# Coupled Loads Analysis Transient

## English units

Mass entered in lbm, converted to consistent units: $m = W/386$ [lbf sec$^2$/in]

Stiffness $k$ [lbf/in], length [in], force [lbf], acceleration [in/sec$^2$]

$1\,G = 386$ in/sec$^2$

## Metric units

Mass $m$ [kg], stiffness $k$ [N/m], length [m], force [N]

$1\,G = 9.81$ m/sec$^2$

## Modal transient

$\ddot{q}_j + 2\zeta\omega_j\dot{q}_j + \omega_j^2 q_j = \{\phi_j\}^T\{F(t)\}$, $\{x\} = [\Phi]\{q\}$

Exact solver: $F$ linear between samples, $z_{k+1} = e^{A\Delta t}z_k + \Gamma_a F_k + \Gamma_b F_{k+1}$

Newmark-beta: $\beta = 1/4$, $\gamma = 1/2$ (average acceleration)

## Recovery

Interface force on SC: $F_i = [M_{SC}]_b\{\ddot{u}_{SC}\} + [K_{SC}]_b\{u_{SC}\}$

SC net CG load factor: $n_{cg} = \{r\}^T[M_{SC}]\{\ddot{u}_{SC}\} \,/\, (\{r\}^T[M_{SC}]\{r\}\, g)$

Forcing: step / ramp, decay ramp (MECO), sine burst $A\sin 2\pi f(t - t_0)$, user array