## An Internet Book on Fluid Dynamics

## Solution to Problem 205F:

The definitions of the head coefficient, $\psi$, and the flow coefficient, $\phi$, are

$$
\begin{equation*}
\psi=g H / R^{2} \Omega^{2} \quad \text { and } \quad \phi=Q /(A \Omega R) \tag{1}
\end{equation*}
$$

where $H$ is the head rise in meters, $Q$ is the volume flow rate, $A$ is the cross-sectional area $\left(A=\pi R^{2}\right)$ and $\Omega R$ is the velocity of the tips of the blades where $\Omega$ is the rotational speed (in radians/second) and $R$ is the impeller radius.

Therefore with the values given

$$
\begin{equation*}
0.2=\frac{9.8 \times 10}{R^{2} \Omega^{2}} \quad \text { and } \quad 0.08=\frac{0.1}{\pi \Omega R^{3}} \tag{2}
\end{equation*}
$$

or

$$
\begin{equation*}
\Omega^{2} R^{2}=490 \quad \text { and } \quad \Omega R^{3}=0.398 \tag{3}
\end{equation*}
$$

Solving for R:

$$
\begin{equation*}
R=\left(0.398^{2} / 490\right)^{1 / 4}=0.134 \mathrm{~m}=13.4 \mathrm{~cm} \tag{4}
\end{equation*}
$$

and for $\Omega$ :

$$
\begin{equation*}
\Omega=165.2 \text { radians } / \mathrm{sec}=1578 \mathrm{rpm} \tag{5}
\end{equation*}
$$

