Question 2

Figure 1 shows a well-mixed buffer tank of volume V_1, which is used to attenuate fluctuations in the feed composition to a fluidised bed reactor of volume V_2. The liquid phase reaction A $\longrightarrow$ B occurs only in the fluidised bed, which is perfectly mixed and operates at constant temperature. The feed flow rate, q, is steady and the rate of disappearance of A is given by

$$-r_A = \frac{kc_A}{1 + Kc_A}$$

where K = 2.7 $m^3/kmol$, k = 0.135 s^{-1} and c_A is the concentration of A.

(a) Find the steady-state exit concentration from the fluidised bed reactor, when the feed composition is $c_{A0} = 3\ kmol/m^3$.

[4 marks]

(b) Derive an expression for the linearised transfer function relating the exit concentration, c_{A2} to the feed concentration, c_{A0}.

[8 marks]

(c) There is a step increase of 10% in the feed concentration. Using the linearised model, estimate the exit concentration after 100 s and at the new steady-state.

[8 marks]

Data:

$V_1 = 0.2\ m^3$, $V_2 = 0.5\ m^3$, $q = 0.008\ m^3/s$.

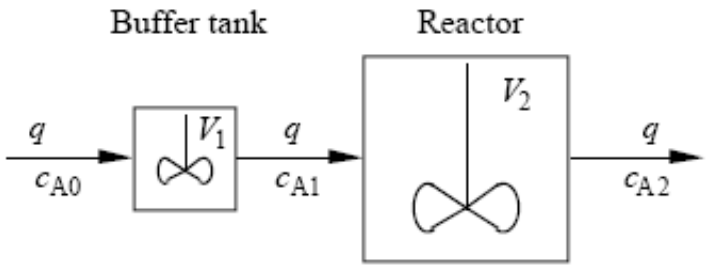

Figure 1: Process Diagram.