

## Shafts – Multimodal loading

### Bending, Torsion, Axial Loading

Given the following information, see if you can derive an expression for the diameter of a shaft that is loaded in torsion and bending. You may assume that there are both mean and alternating components of stress for both shear and normal stresses.

Let the fatigue stress concentration factor for normal stresses be  $K_f$  and the fatigue stress concentration factors for shear stresses by  $K_{fs}$ .

You may also assume that the shaft is a solid round and that no axial load is being applied.

The steps you need to follow are:

- **determine  $I$  and  $J$  for a solid round**
- **determine  $\sigma_m$  and  $\tau_m$**
- **determine  $\sigma_a$  and  $\tau_a$**
- **compute the von Mises alternating stress component**
- **compute the von Mises mean stress component**
- **write out the Goodman failure line equation in terms of these two stresses**
- **Replace expressions for  $\sigma'_m$  and  $\sigma'_a$  with terms that include  $M_a$ ,  $T_a$ , and  $d$**
- **solve for  $d$**