**System Description:**

Primary objective is to train undergraduate pilot students to successful completion of wings and secondary objective is to facilitate Qualified Flying Instructor (QFI) development. The flight school is structured into four sections where three facilitate flying instruction of undergraduate students and the remaining section manages the syllabus and QFI progression. At any given time, there are three courses of students that initially range from 20-25 students.

The following will individually investigate the components that form the system that are relevant to a scheduling tool.

**Syllabus:**

The syllabus will be a dynamic update excel that takes the following format. Stage, event, allocation, timing.

Stages are:

1. Basic General Flying
2. Basic Instrument Flying
3. Intermediate General Flying
4. Formation Flying
5. Navigation Flying
6. Intermediate Instrument Flying
7. Combination Flying
8. Advanced Phase Flying
9. Instructor Upgrade Syllabus 2
10. Instructor Upgrade Syllabus 3

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| STAGE 1 | | | | | | | | |
| Event | Pre-Brief (mins) | Event time (mins) | Debrief Admin (mins) | Aircraft  (qty) | Simulator (qty) | Instructor (qty) | Student (qty) | Away Base |
| LEC1 | 0 | 60 | 0 | 0 | 0 | 1 | uncapped |  |
| LEC2 | 0 | 60 | 0 | 0 | 0 | 1 | “” |  |
| SIM1 | 45 | 78 | 45 | 0 | 1 | 1 | 1 |  |
| SIM2 | 45 | 78 | 45 | 0 | 1 | 1 | 1 |  |
| GF1 | 70 | 78 | 45 | 1 | 0 | 1 | 1 |  |
| GF2 | 65 | 78 | 45 | 1 | 0 | 1 | 1 |  |
| TUT1 | 0 | 60 | 0 | 0 | 0 | 1 | Max 6 |  |
| LEC3 | 0 | 60 | 0 | 0 | 0 | 1 | Uncapped |  |
| SIM3 | 30 | 78 | 45 | 0 | 1 | 1 | 1 |  |
| GF3 | 65 | 78 | 45 | 1 | 0 | 1 | 1 |  |

**Instructor Pilots:**

Instructors arrive and are afforded a basic level 1 category. This authorises them to conduct majority of the flight syllabus with exception to the advanced packages at the final stage of course and instructor to instructor mentor flights. Given this, instructors need to be assigned a variable to denote what stage they can teach.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Instructor Level** | **Syllabus stages they can teach** | **Currency Events** | **Check Rides** | **Emerg Sim** |
| 1 | 1-7 | 1 every 3 weeks (must be flown with level 3) | 1 x flight every 12 months  2 x sims every 12 months | Every 90 days |
| 2 | 1-8 | 1 every 3 weeks (must be flown with level 3) |
| 3 | ALL | 1 every 4 weeks | 1 x flight every 24 months  1 x sim every 24 months |

QFI’s follow an upgrade process to advance through the levels. It should be assumed that a new QFI is afforded an upgrade ride every 3 weeks. Level 1 and 2 instructors should be programmed with a level 3 instructor, in the absence of an available level three instructor, they can be programmed SOLO. Level 3 instructors should be programmed for a SOLO flight every 4 weeks.

**Student Pilots:**

Student pilots arrive at event 1 and progress linearly through flight, simulator and tutorial events. Lecture events occur once the first student in the course reaches the lecture requirement

From a scheduling perspective, students must maintain a currency of 14 days on flight and simulator events. A warmup event is required if these lapses.

**Aircraft:**

There are 16 aircraft available for flying on a daily schedule. This variable can be updated to account for any shortages due maintenance. Ideally the availability will be tied into a dynamic excel worksheet.

**Simulator:**

There are 2 simulator devices available. In periods of surge, we can extend the simulator working hours into evening time slots.

**Crew Duty:**

All pilots are subject to limitations on how many flights they can do per day. This table will be user centred dynamic.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Flight Type** | **LIMIT** | | | | | | | |
| **Daily** | | **48hrs** | | **7 Days** | | **30 Days** | **12 Months** |
| **Flight Hours** | **Flights** | **Flight Hours** | **Flights** | **Flight Hours** | **Flights** | **Flight Hours** | **Flight Hours** |
| **QFI** | 6H | 2  (3 approved on surge events) | 10H | 6 | 21H | 18 | 65H | 550H |
| **STUDENT** | 4H | 2 | 7H | 5 | 14H | 10 | 40H |  |

**Objective Function:**

1. **Indices**

D The set of days: [7]

E The set of all student events: [Dynamic Excel]

I The set of instructors [Dynamic Excel]

J The set of training stages [Dynamic Excel]

P Set of periods [168]

S Set of students [Dynamic Excel]

1. **SubSets**

Periods where event e is allowed to start

(*e’*,*e*) ∈ *DD* if event *e*’ cannot be the same day as event *e*

Flight events

Simulator events

Events that are in stage j

Lecture events

Tutorial events

Flights requiring an on-wing instructor

Away base events

Instructors who can instruct event e

Instructors who are on-wing for student s.

Periods in day d

Periods where instuctor i not avail. [dynamic update]

Periods where student s not avail. [dynamic update]

(*e’*,*e*) ∈ *R* if event *e*’ precedes event *e*

Events e’ that satisfy event e

All periods p’ that prohibit starting any event if event e started in period p.

(*e’*,*e*) ∈ *warmups* if event *e*’ reinstates currency for event *e*

Events e’ that satisfy warmup event e

1. **Data**

Time required after event e before staring the next event [periods].

Max number of students assigned to tutorial event Default

1 is student *s*  already completed event *e,* 0 otherwise

Pair of days that indicate maximum number of days a until a student requires a currency flight. Student must redo *e’* before being able to shcedule event *e.*

Number of days since student *s* completed event *e.*

1 if instructor *I* can be scheduled for an extra event on day *d.* [events]

Pair of values (ceiling, visibiliity) that are the expected weather forecast during period *p.* [dynamic update]

1 if requiring completion of event *e* for student *s (desired),* 0 otherwise.

Penalty for scheduling instructors to events. Default

Maximum number of flights in period *p* (aircraft availability). Default

Number of aircraft required for event *e.*

Number of instructors required for event *e.*

Number of periods in event *e.*

Number of warmups (0,1) required for student *s* to complete event  *e* in period *p*. If a student is current, 0, otherwise, 1.

1 if student *s* can complete event *e* during the week, 0 otherwise. Calculated to be all events in that are not in where is 1 if student s is in stage *j* and 0 otherwise. Also 1 if *e* is a warmup event a student needs to complete to be current to conduct other possible events, even if student *s* has previously completed *e*.

Reward for scheduling student *s* to event *e* in period *p.* [number] Calculated as ∀ where is the reward for scheduling student *s* to event *e* in period *p* [number] and is the reward for scheduling an event in period *p* that is earlier in the week, which is calculated as . [number}

Penalty for scheduling an event in period p. {number}

Penalty for student s not completinfg event e. {number}

Reward for student s completing warmup event e in period p. {number}

Pair of values (cloud ceiling, visibility) that are the minimum weather required to schedule flight event e. [dynamic update based on weather forecast]

Reward for scheduling event e in period p. Based on automatic assignment of values from weather forecast.

1. **Decision Variables**

Non-negative variable with value of 1 if student *s* is not scheduled to a flight event in a week.

Binary variable with value of 1 if instructor *i* instructs lecture or tutorial event *e* in period *p* and 0 otherwise.

Binary variable with value of 1 if student s has more than four lecture or tutorial hours on day d and 0 otherwise

Binary variable with value of 1 if instructor *i* instructs more than four lecture/ tutorial hours on day *d* and 0 otherwise.

Binary variable with value of 1 if instructor *i* flies event *e* in period *p* and 0 otherwise.

Binary variable with value of 1 if student *s* starts event *e* in period *p* and 0 otherwise.

TO ADD:

* Instructor lookup variable/ constraint. For levels of instruction.
* Add QFI currency flight.
* Add IRT/ EMERG Check requirements