

**Linköping University**

Summer 2017

Communications and Transport Systems

Department of Science and Technology

Dr. Christiane Schmidt

**Exam****Air traffic and air transportation*****TNFL01*****24.08.2017**

- Time: 14-18
- Number of questions: 8
- Total number of points: 80
- Grades: <40:UK, 40-53: 3, 53,5-66,5: 4, 67-80: 5
- Examiner: Christiane Schmidt
- Jourhavande lärare: Valentin Polishchuk, tel 073-6569219  
(Christiane Schmidt, tel 011-36 3212)
- Hjälpmedel: Räknedosor som ej kan lagra text, alt. med tömda minnen är tillåtna. Inga andra hjälpmedel.
- Results will be published latest on September 9.

**Please note:**

- Carefully account for your computations and solution methods.
- Give reason/facts/motivation for all your claims.
- Always use the standard methods as presented in the course.
- You will rarely get full points on a question by just reciting facts from literature and lectures; discussion, showing up connections and examples are necessary.
- You are allowed to use English-Swedish, Swedish-English dictionaries.
- You can write in either English or Swedish.
- Communications devices of any kind (phones, computers, etc.) are not allowed.
- You may use only one side of your paper for your answers.
- Use one sheet of paper for a single answer only.
- Use a maximum of an A4 page per question. In case figures and computations are included, you may use several pages.
- This exam consists of 4 pages.
- With 40 of 80 points you will pass the exam.
- You may not use a *red* pen for any written answers.
- You have 240 minutes to complete this exam.
- Sort your sheets of paper in the order of the given questions.
- Mark the problems you worked on on the envelope.

- Check how many papers you submit, and fill in the number on the envelope.

**Problem 1: Lufthansa and Air Berlin**

**10 points**

Due to financial problems, the operational margin in 2015 was  $-7.5\%$ , the airline Air Berlin planned to shrink its fleet in 2017. Lufthansa wants to extend the fleet of its subsidiary company Eurowings by renting 35 aircraft (with crew) from Air Berlin, that is, the fleet will grow from 90 to 125 aircraft. With a fast take-over of the Air Berlin flights Lufthansa can avoid that slots are reallocated.

Explain how slots are allocated at a level 3 airport, and then detail why a fast take-over of the Air Berlin flights would be beneficial for Eurowings/Lufthansa.

Possible solution:

Slot allocation at level 3 airport: First historic precedence (historic precedence applies to a series of slots that was operated at least 80% of the time during the period allocated in the previous equivalent season). Second slot pool: Once historic slots and changes to historic slots have been allocated, the coordinator will establish a slot pool, including any newly created slots. Slots available in the pool are allocated to airlines requesting a slot. 50% of the slots contained in the pool at initial slot allocation must be allocated to new entrants, unless requests by new entrants are less than 50% Within each category a request to extend an existing operation to operate on a year round basis should have priority over a new slot request.

With a fast take-over, Eurowings can claim historic precedence on the slots used by Air Berlin until now. Thus, those slots will not end up in the slot pool of the airports served by Air Berlin, which would mean that 50% of these slots are allocated to new entrants.

**Problem 2: Check-in**

**10 points**

The check-in hall for international passengers at Moonriver International airport is classified as level C (IATA Level of service C). Actually, only during peak hours, that is weekdays 7am-9am, the check-in hall fails to qualify for level B.

Explain what may cause Moonriver airport to fail the level B requirements, and propose several actions the airport could take to be classified as level B all of the time.

Possible solution:

Too many people in the check-in hall result in Moonriver airport failing the requirements for level B during peak hours. IATA LOS C allows for less area per pax than IATA LOS B. Possible suggestions to fulfill the level B requirements all of the time are:

- Build a larger check-in hall, but that requires a large investment.
- Decrease check-in time during peak hours. For example by opening more check-in desks, mount check-in kiosks (or if they already exist, mount additional kiosks), cooperate with airlines to allow for check-in via internet, etc.
- Make sure that no queues from (slow) security spill to the check-in hall.
- Consider the arrival of passengers: ensure that not many trains and busses arrive in parallel, that is, even out the inflow of pax.
- Give incentives to the airlines to change flight times (e.g., by increasing prices for peak flights), but if the check-in hall is the only restricting factor, that is most likely not the best idea. In case also the runway is a bottleneck, this is a good suggestion.

**Problem 3: Landing sequence**

**10 points**

The following sequence of aircraft requests to be allowed to land on a specific day at Winterville International Airport. It is your task to assign all aircraft an allocated time of landing (ATA), motivate your choice and discuss which goals and requirements exist for a landing sequence.

Flight Nr.	TA	ETL	STL	LTL	A/C type]
1	32	42	54	71	M
2	35	45	50	75	L
3	37	47	55	76	H
4	37	47	57	77	L
5	37	47	53	76	L
6	38	48	58	79	H
7	40	50	59	79	H
8	41	51	64	80	M
9	42	52	67	81	L
10	42	52	67	80	M
11	43	53	69	82	L

lead	follow	distance [in minutes]
L	L	2
L	M	1
L	H	1
M	L	2
M	M	2
M	H	1
H	L	3
H	M	2
H	H	2

Wake vortex separation.

TA=time (in minutes) when a/c calls the tower

ETL=earliest time of landing

STL=landing time according to schedule

LTL=latest time of landing

ATA=allocated time of landing.

Possible solution:

Flight Nr.	TA	ETL	STL	LTL	A/C type	ATA
1	32	42	54	71	M	54
2	35	45	50	75	L	49
3	37	47	55	76	H	55
4	37	47	57	77	L	51
5	37	47	53	76	L	53
6	38	48	58	79	H	57
7	40	50	59	79	H	59
8	41	51	64	80	M	64
9	42	52	67	81	L	68
10	42	52	67	80	M	66
11	43	53	69	82	L	70

The most important requirement is that the required safety distance for vortex separation is never undercut. The distance differs depending on the size of leading and following aircraft, as heavier aircraft generate more wake vortex than lighter planes, plus lighter aircraft are more sensitive to the resulting winds than heavier ones. By planing the sequence such that the total safety distance is minimized, the flow can be increased, that is, more aircraft can land in a certain window of time. A good rule for the given sequence can be to try to circumnavigate having a light plane landing after a heavy one (safety distance of 3 minutes). The goal then is to maximize the flow. A secondary goal is to have the landing time as close as possible to the planned time of landing (and if this is necessary to rather arrive a bit earlier than later). For example, I chose to assign later times for the last four aircraft

than would have been possible due to the separation, to have the landing time closer to the planned time—instead of following the main goal of maximizing the flow.

**Problem 4: Low-cost carriers**

**10 points**

A new manager, Z, starts at the low cost carrier FlyNow, he wonders how FlyNow is able to offer tickets that are more than 50% cheaper than those of competing full service carriers. Explain to Z in a broad picture what factors result in these ticket prices. Do not focus on a single area, but make sure that you highlight various sectors.

Possible Solution.

FlyNow has reduced cost in various sectors when compared to a full service carrier, this includes, for example:

- Higher Aircraft Utilisation: A/c are used for more flight hours per day.
- No In-Flight Catering/Sales on Board: all food and drinks must be bought.
- No Agent Commission: tickets are sold via the internet, direct contact to customer, no agents.
- Cheaper Airports/Landing Fees: FlyNow flies from smaller airports, not located direct in metropolitan areas.
- Seat Density: more seats are used on the same a/c type.
- One a/c type: crew and maintenance don't need to be qualified for several types.
- Lower Crew Cost and longer working hours.
- High Cabin Factor: different prices to reach high cabin factor in the end.

Because of reduced cost, it can offer cheaper tickets.

**Problem 5: Cabin factor and yield**

**10 points**

On the flight from Arlanda to Charles-de-Gaulle (950km) FlyNow had the following information:

	PAX	income
monday	50	98000
tuesday	41	84500
wednesday	32	70000
thursday	48	87000
friday	33	69000
saturday	13	24000
sunday	329	61500

The route is served by a F50 with a capacity of 50 passengers.  
 Compute the average cabin factor and yield for the given week.

FlyNow realized that the demand on Saturdays is too low to keep serving the route on that day. Discuss possible measures FlyNow can take.

*Max. one A4 page text!*

Possible solution: cabin factor = share of seats occupied by paying pax =  $(50+41+32+48+33+13+29)/50/7=70,29\%$   
yield=income per paxkm =  $(98000/50 + 84500/41 + 70000/32 + 87000/48 + 69000/33 + 24000/13 + 61500/29)/550/7=2,11$  kr/paxkm

Alternatives for Saturdays are, e.g., to shut down the route on Saturdays and to use the aircraft for a more profitable route, or to use a smaller aircraft on this route. Any such solution also must consider that a balance has to be kept: if there are, e.g., flights from Charles-de-Gaulle to Arlanda on Saturday, also that one must either be shut down or flown with a smaller aircraft. Another possibility is to try to increase the demand for the flight by moving the departure time, reducing the price (probably not profitable), or with other marketing measures. Alternatively, maybe it is possible to increase the price without losing much demand, which again makes the flight more profitable.

**Problem 6: Nine freedoms of the air**

**10 points**

FlyNow, a small Swedish airline, has new employees, and it is your job to explain the nine freedoms of the air to them. Give a general definition, and name at least 3 freedoms and what they could enable FlyNow to do.

*Max. one A4 page text!*

Possible Solution.

The nine freedoms of the air are a set of commercial aviation rights granting a country's airlines the privilege to enter and land in another country's airspace, formulated as a result of disagreements over the extent of aviation liberalisation in the Convention on International Civil Aviation of 1944, known as the Chicago Convention.

One freedom grants an airline to fly from one's own country to another. FlyNow could operate the route Arlanda-London, arriving in the UK.

Another freedom grants an airline the right to fly over a foreign country without landing. FlyNow could for example operate the route Arlanda-London, overflying Denmark without landing in Denmark.

Another freedom grants an airline the right to fly inside a foreign country without continuing to one's own country. FlyNow could operate a flight Paris-Marseille, without offering any flight from Marseille to Sweden.

**Problem 7: Route network**

**10 points**

FlyDirect, a medium-size airline, has operated a hub-and spoke system with a hub at Moonriver International Airport for many years. Recently, FlyDirect observed that more passengers are interested in direct flights. Thus, FlyDirect considers switching to mainly using a point-to-point system. Assume FlyDirect implements that change, discuss how it will influence the relevant players.

Max. one A4 page text!

Possible Solution.

Passengers might appreciate the new direct flights, which will lead to an increased demand on some flights. On the other hand, FlyDirect will offer fewer options, and a flight with a demand mainly driven by the fact that it transports passengers to the hub might have a decreased demand. Consequently, the airline might need aircraft with other capacities than the ones currently in the fleet. Probably, before the change small aircraft served the routes in the network from a spoke airport to the hub, and big aircraft served the routes inbetween hubs or from the hub to large spoke cities. After the change, the network will require more medium-sized aircraft.

For the airline the change implies that their resources are spread out more than before: the crews will have more than one home base, and most likely several maintenance bases are needed. The flight schedule will be easier to plan, but it will offer fewer possibilities to find a cheap/good schedule.

The hub airport will lose traffic volume, other airports might experience an increase in traffic. At airports that are not already at capacity this will also influence ground handling, shops, ground transportation, air traffic control, etc..

**Problem 8: Change of plans**

**10 points**

FlyNow has a fleet of two J31 (capacity 18 pax) and four F50 (capacity 50 pax). At 16:00 a routine aircraft:

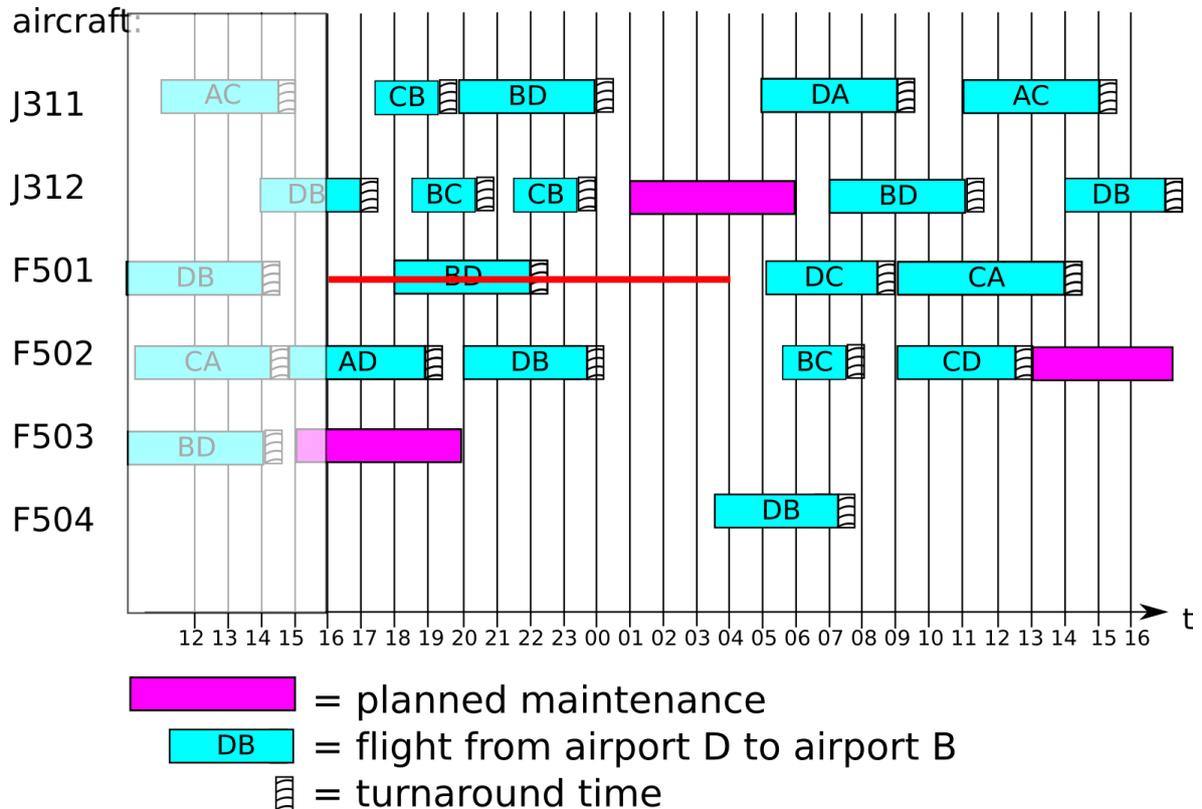


Figure 1: Screenshot of planning at 16:00.

control detects that one of the F50, which is currently located at airport B is damaged by hail. This

can be fixed, but it is expected to take 12 hours. Figure 1 shows a screenshot of the system used for the daily planning and surveillance of flights and aircraft at FlyNow.

The flight controller at FlyNow has a suggestion for the current situation: swap the flight B-D and the later flight D-C that F501 should have served and let F502 operate them, which results in about 6.5 hours delay for the flight B-D. Then, F501 will operate F502's flight B-C.

Discuss how this suggestions influences the crew planning, maintenance planning and passenger planning. *Max. one A4 page text!*

Possible solution:

**Crew planning:** We can assume that the crew who should have flown on the F501 is able to operate the F502. They will have to handle a delayed departure. Plus, they probably will have left for home and night rest at about 10:30 pm, which will now be about 5 am. That might influence their possibilities to continue their planned scheme after the night rest—they will have to delay the end of their night rest by 6.5 hours. If they would have worked over the night anyway and would have operated the flight D-C with the F501, the change shouldn't influence them a lot. The crew who should have flown the B-C flight with the F502 and will now operate it with the fixed F501 shouldn't be influenced at all.

**Maintenance planning:** The F502 will increase the flight time by about 5.5 hours—in comparison to the planned scheme. That might result in the need for maintenance earlier than planned originally. In the worst case, it might not be able to serve the additional flights at all. The next maintenance was scheduled after about 12 more flight hours, so, adding 5.5 flight hours might result in a violation of a rule for the max allowed flight hours inbetween maintenance. For the F501: the flight hours will be decreased by the schedule change, so, it won't violate any maintenance rules. Moreover, maybe it is possible to perform a service check during the reparation, which might postpone the next necessary maintenance.

**Passenger planning:** The only passengers that will be influenced by the change are those that are booked on the flight B-D that should have been operated by the damaged F501 (original flight time 18:00-22:00). But the delay will probably be perceived as very inconvenient, as they will now land at 4:30 in the morning. The airline must check that the airport is open at that hour. The new arrival time might result in transport problems (leaving the airport) for the passengers etc. Possibly, the airline can help with ground transport, hotel or the like to reduce the bad-will.

**Good Luck!!!**