Using Equations of Motion in a Simulation

Parameter	Equation	Units	Notes
Time	Increments by 1 second	seconds	Update rate of simulation = 1 second
Thrust	Input	Lbs	This is an input that must be determined by the "pilot." This determined to meet the profile requirements
Flightpath Angle	Input	Angles	This is an input that must be determined by the "pilot." This is set to meet the profile requirements
Sin (FPA)	= sin (FPA)		Calculated. Be careful to convert degrees to radians depending on the type of sin function used
Weight	= Constant	Lbs	Generally constant. May decrease with time for long distance due to fuel burn = mass * g
Drag	= 0.5 * Air Density * Drag Coefficient * Surface Area * (True Airspeed)^2	Lbs	
(T-D)/M	=(T-D)/M	Lbs	Intermediate computation. Note 1: T-D=0 for level flight, constant speed. Note 2: M= W/g
Inertia	=[Weight * sin (FPA)]/M	Lbs	Intermediate computation. Note: M= W/g. Note: Depending on sin function used may need to turn degrees in radians
Flightpath Acceleration	= [T-D-Wsin(FPA)]/M	ft/sec^2	
Flightpath Acceleration (g's)	= FPAcc/g	g's	G = 32.2 ft/sec^2
True Airspeed (ft/sec)	= Last Cycle True	ft/sec	Integrating FPAcc by

	Airspeed + FPAcc		adding ft/sec^2 to velocity computed 1 second ago
True Airspeed (knots)	= True Airspeed in ft/sec * (3600/6076)	knots	6076 feet in a nautical mile. 3600 seconds in an hour
Groundspeed (ft/sec)	= True Airspeed * cos (FPA)	ft/sec	Use trig to compute Groundspeed from Groundspeed, True Airpseed and Vertical speed triangle
Groundspeed (knots)	= Groundspeed in ft/sec * (3600/6076)	knots	6076 feet in a nautical mile. 3600 seconds in an hour
Distance traversed (ft)	= Last Cycle Distance (ft) + Groundspeed (ft/sec)	ft	Integrate Velocity by adding velocity to distance computed 1 second ago
Distance Traversed (nautical miles)	= Distance Traversed/6076	nm	6076 feet in nm
Vertical Speed (ft/sec)	= True Airspeed * sin (FPA)	ft/sec	Use trig to compute Verticalspeed from Groundspeed, True Airpseed and Vertical speed triangle
Vertical Speed (fpm)	= vertical speed * 60	fpm = ft per minute	Convert from ft/sec to fpm by multiplying by 60 secs
Altitude	= Last Cycle Altitude (ft) + Verticalspeed (ft/sec)	ft	Integrate Vertical speed by adding vertical speed to altitude computed 1 second ago
Distance to Runway Threshold	= 6nm – distance traversed (nm)	nm	Assume approach starts 6nm from runway threshold, then subtract distance traversed
Altitude for 3 degree Glideslope based on distance to Runway Threshold	= Distance to runway Threshold * tan (FPA)	ft	
Vertical Deviation (+ high)	=Altitude – 3 degree Slope	ft	Vertical distance (i.e. altitude from glideslope)
Excess Power	= Thrust - Drag	Lbs	Additional Thrust over the Thrust required to

			maintain speed in level flight. This Thrust can be used to climb or accelerate (or both)

To achieve the desired vertical profile:

(1) Set the flightpath angle

(2) Compute the Thrust required to maintain the profile:

a. Level flight, constant speed: Thrust = Drag
b. Level flight, accelerate/decelerate: Thrust =Drag + (mass * dV/dt) [use 0.05g accel/decal]
c. Climb constant speed: Thrust = Drag + W sin (FPA)
d. Climb, accel/decel: Thrust = Drag + W sin (FPA) + (mass * dV/dt)
e. Descend at constant speed: Thrust = Drag + Wsin(FPA) [note FPA is negative]
f. Climb, accel/decel: Thrust = Drag + W sin (FPA) + (mass * dV/dt) [note FPA is negative]