Question 1:

Figure 1 is a schematic representation of a conical gravitational tank. An incompressible fluid with constant density, $\rho$, enters the tank at a volumetric flowrate $F_i$ (m$^3$/sec). The outlet volumetric flow $F$ is assumed to be proportional the square root of the level in the tank $h$, i.e. $F = \beta\sqrt{h}$ for some strictly positive constant $\beta$. The total height of the tank is $H$ (m) and the tank has a radius of $R$ at the top of the tank.

Your task is to develop a mathematical model that describes the dynamic of the tank level in response to changes in the inlet flow. In doing so, clearly identify:

- the control objective
- the inputs and outputs of the system
• the fundamental quantity of interest

Is the resulting model linear or nonlinear?

Question 2:

A mixing tank shown in Figure 2 receives feed from two different streams of an incompressible fluid with constant density. Stream 1 has volumetric flowrate $F_1$ and temperature $T_1$. Stream 2 is equipped with a pump and delivers fluid at a flow $F_2$ and temperature $T_2$. The level of fluid in the tank is given by $L$. The tank is assumed to be well-mixed. The temperature of the fluid in the tank is given by $T$. The outlet stream (Stream 3) is equipped with a pump which delivers a volumetric flowrate $F_3$. It is assumed that tank level and the outlet tank temperature are measured.

![Figure 2: Mixing Tank.](image)

Develop a model that describes the dynamics of this system. It can be assumed that the heat capacities and densities are of all streams are constant and equal.