SYST 460/560 FALL 2010
Aircraft Performance (Aerodynamic Simulation)

INSTRUCTIONS

Build a Simulation of Aerodynamics (using the point-mass model)

Instructions:

1. Use Excel (or any other application or software language)

Example: Excel Spreadsheet

Time	Thrust (lbs	Drag (lbs)	Weight (lbs	Mass	Flight Path	sin(Flightpa	dV/dt (ft/se	g		VTAS (ft/se	VTAS (Kno	Vground (ft	Vground (K	Distance T	Distance T	Vertical Sp	Vertical Sp
1	6404	6404	100,000	3105.59	0	0	0	0		422	250.0329	422	250.0329	0	0	0	0
2	6404	6404	100,000	3105.59	0	0	0	0		422	250.0329	422	250.0329	422	0.069454	0	0

2. Create a simulation using the following parameters (i.e. columns)
    a. Time (secs) – range 0 to 200. Initial condition is at time step 0.
    b. Thrust (lbs)
    c. Drag (lbs)
    d. Weight (lbs)
    e. Mass = Weight/Gravitational Force
    f. Flight Path Angle (Degrees)
    g. Sin (FlightPath Angle) (radians)
    h. dv/dt = acceleration on Flight Path Axis (ft/sec2)
    i. VTAS (ft/sec) = True Airspeed on Flight Path Axis
    j. VTAS (knots)
    k. VGroundSpeed (ft/sec)
    l. VGroundSpeed (knots)
    m. Distance Travelled (feet)
    n. Distance Travelled (knots)
    o. Vertical Speed (ft/sec)
    p. Vertival Speed (ft/min)
    q. *Altitude (ft)*

    Note1: Parameters shown in *italics* are derived from equations of motion using the parameters in the list. Parameters in plan text are fixed (i.e. constants). Parameters in **bold** are input (see input profile below).

    Note2: All Excel trig functions use radians (not degrees). Convert degrees to radians using RADIANS(angle) function. Convert radians to degrees using DEGREES(radians) function.

3. Initial Conditions
    a. VTAS (ft/sec) = 422 ft/sec = 250 knots
    b. Distance Travelled = 0 ft
    c. Altitude = 0 ft

4. Test Cases. Make sure that your simulation is working correctly. In level flight, when thrust = drag, dV/dt should equal zero. In climb (i.e. Flight Path Angle > 0), at constant speed, it will require more thrust than in level flight. Check all the other cases too.

5. Create the following Charts:
    a. Time (x-axis), Thrust (lbs) (primary y-axis), Flight Path Angle (degrees) (secondary y-axis) and dV/dt (ft/sec2) (secondary y-axis)
    b. Time (x-axis), VTAS (knots) and VGroundspeed (knots) (primary y-axis), Distance Travelled (nm) (secondary y-axis)
    c. Time (x-axis), Flight Path Angle (degrees) (primary y-axis), Altitude (ft) (secondary y-axis), Vertical Speed (fpm) (secondary y-axis)
    d. Distance (nm) (x-axis), Altitude (ft) (primary y-axis), Vertical Speed (fpm) (primary y-axis)

6. The aircraft performs the following maneuvers. Using the charts from #5, complete the table below.

Maneuver	Thrust Setting (lbs)	Flight Path Angle (degrees)	Start Time (secs)	End Time (secs)	Start Distance (nm)	End Distance (nm)	Start Altitude (ft)	End Altitude (ft)	Start VTAS (knots)	End VTAS (knots)	Vertical Speed (fpm)
1. Level Flight, constant speed											
2. Level flight acceleration											
3. Level Flight, constant speed											
4. Climb Deceleration											
5. Climb at Constant Speed											
6. Climb with Acceleration											
7. Climb with Constant Speed											
8. Level Flight Constant Speed											

7. Deliverables:
    a. Table from Question #6
    b. Charts From Quedstion #5
    c. Spreadsheet or Code

8. Input Profile

Time	Thrust (lbs)	Flight Path Angle (degrees)
1	6404	0
2	6404	0
3	6404	0
4	6404	0
5	6404	0
6	6404	0
7	6404	0
8	6404	0
9	6404	0
10	6404	0
11	6404	0
12	6404	0
13	6404	0
14	6404	0
15	6404	0
16	6404	0
17	6404	0
18	6404	0
19	6404	0
20	6404	0
21	19500	0
22	19500	0
23	19500	0
24	19500	0
25	19500	0
26	19500	0
27	19500	0
28	19500	0
29	19500	0
30	19500	0
31	19500	0
32	19500	0
33	19500	0
34	19500	0
35	19500	0
36	19500	0
37	19500	0
38	19500	0
39	19500	0
40	19500	0
41	6404	0
42	6404	0
43	6404	0
44	6404	0
45	6404	0
46	6404	0

47	6404	0
48	6404	0
49	6404	0
50	6404	0
51	6404	0
52	6404	0
53	6404	0
54	6404	0
55	6404	0
56	6404	0
57	6404	0
58	6404	0
59	6404	0
60	6404	3
61	6404	3
62	6404	3
63	6404	3
64	6404	3
65	6404	3
66	6404	3
67	6404	3
68	6404	3
69	6404	3
70	11,750	3
71	11,750	3
72	11,750	3
73	11,750	3
74	11,750	3
75	11,750	3
76	11,750	3
77	11,750	3
78	11,750	3
79	11,750	3
80	11,750	3
81	11,750	3
82	11,750	3
83	11,750	3
84	11,750	3
85	11,750	3
86	11,750	3
87	11,750	3
88	11,750	3
89	11,750	3
90	24,500	3
91	24,500	3
92	24,500	3
93	24,500	3
94	24,500	3
95	24,500	3
96	24,500	3
97	24,500	3
98	24,500	3

99	24,500	3
100	24,500	3
101	24,500	3
102	24,500	3
103	24,500	3
104	24,500	3
105	24,500	3
106	24,500	3
107	24,500	3
108	24,500	3
109	24,500	3
110	24,500	3
111	24,500	3
112	24,500	3
113	24,500	3
114	24,500	3
115	24,500	3
116	24,500	3
117	24,500	3
118	24,500	3
119	24,500	3
120	24,500	3
121	24,500	3
122	24,500	3
123	24,500	3
124	24,500	3
125	24,500	3
126	24,500	3
127	24,500	3
128	24,500	3
129	24,500	3
130	24,500	3
131	24,500	3
132	24,500	3
133	24,500	3
134	24,500	3
135	12,000	3
136	12,000	3
137	12,000	3
138	12,000	3
139	12,000	3
140	12,000	3
141	12,000	3
142	12,000	3
143	12,000	3
144	12,000	3
145	12,000	3
146	12,000	3
147	12,000	3
148	12,000	3
149	12,000	3
150	12,000	3

151	12,000	3
152	12,000	3
153	12,000	3
154	12,000	3
155	12,000	3
156	12,000	3
157	6,404	3
158	6,404	0
159	6,404	0
160	6,404	0
161	6,404	0
162	6,404	0
163	6,404	0
164	6,404	0
165	6,404	0
166	6,404	0
167	6,404	0
168	6,404	0
169	6,404	0
170	6,404	0
171	6,404	0
172	6,404	0
173	6,404	0
174	6,404	0
175	6,404	0
176	6,404	0
177	6,404	0
178	6,404	0
179	6,404	0
180	6,404	0
181	6,404	0
182	6,404	0
183	6,404	0
184	6,404	0
185	6,404	0
186	6,404	0
187	6,404	0
188	6,404	0
189	6,404	0
190	6,404	0
191	6,404	0
192	6,404	0
193	6,404	0
194	6,404	0
195	6,404	0
196	6,404	0
197	6,404	0
198	6,404	0
199	6,404	0
200	6,404	0