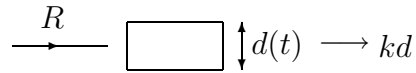**Question**

Water flows into a reservoir from a river at the rate of $R\,\text{kgs}^{-1}$. The outflow from the reservoir is $kd\,\text{kgs}^{-1}$, where d is the depth of the reservoir and $k(>0)$ is a constant. Assuming that the reservoir is a cylinder with cross-sectional area A and depth d find the depth of the reservoir as a function of time if it initially has a depth d_0.

Answer

Mass is conserved, so $\dfrac{dm}{dt} = $ net inflow; $m = Ad\rho$

$A\rho\dot{d} = R - kd$

This differential equation for d has the solution:

$d(t) = \dfrac{R}{k} - B\exp\left(-\dfrac{k}{A\rho}t\right)$

Now $\text{d}(0) = \text{d}_0$ therefore $d = \dfrac{R}{k} + \left(d_0 - \dfrac{R}{k}\right)\exp\left(-\dfrac{kt}{A\rho}\right)$