# Fundamental Equations of Mechanics of Materials

**Axial Load**

*Normal Stress*

$$\sigma = \frac{N}{A}$$

*Displacement*

$$\delta = \int_0^L \frac{N(x)\,dx}{A(x)E}$$

$$\delta = \Sigma \frac{NL}{AE}$$

$$\delta_T = \alpha \Delta T L$$

**Torsion**

*Shear stress in circular shaft*

$$\tau = \frac{T\rho}{J}$$

*where*

$$J = \frac{\pi}{2}c^4 \quad \text{solid cross section}$$

$$J = \frac{\pi}{2}(c_o^4 - c_i^4) \quad \text{tubular cross section}$$

*Power*

$$P = T\omega = 2\pi f T$$

*Angle of twist*

$$\phi = \int_0^L \frac{T(x)\,dx}{J(x)G}$$

$$\phi = \Sigma \frac{TL}{JG}$$

*Average shear stress in a thin-walled tube*

$$\tau_{avg} = \frac{T}{2tA_m}$$

*Shear Flow*

$$q = \tau_{avg} t = \frac{T}{2A_m}$$

**Bending**

*Normal stress*

$$\sigma = \frac{My}{I}$$

*Unsymmetric bending*

$$\sigma = -\frac{M_z y}{I_z} + \frac{M_y z}{I_y}, \qquad \tan \alpha = \frac{I_z}{I_y}\tan \theta$$

**Shear**

*Average direct shear stress*

$$\tau_{avg} = \frac{V}{A}$$

*Transverse shear stress*

$$\tau = \frac{VQ}{It}$$

*Shear flow*

$$q = \tau t = \frac{VQ}{I}$$

**Stress in Thin-Walled Pressure Vessel**

*Cylinder*

$$\sigma_1 = \frac{pr}{t} \qquad \sigma_2 = \frac{pr}{2t}$$

*Sphere*

$$\sigma_1 = \sigma_2 = \frac{pr}{2t}$$

**Stress Transformation Equations**

$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

*Principal Stress*

$$\tan 2\theta_p = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2}$$

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

*Maximum in-plane shear stress*

$$\tan 2\theta_s = -\frac{(\sigma_x - \sigma_y)/2}{\tau_{xy}}$$

$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2}$$

*Absolute maximum shear stress*

$$\tau_{max}^{abs} = \frac{\sigma_{max}}{2} \quad \text{for } \sigma_{max}, \sigma_{min} \text{ same sign}$$

$$\tau_{max}^{abs} = \frac{\sigma_{max} - \sigma_{min}}{2} \quad \text{for } \sigma_{max}, \sigma_{min} \text{ opposite signs}$$

# Mechanical Engineering Formulas Cheat Sheet

**Yicheng Fang**

**Mechanical Engineering Formulas Cheat Sheet:**

This book delves into Mechanical Engineering Formulas Cheat Sheet. Mechanical Engineering Formulas Cheat Sheet is an essential topic that needs to be grasped by everyone, ranging from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Mechanical Engineering Formulas Cheat Sheet, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:

   - Chapter 1: Introduction to Mechanical Engineering Formulas Cheat Sheet
   - Chapter 2: Essential Elements of Mechanical Engineering Formulas Cheat Sheet
   - Chapter 3: Mechanical Engineering Formulas Cheat Sheet in Everyday Life
   - Chapter 4: Mechanical Engineering Formulas Cheat Sheet in Specific Contexts
   - Chapter 5: Conclusion

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