

### Problem 205A

A manufacturer advertises a line of centrifugal pumps of various sizes given by the radius of the impeller (the rotating part) denoted by  $R$ . These can be run by a motor at any rotating speed,  $N$  (in radians per sec). The manufacturer also states that the “operating condition” for this line of pumps is given by specific values of the “flow coefficient” and “head coefficient”. The flow coefficient,  $\phi$ , is defined by  $\phi = Q/\pi NR^3$  where  $Q$  is the volume flow rate and the head coefficient,  $\psi$ , is defined by  $\psi = \Delta P/\rho N^2 R^2$  where  $\Delta P$  is the total pressure rise across the pump and  $\rho$  is the fluid density. We denote the manufacturer’s specific design values for the operating condition by  $\phi_D$  and  $\psi_D$  and regard them as given constants.

We now wish to choose one of these pumps for a system in which we want a particular flow rate,  $Q$ , with a particular total pressure rise,  $\Delta P$ . How do we decide on the necessary size of pump ( $R$ ) and the necessary speed,  $N$  ?