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CS 174A

ASSIGNMENT 2 - PART 1

1. Step 1: $a_i^t = \frac{F_{i,total}^t}{m_i}$ $\quad F_{total} = -\gamma_i \dot{x}_i + g_i + f_i$

γ - DAMPING COEFF

Step 2: $v_i^{t+1} = v_i^t + \Delta t\, a_i^t$ $\quad g$ - TOTAL INTERNAL FORCE

f - EXTERNAL FORCE

Step 3: $x_i^{t+1} = x_i^t + \Delta t\, v_i^{t+1}$

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2. $f_{ext} = (2, 14.7, -5)^T \quad m = 1 \quad dt = 1 \quad v(0) = 0 \quad a(0) = 0$

$t=0$ $\quad F_{total} = (2, 14.7, -5) + (0, -9.8, 0) = (2, 4.9, -5)$

$x(0) = (0,0,0)^T$

$a(0) = \frac{F_{total}}{m} = (2, 4.9, -5)$

$v(0+1) = v(0) + \Delta t\, a(0) = 0 + 1(2, 4.9, -5) = (2, 4.9, -5)^*$

$x(0+1) = x(1) + \Delta t\, v(t+1) = (0,0,0)^T + 1(2, 4.9, -5) = (2, 4.9, -5)^*$

$t=1$ $\quad a(1) = (0, -9.8, 0)^T$

$v(1+1) = (2, 4.9, -5) + 1(0, -9.8, 0) = (2, -4.9, -5)^T$

$x(1+1) = (2, 4.9, -5) + 1(2, -4.9, -5) = (4, 0, -10)^T$

$x(2) = (4, 0, -10)^T$

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3. LAGRANGE EQUATIONS OF MOTION: $m_i \ddot{x}_i + \gamma_i \dot{x}_i - g_i - f_i = 0$

γ_i - DAMPING COEFF $\quad f_i$ - external force $\quad g_i$ - total force due to springs

a) HEATING & MELTING DEFORMABLE MODELS - MASS-SPRING MODEL

- DIFFUSION OF HEAT IN MATERIALS: $\frac{\partial}{\partial t}(\mu\sigma\theta) - \nabla \cdot (C \nabla\theta) = q$

q = rate heat gen/loss per vol $\quad \mu$ - kg/m^3 $\quad \sigma$ - SPECIFIC HEAT $\quad \theta$ - Temp, Kelvin

C - THERMAL CONDUCTIVITY MATRIX $\quad \nabla = \left[\frac{\partial}{\partial u}, \frac{\partial}{\partial v}, \frac{\partial}{\partial w}\right]$

- HOMOGENEOUS, ISOTROPIC MATERIAL: $\frac{\partial}{\partial t}(\mu\sigma\theta) - c\nabla^2\theta = q \quad [\cdots] = {}^*\theta$

DISCRETE HEAT EQ: $\mu\sigma\frac{(\theta^{t+\Delta t} - \theta^t)}{\Delta t} - c\left[\frac{\theta^t_{u+\Delta u,v,w} - 2\theta^t_{u,v,w} + \theta^t_{u-\Delta u,v,w}}{\Delta u^2}\right.$

$\left. + \frac{\theta^t_{u,v+\Delta v,w} - 2\theta^t_{u,v,w} + \theta^t_{u,v-\Delta v,w}}{\Delta v^2} + \frac{\theta^t_{u,v,w+\Delta w} - 2\theta^t_{u,v,w} + \theta^t_{u,v,w-\Delta w}}{\Delta w^2}\right] = q$

UPDATE θ $\quad \theta^{t+\Delta t}_{u,v,w} = \theta^t_{u,v,w} + \frac{\Delta t}{\mu\sigma} c\,({}^*\theta)$