Exam 3 Notes Sheet.

Momentum Balance: $\sum \vec{F} = \frac{d}{dt}\int_{CV} \rho \vec{V} dV + \int_{CS} \rho \vec{V}(\vec{V}\cdot\vec{n}) dA$

$\sum \vec{F} = \frac{d(m\vec{V})_{CV}}{dt} + \left(\sum \dot{m}\vec{V}\right)_{out} - \left(\sum \dot{m}\vec{V}\right)_{in}$

$\dot{m} = \rho A |\vec{V}|$

Differential Balance:

$\frac{\partial \rho}{\partial t} + \nabla \cdot \rho\vec{V} = 0 \longrightarrow \nabla \cdot \vec{V} = 0$

N.S. eqn: (will be given)

$\rho \frac{D\vec{V}}{Dt} = -\nabla P + \rho\vec{g} + \mu \nabla^2 \vec{V} = \rho \frac{\partial \vec{V}}{\partial t} + \rho \vec{V}\cdot\nabla\vec{V}$

(m)(accel) = pressure, gravity, visc. forces

B.C.	wall,	Free,	fluid/fluid
	$V=0$	$\tau=0$	$V=V$, $\tau=\tau$
	$(V=V_{wall})$	$P=P$	

Cancel Terms, Sep. vars, integrate, apply B.C. for constants of integration.

Boundary Layers:

Approximations; $\tau_{turb} > \tau_{laminar}$; τ Decreases w/ Length, etc.

$Re_c = 5\times10^5$

Drag: $C_D = \frac{F_D}{\frac{1}{2}\rho V^2 A}$: $C_D = C_D(Re, \frac{\epsilon}{D})$; A is Frontal or Top Projection

Drag is force of fluid on object in Direction of Flow

$F_D = A(-P\cos\theta + \tau \sin\theta)$; θ between normal and flow Dir

- Form Drag, Friction Drag

Pumps: BHP, operating point.

$H_{req} = H_{pump} = \frac{P_2 - P_1}{\rho g} + \frac{V_2^2 - V_1^2}{2g} + (z_2 - z_1) + H_{Loss}$ → $\frac{fLV^2}{2gD} + \frac{KV^2}{2g}$

$NPSH = \left(\frac{P}{\rho g} + \frac{V^2}{2g}\right)_{inlet} - P_v/\rho g$

Parallel: Add flow for same Head; Series: Add Head for same flow

Turbines:

N_{sp} → Sizing: