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Civil Engineering
ENG 282 (Engineering Math II)

1) Using "Balance law", The acceleration rate of salt within a system is equal to the input rate of salt into the system minus the output rate of salt from the system.

Acceleration rate of salt within a system = Input rate of salt into the system − Output rate of salt from the system

Let the amount of salt present in the tank at any time 't' be 'y'.

Time rate of change of y = $\frac{dy}{dt}$ = $y_{in} - y_{out}$

If 50gal of brine enters the tank per minute and one gallon contains $(1+\sin t)$ lb of salt, then

at $t = 1$, $(1+\sin t) = (1+\sin(1)) = 1.02$ lb

Hence, the amount of salt entering into the tank is

$50\,gal/min \times 1.02\,lb/gal = 51\,lb/min$

The tank contains 1200 gal of water with dissolved salt and 30 gal of the solution exits the tank per min i.e. $\frac{30\,gal}{1200\,gal} = 2.5\%$

at the center of the tank. So 2.5% of the salt present inside the tank will also leave the tank per minute. i.e

$y_{out} = 2.5\%$ of y

a) $\frac{dy}{dt}$ lb/min = 51 lb/min − 2.5% of y lb/min

b) $\frac{dy}{dt} = 51 - 0.025y$; $\frac{dy}{dt} = -0.025y + 51$

$$\frac{dy}{dt} = -0.025\left(\frac{-0.025y + 51}{-0.025y - 0.025}\right); \quad \frac{dy}{dt} = 0.02(y - 2040)$$

$$\frac{dy}{(y-2040)} = -0.025dt; \int \frac{dy}{(y-2040)} = \int -0.025dt$$

$$\int \frac{dy}{(y-2040)} = -0.025\int dt; \ln(y-2040) = -0.025t + C$$

$$y - 2040 = e^{-0.025t + C}; \quad y - 2040 = e^{-0.025t + C}$$

$$y - 2040 = e^{-0.025t} \quad y_0; \quad y - 2040 = y_0 e^{-0.025t}$$

$$y = y_0 e^{-0.025t} + 2040; \quad \text{initally when } t = 1, \ y = 1806$$

$$150 = y_0 e^{-0.025t} + 2040; \quad 150 - 2040 = y_0 \times 1$$

$$y_0 = -1890$$

50;

$$y = -1890 e^{-0.025t} + 2040$$

$$y = 2040 - 1890 e^{-0.025t}$$