CE11 Midterm Review

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1 Growth Rate

1.1 Exponential

1. Look for the initial population P_0 and the rate r and plug into $P(t) = P_0 e^{rt}$.
2. Solve for whatever you need to solve for.

1.2 Logistical

Remember that r_0 is the instantaneous growth rate at t = 0. We find r, the growth rate we want, from r_0.

1. Look for the initial population P_0, the initial rate r_0, and the carrying capacity K.
2. Calculate r from r_0 with the equation $r = \frac{r_0}{1-\frac{P_0}{K}}$ if P_0 is **NOT** << K
3. Calculate t_m with equation on aid sheet.
4. Plug into the formula for logistic growth on sheet and solve.

2 Symmetric Production Curve

Beware of units. Days are days. Years are years.

1. Find σ with $Q_\infty = \sigma P_{max}\sqrt{2\pi}$
2. Plug into equation on aid sheet and solve.

3 Oxygen Demand and Dissolved Oxygen

3.1 BOD

3.1.1 Five Day BOD Test

5 day BOD of a diluted sample is given by $BOD_5 = \frac{DO_i - DO_f}{P}$, where P = $\frac{\text{volume of } \textbf{wastewater}}{\text{volume of wastewater plus dilution water}}$.

3.1.2 BOD vs. Time (days)

L means oxygen demand. Q means flow rate.

3.1.3 Ultimate BOD

If $L_t = L_0(1 - e^{-(kt)})$, then a BOD 5 test would have a t value of 5, a rate of whatever the rate was found to be, so finding L0 is as easy as solving.

3.1.4 Finding Minimum Dissolved Oxygen

1. Calculate the saturated DO value using henry's law on the equation sheet.
2. Find the BOD at the site with $L_0 = \frac{L_r Q_r + L_w Q_w}{Q_r + Q_w}$
3. Find the initial oxygen deficit at the site with $D_0 = \frac{D_r Q_r + D_w Q_w}{Q_r + Q_w}$
4. You should have been given k_r and k_d, so plug those values and those you just solved for into the equation for t_c.
5. Plug D_0, L_0, and t_c into the equation for D(t).
6. Plug D(t) in for DO_{actual} and the value you found for saturated DO value into the oxygen sag curve equation on the equation sheet to find the minimum DO.

4 Wells

Q is negative when we inject water and positive when we draw water.

4.1 Hydraulic Gradient

The hydraulic gradient is the change in head – the distance from the bottom to the top of the water table – divided by the change in horizontal distance L.

We can estimate the gradient with 3 wells by doing this:

1. Draw a line between two wells with highest and lowest head
2. Find the point on this line where the head height is equal to the third well.
3. Draw an equipotential line from the third well to the above point.
4. Draw **flow lines** perpendicular to the equipotential line through the well with the lowest or highest head.
5. Calculate the gradient with h1 being the height of the third well and the equipotential line and h2 being the head at lowest or highest well, and divide this by the distance of the line from the equipotential line to the other well, found using geometry.

4.2 Darcy Velocity

The Darcy velocity $V = K\frac{dh}{dL}$