Valery's Rocket

Values from

$m_{PL} := 0.8 \cdot tonne$ Load mass

$m_o := 0.45 \cdot tonne$ Empty rocket mass

$9000 \cdot .05 =$

$b := 0.1 \cdot \frac{kg}{s}$ Shape Factor

$m_f := 9 \cdot tonne$ Fuell mass

$m_c(t) := 1 \cdot t \cdot \frac{tonne}{s}$ Fuel comsuption

$u(t) := 2 \cdot \frac{km}{s}$ Propellant speed

mc' and u
control syst

$t_{end} := \left\| \begin{array}{l} t_{end} \leftarrow 10 \cdot s \\ \mathbf{root}\left(m_f - m_c\left(t_{end}\right), t_{end}\right) \end{array} \right|$

$t_{end} = 9\ s$ Time for empty the fuel

$m(t) := m_{PL} + m_o + m_f - m_c(t)$ Mass of the rocket as time function

$R := 6371 \cdot km$ Medium earth radious

$g(y) := g \cdot \left(\frac{R}{R+y}\right)^2$ Acc due gravity, as function of altitude

$g(300 \cdot m)$

More accurate, accounting the lattitude $\varphi := 53 \cdot deg$

$g(y) := 1.002691423 \cdot \left(1 + 0.0053024 \cdot \sin(\varphi)^2 - 0.0000058 \cdot \sin(2\ \varphi)^2\right) \cdot g(y)$

$g(300 \cdot m)$

Newton Law $F = \frac{d}{dt} p = \frac{d}{dt}\left(m \cdot \frac{d}{dt} y\right) = \frac{d}{dt} m \cdot \frac{d}{dt} y + m \cdot \frac{d^2}{dt^2} y$

Forces balance $F = -m \cdot g - f_r$ with $f_r = -b \cdot \frac{d}{dt} y$

Solve Block $y(0 \cdot s) = 0 \cdot m$ $y'(0 \cdot s) = 0 \cdot \frac{m}{s}$

$-m(t) \cdot g(y(t)) - b \cdot \frac{d}{dt} y(t) = u(t) \cdot \frac{d}{dt} m(t) + m(t) \cdot \frac{d^2}{dt^2} y(t)$

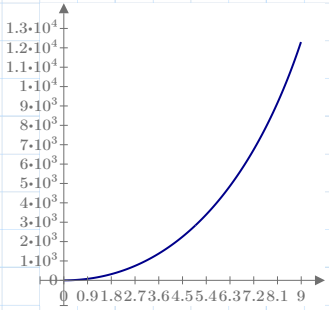
Solver $y := \mathbf{Odesolve}\left(y(t), t_{end}\right)$

Avoid the bound $t_1 := t_{end} - 0.01 \cdot s$

y and y' plots $tt := 0 \cdot s, 0.01 \cdot s .. t_1$

$y\left(t_1\right) = 12.298\ km$

$\frac{d}{dt_1} y\left(t_1\right) = 4.104\ \frac{km}{s}$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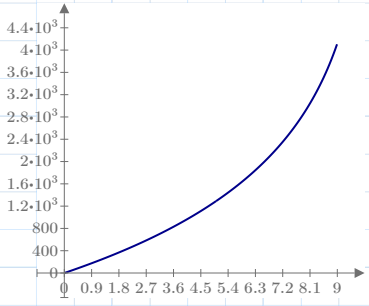
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