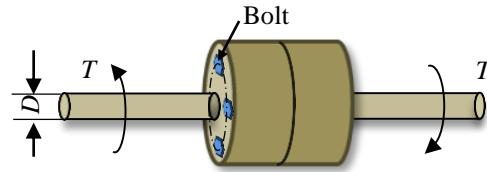3-4. A coupling connects the two shafts as shown. The torque T applied on the shafts follows a normal distribution $T \sim N(220, 20^2)\,\text{N}\cdot\text{m}$. The diameter of the shafts is $D = 0.03\,\text{m}$. Determine the distribution of the maximum shear stress of the shaft. Assume that the shear stress in the bolts is uniform.

Solution:

The maximum shear stress in the shaft could be obtianed by

$$\tau_{max} = \frac{Tc}{J} = \frac{T(0.03/2)}{\dfrac{\pi}{2}(0.015^4)} = 0.19 \times 10^6 T$$

Thus, τ_{max} also follows a normal distribution. We have

$$\mu_{\tau_{max}} = 0.19 \times 10^6 \mu_T = 0.19 \times 10^6 (220) = 41.8\,\text{MPa}$$

$$\sigma_{\tau_{max}} = 0.19 \times 10^6 \sigma_T = 0.19 \times 10^6 (20) = 3.8\,\text{MPa}$$

Thus, τ_{max} follows a normal distribution $\tau_{max} \sim N(41.8,\ 3.8^2)\,\text{MPa}$.   **Ans.**