FLIGHT DELAYS/DETERMINISTIC QUEUEING MODELS

Three airlines (A, B, C) have scheduled flights (1 – n) for the morning peak hour departure bank as described in the chart below. There is a single runway that can handle one flight per slot.

1) Complete the Queuing Diagram by filling in the sequence of departing flights. The grey cells represent the departure slot (10 pts)

2) Compute the # of Flights in the Queue for each Departure Slot. Enter this information in the row labeled "# Flights in Q". (10 pts)

3) Compute the Total Delay per Flight. Enter this information in the column labeled "Total Delay per Flight." (10 pts)

Slot #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Schedule	A1	A2	A3	A4														
	B1	B2	B3	B4														
	C1		C2															

Total Delay per Flight

Takeoff Slot	A1																		*0*
Q1	B1	B1																	*1*
Q2	C1	C1	C1																*2*
Q3		A2	A2	A2															2
Q4		B2	B2	B2	B2														3
Q5			A3	A3	A3	A3													3
Q6			B3	B3	B3	B3	B3												4
Q7			C2	C2	C2	C2	C2	C2											4
Q8				A2	A2	A2	A2	A2	A2										5
Q9				B4	B4	B4	B4	B4	B4	B4									6
Q10																			
Q11																			
Q12																			
Q13																			
Q14																			
Q15																			
Q16																			
Q17																			
# Flights in Q	*2*	*3*	5	**6**	5	4	3	2	1										31

1)   The max Number of Flights in the Departure Queue (2 pts)

_____6_____

2)   Determine the Total Time the Departure Queue is present (2 pts)

_____9_____

3)   The Total Delay Time for all the flights (2 pts)

_____31_____

4)   the Expected Delay for each Flight (in units of # of slots) (2 pts)

_____31/10 = 3.1 slots_____

5)   If one flight was cancelled, and <u>subsequent flights were moved-up to fill the vacated slot</u>, which flight would reduce the Total Delay the <u>most</u> (2 pts)

_____FIRST flight (all subsequent flights move up one slot)_____

6)   If one flight was cancelled, and subsequent flights were moved-up to fill the vacated slot, which flight would reduce the Total Delay the <u>least</u> (2 pts)

_____LAST flight (no subsequent flights get to move up)_____

7)   Proportional Equity
     i. Compute Proportional Equity for Airline A

___{ [0+2+3+5]/31 }/{4/10} = 100/124__**(i.e. < 1, benefited, proportionally less delays than number of flights)**_____

     ii. Compute Proportional Equity for Airline B

__{ [1+3+4+6]/31 }/{4/10} = 140/124__ **(i.e. > 1, penalized – proportionally more delays than number of flights)_____**

    iii. Compute Proportional Equity for Airline C

__{ [2+5]/31 }/{2/10} = 70/62__ **(i.e. > 1, penalized – proportionally more delays than number of flights)_____**

    iv. Explain causes of the differences in Proportional Equity between the Airlines

__Average delay for each flight = 3.1 slots._____

__Airline A has average delay 10/4 = 2.5 slots_____

__Airline B has average delay 14/4 = 3.5 slots_____

__Airline C has average delay 7/2 = 3.5 slots_____

__Airline A is scheduled always to be first in the queue. Even though Airline B has the same number of flights, it is always scheduled 2nd in the queue.

Airline C has only 2 flights, but is always behind A and B

__LOCATION, LOCATION, LOCATION. Be at the start of the bank. Be ahead of others in time slot.

To have proportional equity, be spread out evenly_____

8)   Exempted Flight
        i. What is an exempted flight

__Flight is given priority. Departs (or arrives at scheduled time even if there is a queue. Not required to queue_____

    ii. How does an exempted flight affect the Total Delay Time for all flights. Explain?

___**Conservation of Delay**. Exempted flight does not change TOTAL DELAY____

9)   Schedule Compression

    i. What is Schedule Compression

__When a flight is cancelled it opens up a slot. That slot is then filled by bumping each of the remaining flights forward in the schedule. (i.e. COMPRESSING THE SCHEDULE) The reduces the queueing delay for all the remaining flights.
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    ii. How does Schedule Compression affect the Total Delay Time for all flights. Explain?

_____Total Delay decreased. Each flight remaining the schedule has delay reduced by 1 slot for each cancelled flight. (Note: if cancelled flight is last flight there is no Compression_____

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