Introduction to System Dynamics Modeling
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Dynamic of Negative Feedback
Lecture - 8.1
Negative Feedback Loop: Introduction

Let us get a class started today. Today we are going to look at our new topic on the dynamics of negative feedback system, and through that I will introduce you to hands on modeling using Vensim software. Before you get to Vensim, let us look at what is negative feedback system.

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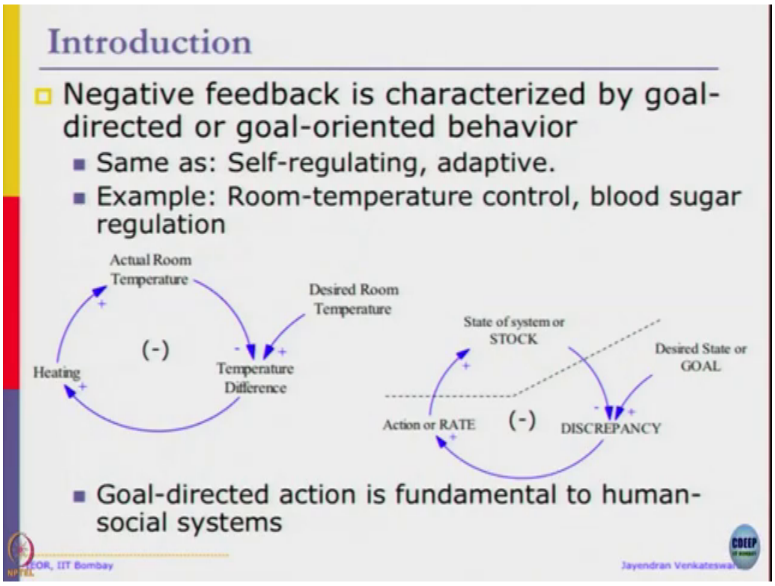

We have seen the negative feedback is characterized by goal-directed or goal-oriented behavior. Common similar terminologies includes self-regulating or a adaptive terminologies end up using. Most of the control systems models where there is feedback involved falls under this category where you are looking at current state versus actual I mean desired state, and then start taking gap between with them and try to control the system.

The most of the system there you going to study there is also can be classified as a negative feedback system examples room temperature control, blood sugar regulation etcetera. Now, CLD representation of that would be this is a kind of a example based where we are looking at current state of the system. So, this is actual room temperature represents the current state. We need we know desired room temperature; we fix it AC all the time.

It is the difference according to heating or cooling whatever it is as the (Refer Time: 01:42). We know that the state of the system can represented as the stock. Desired behavior is defined as the goal of system, and discrepancy is used to effect the rate which in intern effect the stock of the system or a state, this is the general casual diagram of a simple negative feedback system.

This goal-directed action is fundamental to any human-social systems also always, there is some sort of a goal towards which is working on under the current state. And we look at the gaps and gap is to high, then we start talking about inequalities and things like that or access to basic services and needs, and try to cover bit of policies or actions which will fulfill that gap.

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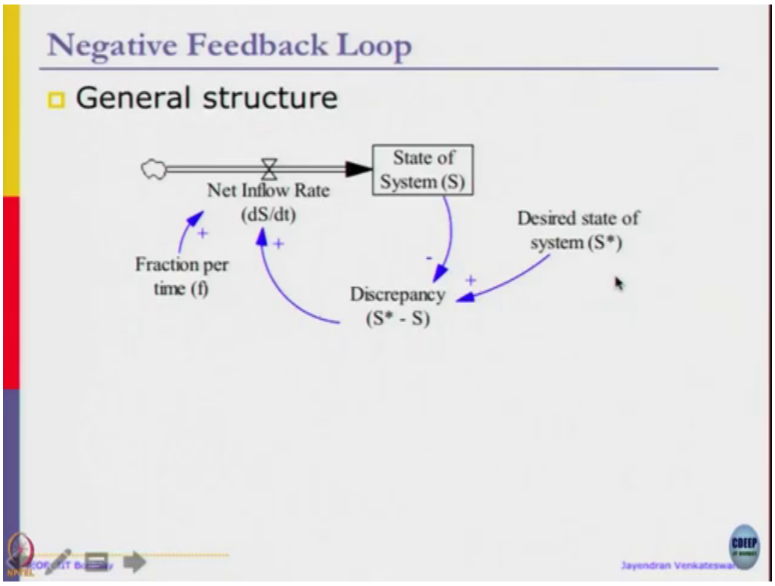

Next go to general stock flow diagram of this negative feedback system or a balancing or goal seeking system or a balancing loop system. So, you can simply represent the state of the system as a rectangle. And this net inflow rate which flows into the stock and changes the stock, we have desired state of the system let us denoted it as S star. You take the discrepancy, and we adjust that discrepancy some fraction f every time unit until the desired state is achieved. So, this is very general structure of the system.

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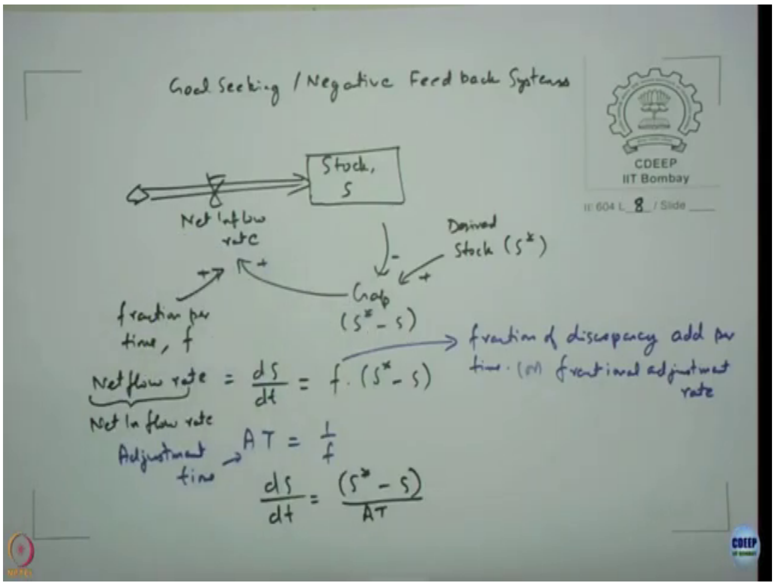

So, let us goal seeking or negative feedback systems, let us we just saw we have a stock S which is affected by some net inflow rate. I have desired stock S star. I have gap, you take in the gap as S star minus S. We can simply denote a fraction per time denote by symbol f, I shown here. So, we already know that net inflow rate or net flow rate dS by dt, this is your net inflow rate as given this diagram.

This is nothing but f into S star minus S. This is this f represents the fraction of discrepancy kind of added per time. There is a gap and some fraction is what we are fulfilling every time unit or it is also called as the fractional adjustment rate. In most, most of our time, it is not possible to completely eliminate the gap at one time step itself, it takes some time for the room to cool down.

Every time some small amount of this difference is kind of added. If we think of the stock as a current room temperature and the desired cooling that we want, so some small amount of gap is kind of satisfied every time unit, so that is what we are modeling here and rate at which is going to happen is defined by that fraction. So, fraction of discrepancy added per time or the fraction adjustment rate is what is defined as f.

We can also denote say A T. So, this is nothing but adjustment time. This can be defined as just 1 over f. See if we are instead of fractions if it time is more convenient to us, we can define adjustment time, it is just 1 over f, and we can rewrite the original equations as inflow as dS by dt S star minus S divided by A T. A T is the kind of the symbol for the adjustment time.

So, in coming up with the model for this negative feedback system, all we need to find is this stock, desired stock, and immediately we know the gap and the equations of the gap is the desired minus this stock. And inflow rate all we are going to do is multiply by fraction rate per time which is f, or we can divide it by adjustment time whichever very equivalent, and we define a net inflow rate this is what we are going to learn to model today.

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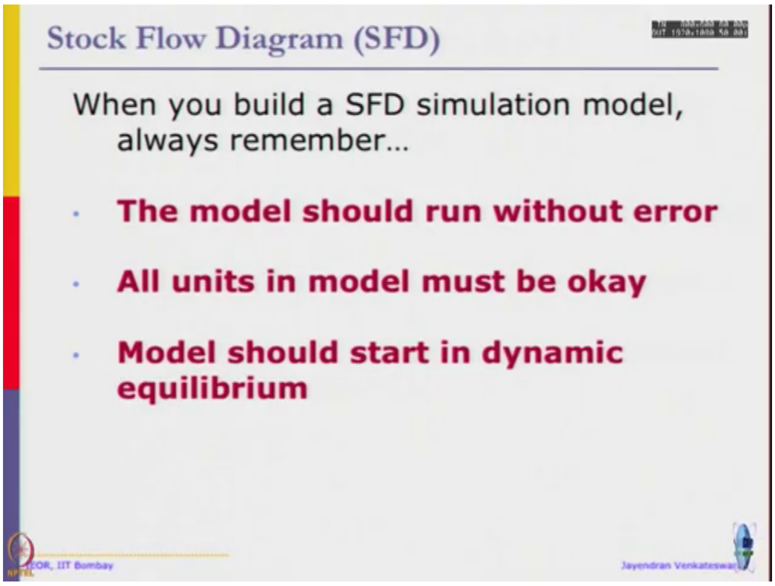

Before we start modeling, let us start with kind of a three very three basic pointers. When you build stock flow diagram based simulation model or stock flow simulation model as remodel as we call it, always remember in the model should run without error, all units in model should be ok, and model should start in dynamic equilibrium. Pardon me in dynamic equilibrium is for the given values in the system at the start itself we do not need to observe any dynamics in the system, it should remain kind of constant. We will looked at through an example.

And when suppose this features, where you can whether there is any where units are all ok, and debug the models, (Refer Time: 08:06) an errors, and just check where the error is fix it. We will learn all these points through a simple example.