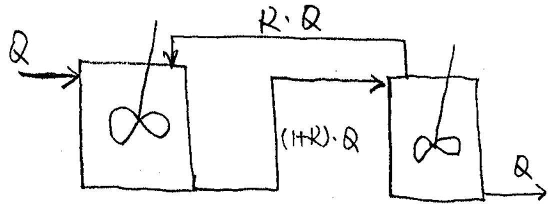
1. Modified Euler Method is used to compute the solution of $\frac{dy}{dx} = -ky$, where k is greater than zero. Please derive the order of accuracy and the range of interval to have convergent solution. (20%)

2. Two continuous stirred tank reactors with the same volume of V are used in series and fraction of R is recycled from the second reactor to the first reactor, as shown in the following. If the reduction of concentration for only one reactor with first order reaction is 60%, what is the fraction of recycling to achieve more than 80% reduction ? (20%)



3. If vector **F**(x,y,x) = P(x,y,x) **i** + Q(x,y,x) **j** + R(x,y,x) **k** and P, Q, and R have continuous second partial derivatives, please evaluate the value of $\iint (curlF \bullet n) dS$, where n is the unit vector in normal direction with respect to surface S. (20%)

4. Solve the following partial differential equation for the unsteady state diffusion in a droplet with no solute at the beginning: (20%)

$$\frac{\partial C}{\partial t} = D\left(\frac{\partial^2 C}{\partial r^2} + \frac{2}{r}\frac{\partial C}{\partial t}\right) \quad \text{with } C(r,0) = 0, 0 \le r \le Rp,$$
$$t > 0, \frac{\partial C}{\partial r} = 0, r = 0 \text{ and } C(r,t) = Cs, r = Rp$$

5. Please solve the following partial differential equation: (20%)

$$\frac{\partial C}{\partial t} = k\frac{\partial^2 C}{\partial x^2} \quad \text{with } C(x,0) = Co, x \ge 0$$
$$t > 0, C(0,t) = C_1 \text{ and } C(\infty,t) = Co$$

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