Department of Mechanical Engineering
ME 215.3 Fluid Mechanics I
Formula Sheet

$$\overrightarrow{\nabla P} = \rho(\vec{g} - \vec{a})$$

$$\mathrm{d}P = \overrightarrow{\mathrm{d}R} \cdot \overrightarrow{\nabla P}$$

$$\vec{F}_\mathrm{s} = -\iint\limits_S P\hat{n}\mathrm{d}A$$

$$\vec{M}_\mathrm{s} = -\iint\limits_S \vec{r} \times \hat{n}P\mathrm{d}A$$

$$\frac{\mathrm{d}}{\mathrm{d}t}B_\mathrm{cm} = \frac{\mathrm{d}}{\mathrm{d}t}\iiint_{\tilde{V}}(\rho\beta)\mathrm{d}\tilde{V} + \iint_S \rho\beta(\vec{V}_\mathrm{r} \cdot \hat{n})\mathrm{d}A$$

$$\frac{\mathrm{d}}{\mathrm{d}t}\iiint_{\tilde{V}}\rho\mathrm{d}\tilde{V} + \iint_S \rho(\vec{V}_\mathrm{r} \cdot \hat{n})\mathrm{d}A = 0$$

$$\iiint_{\tilde{V}}\rho\vec{g}\mathrm{d}\tilde{V} - \iint_S P\hat{n}\mathrm{d}A + \vec{F}_\mathrm{v} + \vec{R} = \frac{\mathrm{d}}{\mathrm{d}t}\iiint_{\tilde{V}}(\rho\vec{V})\mathrm{d}\tilde{V} + \iint_S \rho\vec{V}(\vec{V}_\mathrm{r} \cdot \hat{n})\mathrm{d}A$$

$$\iiint_{\tilde{V}}\vec{r} \times \vec{g}\rho\mathrm{d}\tilde{V} - \iint_S \vec{r} \times \hat{n}P\mathrm{d}A + (\vec{r} \times \vec{F}_v) + \vec{T} = \frac{\mathrm{d}}{\mathrm{d}t}\iiint_{\tilde{V}}\vec{r} \times \vec{V}\rho\mathrm{d}\tilde{V} + \iint_S \vec{r} \times \vec{V}\rho(\vec{V}_\mathrm{r} \cdot \hat{n})\mathrm{d}A$$

$$P_1 + \frac{\rho V_1^2}{2} + \rho g z_1 = P_2 + \frac{\rho V_2^2}{2} + \rho g z_2 + \Delta P_\mathrm{L} - \Delta P_\mathrm{p}$$

$$\Delta P_\mathrm{L} = \sum f\frac{L}{D}\frac{\rho V^2}{2} + \sum K_\mathrm{m}\frac{\rho V^2}{2}$$

$$\dot{W}_\mathrm{p} = \frac{\Delta P_\mathrm{p} Q}{\eta}$$

$$Re = \frac{\rho V D}{\mu}$$

$$f = \frac{64}{Re}$$

$$\frac{1}{\sqrt{f}} = -2.0\log\left(\frac{\epsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f}}\right)$$

$$\frac{1}{\sqrt{f}} \approx -1.8\log\left(\frac{6.9}{Re} + \left(\frac{\epsilon/D}{3.7}\right)^{1.11}\right)$$

$$H = \frac{\omega^2 r_2}{g}\left(r_2 - \frac{r_1^2 b_1}{r_2 b_2}\tan\beta_1\cot\beta_2\right)$$

$$Q = 2\pi r_1 b_1 V_{\mathrm{n}_1} = 2\pi r_1^2 b_1 \omega\tan\beta_1$$

$$\dot{W}_\mathrm{f} = Q\rho\omega^2 r_2\left(r_2 - \frac{r_1^2 b_1}{r_2 b_2}\tan\beta_1\cot\beta_2\right)$$

$$\dot{W}_\mathrm{f} = \omega T = \rho Q\omega\left(r_2 V_{\mathrm{t}_2} - r_1 V_{\mathrm{t}_1}\right)$$

$$H = \frac{\dot{W}_\mathrm{f}}{\rho g Q} = \frac{\omega}{g}\left(r_2 V_{\mathrm{t}_2} - r_1 V_{\mathrm{t}_1}\right)$$

$$NPSH = \frac{P_{\mathrm{i}}}{\rho g} + \frac{V_{\mathrm{i}}^2}{2g} - \frac{P_{\mathrm{v}}}{\rho g}$$

$$\frac{Q_2}{Q_1} = \frac{n_2}{n_1}\left(\frac{D_2}{D_1}\right)^3$$

$$\frac{H_2}{H_1} = \left(\frac{n_2}{n_1}\right)^2\left(\frac{D_2}{D_1}\right)^2$$

$$\frac{\dot{W}_{\mathrm{s}_2}}{\dot{W}_{\mathrm{s}_1}} = \frac{\rho_2}{\rho_1}\left(\frac{n_2}{n_1}\right)^3\left(\frac{D_2}{D_1}\right)^5$$

$$N_{\mathrm{s}}' = \frac{n(Q^*)^{1/2}}{(gH^*)^{3/4}}$$

$$N_{\mathrm{s}} = \frac{\mathrm{rpm}(\mathrm{gal/min})^{1/2}}{(H[\mathrm{ft}])^{3/4}}$$

$$C_P = \frac{\dot{W}_{\mathrm{s}}}{0.5\rho A V^3} = 4a(1-a)^2$$

$$\int \sin\theta \mathrm{d}\theta = -\cos\theta + C$$

$$\int \sin^2\theta \mathrm{d}\theta = \theta/2 - (\sin 2\theta)/4 + C$$

$$\int \sin^3\theta \mathrm{d}\theta = \left(\cos^3\theta\right)/3 - \cos\theta + C$$

$$\int \cos\theta \mathrm{d}\theta = \sin\theta + C$$

$$\int \cos^2\theta \mathrm{d}\theta = \theta/2 + (\sin 2\theta)/4 + C$$

$$\int \cos^3\theta \mathrm{d}\theta = \sin\theta - \left(\sin^3\theta\right)/3 + C$$

$$\int \sin\theta\cos\theta \mathrm{d}\theta = \left(\sin^2\theta\right)/2 + C$$

$$\int \sin^2\theta\cos\theta \mathrm{d}\theta = \left(\sin^3\theta\right)/3 + C$$

$$\int \sin\theta\cos^2\theta \mathrm{d}\theta = -\left(\cos^3\theta\right)/3 + C$$

$$\int \sin^2\theta\cos^2\theta \mathrm{d}\theta = \theta/8 - (\sin 4\theta)/32 + C$$