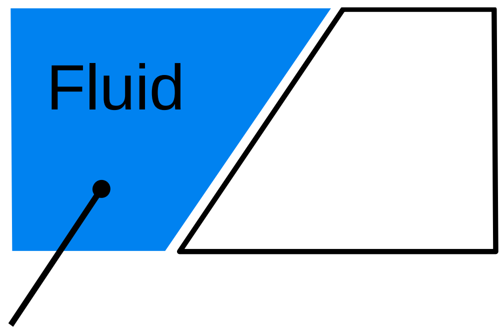
DIMENSIONLESS QUANTITIES IN THE FLUID



$$\underline{x}$$

$$\underline{U}$$

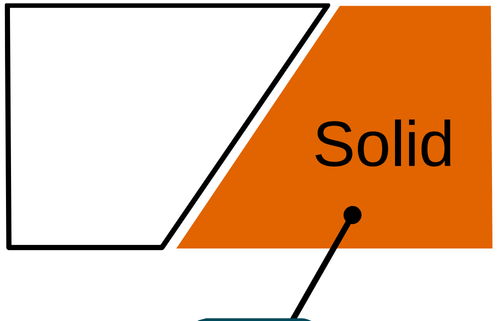
$$p$$

$$\underline{\tilde{x}} = \frac{\underline{x}}{L}$$

$$\underline{\tilde{U}} = \frac{\underline{U}}{U_0}$$

$$\tilde{p} = \frac{p}{\rho U_0^2}$$

DIMENSIONLESS QUANTITIES IN THE SOLID



$\underline{x}$

q

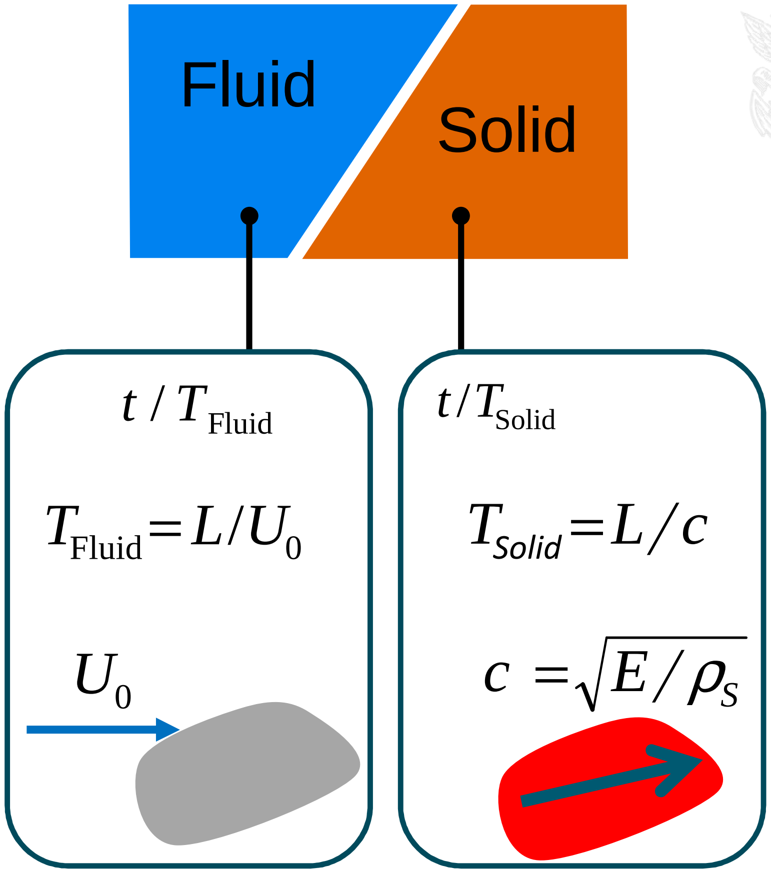
f

$$\bar{\underline{x}} = \frac{\underline{x}}{L}$$

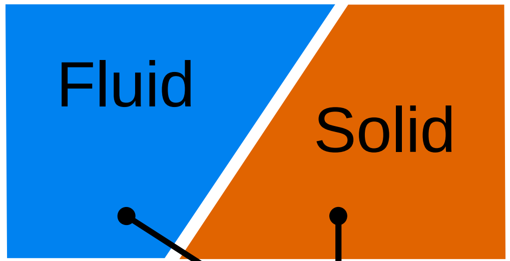
$$\bar{q} = \frac{q}{\xi_0}$$

$$\bar{f} = \frac{f}{k\xi_0}$$

DIMENSIONLESS TIME



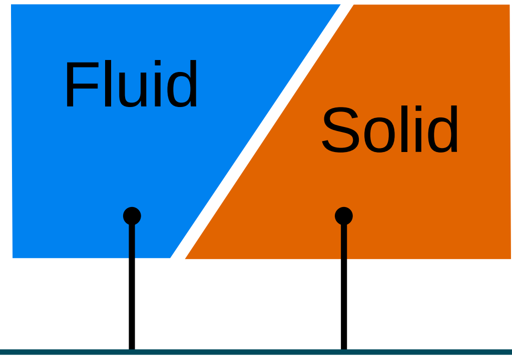
DIMENSIONLESS TIME



$$\bar{t} = \frac{t}{T_{\text{Solid}}}$$

$$T_{\text{Solid}} = \sqrt{\frac{m}{k}}$$

DIMENSIONLESS VARIABLES

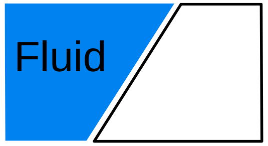


$$\underline{\tilde{x}} = \frac{\underline{x}}{L} \qquad \underline{\bar{x}} = \frac{\underline{x}}{L}$$

$$\underline{\tilde{U}} = \frac{\underline{U}}{U_0} \qquad \bar{t} = \frac{t}{T_{\mathrm{Solid}}} \qquad \bar{q} = \frac{q}{\xi_0}$$

$$\tilde{p} = \frac{p}{\rho U_0^2} \qquad \bar{f} = \frac{f}{k\xi_0}$$

DIMENSIONLESS EQUATIONS IN THE FLUID DOMAIN



$$div\,\underline{U} = 0$$

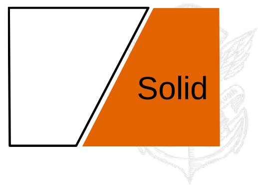
$$div\,\underline{\tilde{U}} = 0$$

$$\rho \frac{d\underline{U}}{dt} = -\rho\, g\underline{e}_Z - \underline{\nabla} p + \mu \Delta \underline{U}$$

$$\frac{c}{U_0} \frac{d\underline{\tilde{U}}}{d\tilde{t}} = -\frac{gL}{U_0^2} \underline{e}_Z - \underline{\nabla} \tilde{p} + \frac{\mu}{\rho U_0 L} \Delta \underline{\tilde{U}}$$

$$\frac{1}{U_R} \frac{d\underline{\tilde{U}}}{d\tilde{t}} = -\frac{1}{F_R^2} \underline{e}_Z - \underline{\nabla} \tilde{p} + \frac{1}{R_E} \Delta \underline{\tilde{U}}$$

DIMENSIONLESS EQUATIONS IN THE SOLID DOMAIN

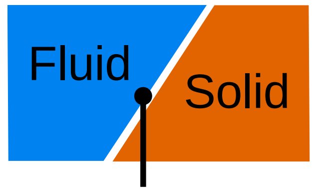


$$m\frac{d^2q}{dt^2}+kq=f$$

$$m\left[\sqrt{\frac{k}{m}}\right]^2\xi_0\frac{d^2\bar{q}}{d\bar{t}^2}+k\xi_0\bar{q}=k\xi_0\bar{f}$$

$$\boxed{\frac{d^2\bar{q}}{d\bar{t}^2}+\bar{q}=\bar{f}}$$

DIMENSIONLESS EQUATIONS AT THE INFERFACE



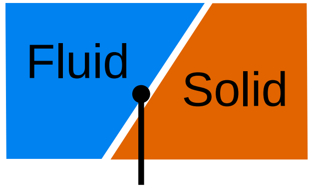
Kinematic condition

$$\underline{U}(\underline{x},t)=\frac{dq}{dt}(t)\underline{\varphi}(\underline{x})$$

$$\frac{U_0 T_{solid}}{L}\underline{\tilde{U}}=\frac{\xi_0}{L}\frac{d\bar{q}}{d\bar{t}}\underline{\varphi}(\underline{x})$$

$$\boxed{U_R\underline{\tilde{U}}=D\frac{d\bar{q}}{d\bar{t}}\underline{\varphi}(\underline{x})}$$

DIMENSIONLESS EQUATIONS AT THE INFERFACE



Dynamic condition

$$\int_{Interface} \left\{ \left[-p\underline{\underline{I}} + \mu\left(\nabla\underline{U} + \nabla^t\underline{U}\right)\right].\underline{n}\right\}.\underline{\varphi}\, dS = f$$

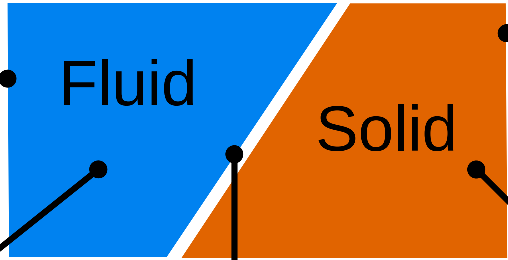
$$\int_{Interface} \left\{ \frac{\rho U_0^2 L}{k}\left[-\tilde{p}\underline{\underline{I}} + \frac{\mu}{\rho U_0 L}\left(\nabla\underline{\tilde{U}}+\nabla^t\underline{\tilde{U}}\right)\right].\underline{n}\right\}.\underline{\varphi}\, dS = \frac{\xi_0}{L}\overline{f}$$

$$\boxed{\int_{Interface} \left\{ C_Y\left[-\tilde{p}\underline{\underline{I}} + \frac{1}{R_E}\left(\nabla\underline{\tilde{U}}+\nabla^t\underline{\tilde{U}}\right)\right].\underline{n}\right\}.\underline{\varphi}\, dS = D\overline{f}}$$

FLUID AND SOLID

Fluid boundary conditions

Solid boundary conditions



$$div\,\underline{\tilde{U}} = 0$$

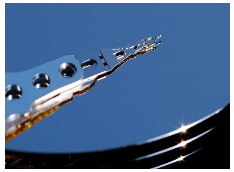
$$\frac{1}{U_R}\frac{d\underline{\tilde{U}}}{d\bar{t}} = -\frac{1}{F_R^2}\underline{e}_Z - \underline{\nabla}\tilde{p} + \frac{1}{R_E}\Delta\underline{\tilde{U}}$$

$$\frac{d^2\bar{q}}{d\bar{t}^2} + \bar{q} = \bar{f}$$

$$U_R\underline{\tilde{U}} = D\frac{\partial\bar{q}}{\partial\bar{t}}\underline{\varphi}(\underline{x})$$

$$\int_{Interface}\left\{C_Y\left[-\tilde{p}\underline{\underline{I}} + \frac{1}{R_E}\left(\nabla\underline{\tilde{U}} + \nabla^t\underline{\tilde{U}}\right)\right].\underline{n}\right\}.\underline{\varphi}\,dS = D\bar{f}$$

CLASSIFYING PROBLEMS USING DIMENSIONLESS NUMBERS



EFFECT OF THE REDUCED VELOCITY

$$U_R = \frac{T_{\mathrm{SOLID}}}{T_{\mathrm{FLUID}}}$$