Lessons Learned from Teaching Advanced Biological Control Systems

1. All the students had BIOE 336 and should have been familiar with Laplace transforms and reaction kinetics. But they still required significant review.
2. The students had very weak knowledge of linear algebra. They knew matrix multiplication, inverses, and how to calculate eigenvalues. But they could not interpret eigenvectors. Also, they did not the know the relationships between the 4 subspaces of matrices, and seemed unfamiliar with change of coordinates.
3. It was effective to restrict to SISO analysis using transfer functions. The key properties of a system are:
   1. Poles – indicates if stable, oscillates
   2. Impulse response / response to initial conditions – indicates if system settles. sG(s), as s->0.
   3. Step response. Indicates controllability. G(s) as s->0.
   4. Initial conditions response. The input signal is a decaying exponential. Use the final value theorem.
4. Develop solutions for the control architectures and its variations
   1. Plant only
   2. Feedback loop with controller + plant. Y(s)/R(s), E(s)/R(s)
   3. Add noise to output. Consider step and sinusoid. Add: E(s)/N(s)
   4. Filter noise
   5. Disturbance. Add E(s)/D(s)
5. Background required
   1. Solving differential equation with a single variable and forced input
   2. Laplace transform. Final value theorem. Impulse response. Exponential decay input signal. Step response. Poles.
6. Sequence
   1. Motivation with example of analysis
   2. Background
   3. Control architectures and variations.