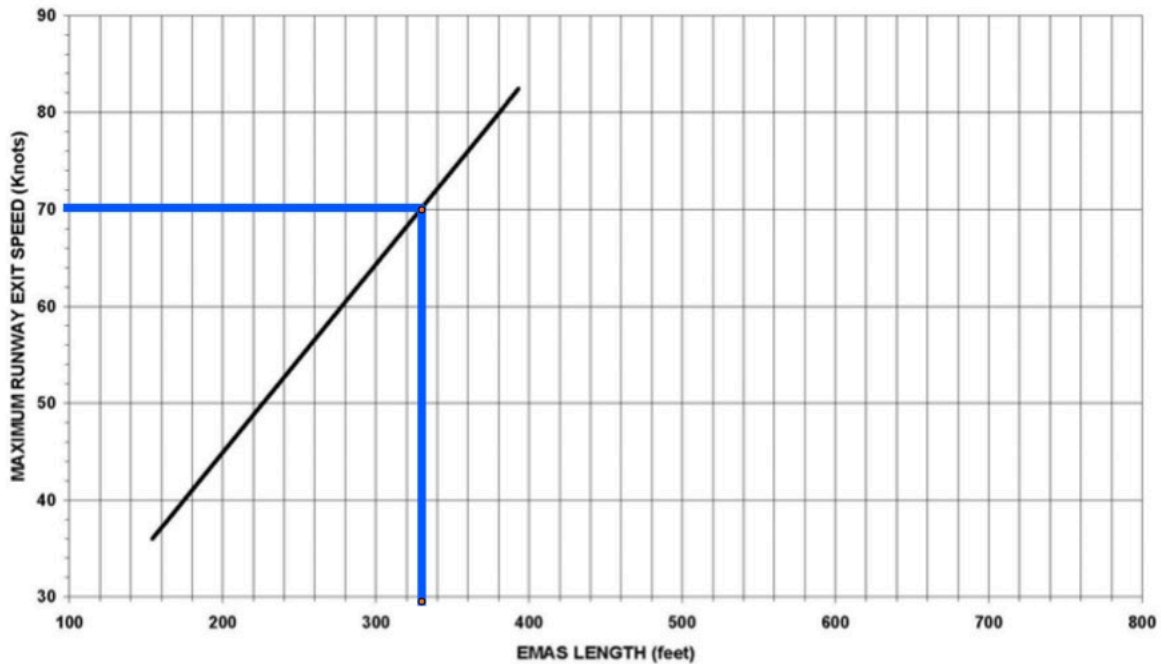
- c) Estimate the fuel (in pounds) needed to fly from Fort Lauderdale to Frankfurt.

Fuel weight is 135,540 lb. This value is below the maximum fuel capacity of the aircraft (161,738 lb).

Problem # 2 (25 points) Short Answers

- a) An airport in the Mid-West is considering installing an Engineering Man-made Arresting System (EMAS). The critical aircraft is the Bombardier CRJ-200. Find the length of the proposed EMAS system. State the design speed used.

Design speed is 70 knots. EMAS length is estimated to be 330 feet.



Bombardier CRJ-200 Regional Jet EMAS Length

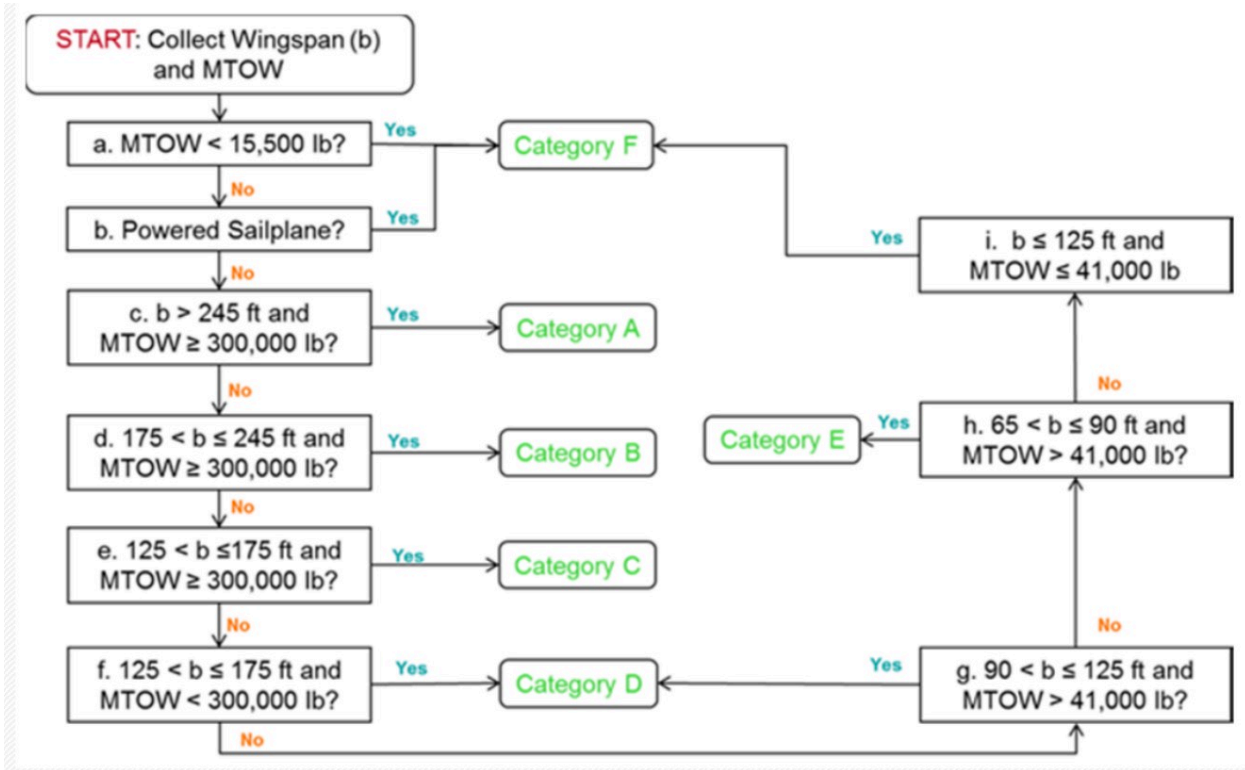
- b) A new commercial airport is to be designed and the Airbus A321 is the critical aircraft. State the FAA Runway Design Code and ICAO airport design code used for runways and taxiways geometric design standards.

Use Appendix 1 of the FAA Advisory Circular 150/5300-13a.

Manu- facturer	Aircraft	AAC	ADG	TDG	Wing- span	Tail Height	Length	CMG	Wheel- base	MGW Outer to Outer	MTOW	V _{REF} / Approach Speed
					ft (m)	ft (m)	ft (m)	ft (m)	ft (m)	ft (m)	lbs (kg)	kts
Airbus	A-321	C	III	5	111.9 (34.1)	39.7 (12.1)	146 (44.5)	64.2 (19.56)	55.4 (16.9)	29.4 (8.97)	206,132 (93500)	142
Airbus	A-321 Sharklet *	C	III	5	117.5 (35.8)	39.7 (12.1)	146 (44.5)	64.2 (19.56)	55.4 (16.9)	29.4 (8.97)	206,132 (93500)	142

c) Find the legacy and RECAT phase 1 wake vortex category for the Airbus A321.

The aircraft wingspan is 111.9 (no sharklets) and 117.5 with sharklets. The aircraft has a weight less than 300,000 lb and greater than 41,000 lb. A321 belongs to Category D.



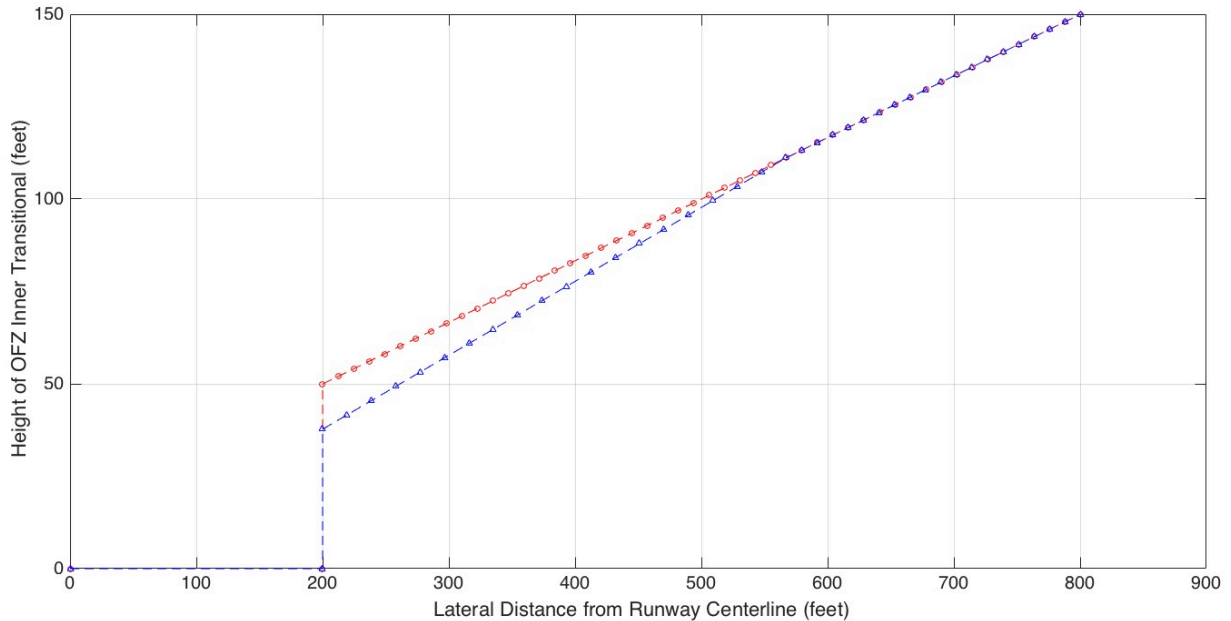
Problem #3 (35 points) - Short Answers

a) Name the first civilian supersonic airliner.

Concorde

b) Estimate the critical height of the inner transitional OFZ surface at a distance 700 feet from the runway centerline. Assume the critical aircraft is an Airbus A321 and the runway supports Category 1 approach procedures.

Assume sea level conditions:



Side View of OFZ for Airbus A321 Aircraft (with Sharklets).

The critical height of the OFZ 700 feet from the runway centerline is 133.3 feet.

c) Find the suitable runway length needed to accommodate Light Sport Aircraft (LSA) such as the Tecnam Mark 2 (see Figure 1) whose approach speed is 49 knots. The airport is to be built at an elevation of 3,200 feet above mean sea level conditions.



Figure 1. Light Sport Aircraft – Tecnam Mark 2 2002 Sierra (source: Tecnam - <http://www.tecnam.com/slider-home-en/discover-the-p2002-sierra-mkii-2nd-generation/>).

**The baseline runway length is 800 feet. Increase 80 ft for each 1,000 feet in airport elevation.
The runway length at 3,200 feet is then 1,056 feet.**