In most patients, it takes time for the concentration of an administered drug to achieve a constant level in the blood stream. Typically, if the drug concentration in the patient's intravenous line is ***C***d*u* (***t***), the concentration in the patient's blood stream is ***Cp( 1 − e−(at))u (t)***.

1. Assuming the relationship between drug concentration in the patient's drug and the delivered concentration can be described as a linear, time-invariant system, what is the transfer function?
2. Sometimes, the drug delivery system goes awry and delivers drugs with little control. What would the patient's drug concentration be if the delivered concentration were a ramp? More precisely, if it were ***Cdtu (t)***?
3. A clever doctor wants to have the flexibility to slow down or speed up the patient's drug concentration. In other words, the concentration is to be ***Cp( 1 − e−(bt))u (t),*** with ***b*** bigger or smaller than ***a***. How should the delivered drug concentration signal be changed to achieve this concentration profile?

**Problem 4.18: Effective Drug Delivery**

RU Electronics has been contracted to design a Doppler radar system. Radar transmitters emit a signal that bounces of any conducting object. Signal diferences between what is sent and the radar return is processed and features of interest extracted. In **Doppler** systems, the object's speed along the direction of the radar beam is the feature the design must extract. The transmitted signal is a sinsusoid: *x* (*t*)= ***A*cos** (***2πfct***). The measured return signal equals ***B****cos* (2π ((fc + Δf) t + ϕ)), where the Doppler offset frequency **Δf** equals **10*v***, where v is the car's velocity coming toward the transmitter.

* Design a system that uses the transmitted and return signals as inputs and produces Δf.
* One problem with designs based on overly simplistic design goals is that they are sensitive to unmodeled assumptions. How would you change your design, if at all, so that whether the car is going away or toward the transmitter could be determined?
* Suppose two objects traveling different speeds provide returns. How would you change your design, if at all, to accomodate multiple returns?

**Problem 4.19: Catching Speeders with Radar**