AEEM 3042 Integrated Aircraft Engineering Project #1 – Flight Manual

Instructor Tips for completing the flight profile project:
- **Time, Fuel, and Distance needs to accounted for in each flight segment**
- **Some hand calculations will be necessary to fill out the Mission Time History and Mission Worksheet (be sure to keep track of your units for each hand calculation!!)**
- **Fill in all cells of the Mission Time History Summary Sheet and the Mission Worksheet**

Instructor Tips for using the flight manual charts:
- **Pay attention to the axis scales and the chart legend when getting data from the charts**
- **Visibly interpolate between the curves to get an approximate value – that will be good enough**

Example #1: when interpolating for 830 lb between the 800 lb and 900 lb curves, look at the midpoints between the two curves (850 lb) and use that data point

Example #2: when interpolating for 810 lb between the 800 lb and 900 lb curves, simply use the 800 lb curve data points

1. **Warm-up and Taxi**

   No range credit = put a zero in the Incremental Distance column of the Mission Time History
   Calculate the fuel burned for the Time and Power Setting stated in the flight profile

$$\text{Fuel} = \text{Time x Power Setting x T x } c_{SL}\left(\frac{a}{a_{SL}}\right)$$

$$\text{where} \quad T = T_{SL}\left(\frac{\rho}{\rho_{SL}}\right)$$

   and Power Setting is expressed as a decimal (i.e. 0.10 for 10% Power Setting)

   This segment's final conditions are zero speed at the airfield's altitude

2. **Takeoff**

   No range credit = put a zero in the Incremental Distance column of the Mission Time History
   Takeoff Time is calculated by Takeoff Distance / Average Velocity
   Takeoff Fuel is calculated by Takeoff Time x Fuel Flow (check your units!)

$$\text{Time} = \frac{s_g}{0.7\ V_{TO}} \qquad \text{Fuel} = \text{Time x T x } c_{SL}\left(\frac{a}{a_{SL}}\right) \quad \text{where} \quad T = T_{SL}\left(\frac{\rho}{\rho_{SL}}\right)$$

   This segment's final conditions are at the 35-foot obstacle

3. **Climb to Altitude**

   For the Time to Climb chart:
   Read the value of Time to Climb at the climb's beginning altitude for the current weight
   Read the value of Time to Climb at the climb's end altitude for the current weight
   Subtract the two values and enter that value in the Incremental Time column
   Repeat the same steps for the Fuel to Climb and Distance to Climb charts

4. **Initial Cruise**

   Use the Specific Range chart for the Cruise Altitude stated in the flight profile
   For the current Aircraft Weight, pick the Velocity that maximizes the Specific Range
   Cruise Time = Cruise Distance / Velocity (check your units!)
   Cruise Fuel = Cruise Distance / Specific Range (check your units!)

5. **Descent**

   For the Time to Descend chart:
   Read the value of Time to Descend at the descent's beginning altitude for the current weight
   Read the value of Time to Descend at the descent's end altitude for the current weight
   Subtract the two values and enter that value in the Incremental Time column

   Repeat the same steps for the Distance to Descend chart
   Enter zero in the Incremental Fuel column

6. **Maneuver**

   Calculate the fuel burned for the turns:
   Time to Turn = # of degrees / Turn Rate (check your units!)
   Fuel to Turn = Time x Fuel Flow (check your units!)

   Subtract the Fuel to Turn from the Maneuver Initial Weight for the acceleration calculation

   Read the value of Time to Accelerate at the maneuver Altitude for the current weight
   Read the value of Fuel to Accelerate at the maneuver Altitude for the current weight

   No range credit = put a zero in the Incremental Distance column of the Mission Time History

7. **Climb to Altitude**

   For the Time to Climb chart:
   Read the value of Time to Climb at the climb's beginning altitude for the current weight
   Read the value of Time to Climb at the climb's end altitude for the current weight
   Subtract the two values and enter that value in the Incremental Time column

   Repeat the same steps for the Fuel to Climb and Distance to Climb charts

8. **Final Cruise**

   Use the Specific Range chart for the Cruise Altitude stated in the flight profile
   For the current Aircraft Weight, pick the Velocity that maximizes the Specific Range

   Cruise Time = Cruise Distance / Velocity (check your units!)
   Cruise Fuel = Cruise Distance / Specific Range (check your units!)

9. **Initial Descent**

   For the Time to Descend chart:
   Read the value of Time to Descend at the descent's beginning altitude for the current weight
   Read the value of Time to Descend at the descent's end altitude for the current weight
   Subtract the two values and enter that value in the Incremental Time column

   Repeat the same steps for the Distance to Descend chart
   Enter zero in the Incremental Fuel column

10. Hold

Use the Specific Endurance chart at the altitude stated in the flight profile
For the current Aircraft Weight, pick the Velocity that maximizes the Specific Endurance

Hold Fuel = Hold Time / Specific Endurance (check your units!)

No range credit = put a zero in the Incremental Distance column of the Flight Time History

11. Final Descent

For the Time to Descend chart:
Read the value of Time to Descend at the descent's beginning altitude for the current weight
Read the value of Time to Descend at the descent's end altitude for the current weight
Subtract the two values and enter that value in the Incremental Time column

Repeat the same steps for the Distance to Descend chart
Enter zero in the Incremental Fuel column

12. Landing

The flight is officially over when the aircraft lands
No time, fuel, or distance credit for this segment

Additional Tips:

1. This project will take some time to complete, so get started right away! You will probably work the problem two or three times before you submit it.

2. Consider using the Excel workbook file provided and programming it to do a lot of the math for you.

3. You may want to print out key pages of the 30-page flight manual to help you use the charts.

4. You may discover that you have speed discrepancies between mission segments
-- Do not worry about those discrepancies!
Example: after the climb segment the aircraft's final speed is 300 ft/sec and the initial cruise segment speed is 340 ft/sec – ignore that discrepancy and keep going

5. Your Remaining Fuel Onboard value should be between 0 and 50 lb when the mission is complete.