# THE COMPONENTS OF THE STRAIN TENSOR IN SPHERICAL AND CYLINDRICAL COORDINATES

Spring semester 2026

https://www.phys.uconn.edu/~rozman/Courses/P3102_26S/

Last modified: February 17, 2026

It is often convenient to use the components of the strain tensor in spherical polar or cylindrical polar coordinates. We give here, for reference, the corresponding formulae.

In cylindrical polar coordinates $r$, $\varphi$, $z$:

$$\varepsilon_{rr} = \frac{\partial u_r}{\partial r}, \quad \varepsilon_{\varphi\varphi} = \frac{1}{r}\frac{\partial u_\varphi}{\partial \varphi} + \frac{u_r}{r}, \quad \varepsilon_{zz} = \frac{\partial u_z}{\partial z}, \tag{1}$$

$$2\varepsilon_{\varphi z} = \frac{1}{r}\frac{\partial u_z}{\partial \varphi} + \frac{\partial u_\varphi}{\partial z}, \quad 2\varepsilon_{rz} = \frac{\partial u_r}{\partial z} + \frac{\partial u_z}{\partial r}, \tag{2}$$

$$2\varepsilon_{r\varphi} = \frac{\partial u_\varphi}{\partial r} - \frac{u_\varphi}{r} + \frac{1}{r}\frac{\partial u_r}{\partial \varphi}. \tag{3}$$

In spherical polar coordinates $r$, $\theta$, $\varphi$:

$$\varepsilon_{rr} = \frac{\partial u_r}{\partial r}, \quad \varepsilon_{\theta\theta} = \frac{1}{r}\frac{\partial u_\theta}{\partial \theta} + \frac{u_r}{r}, \tag{4}$$

$$\varepsilon_{\varphi\varphi} = \frac{1}{r\sin\theta}\frac{\partial u_\varphi}{\partial \varphi} + \frac{u_\theta}{r}\cot\theta + \frac{u_r}{r}, \tag{5}$$

$$2\varepsilon_{\theta\varphi} = \frac{1}{r}\frac{\partial u_\varphi}{\partial \theta} - \frac{u_\varphi}{r}\cot\theta + \frac{1}{r\sin\theta}\frac{\partial u_\theta}{\partial \varphi}, \tag{6}$$

$$2\varepsilon_{r\theta} = \frac{\partial u_\theta}{\partial r} - \frac{u_\theta}{r} + \frac{1}{r}\frac{\partial u_r}{\partial \theta}, \tag{7}$$

$$2\varepsilon_{\varphi r} = \frac{\partial u_\varphi}{\partial r} - \frac{u_\varphi}{r} + \frac{1}{r\sin\theta}\frac{\partial u_r}{\partial \varphi}. \tag{8}$$