

OLLSCOIL NA hÉIREANN
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SEMESTER I, WINTER 2003-2004 EXAMINATION

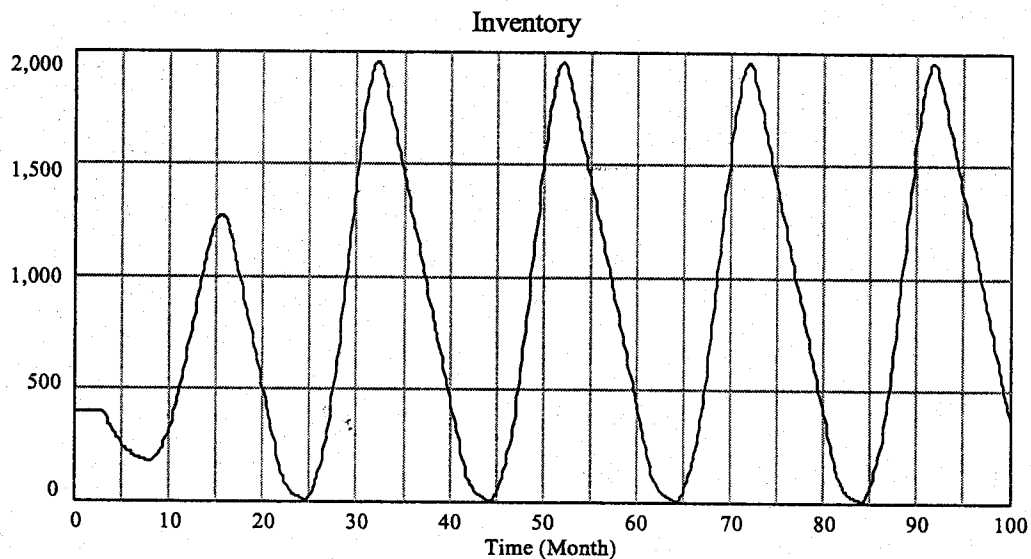
The B.A. Degree
Systems Approach (CT317)

The B.Sc. Degree Examination in Information Technology
Systems Theory (CT423)

Professor P. Nixon
 Professor G. Lyons
 Dr. J. Duggan

Time Allowed: 2 hours
 Answer any THREE questions.

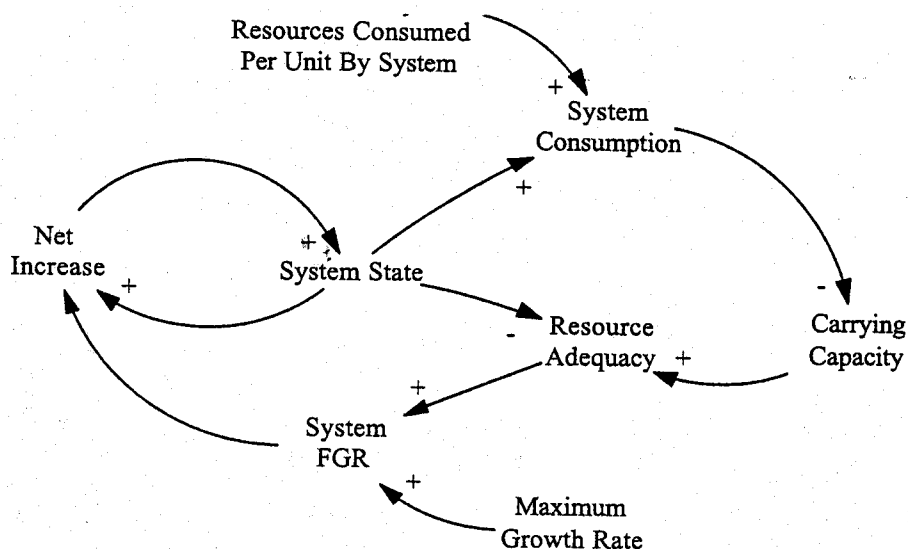
1. Based on this plot of a firm's inventory:



Inventory : Current

- Identify the fundamental mode of behaviour, and model this using a causal loop diagram. (40% marks)
- Derive a set of stock and flow equations that will replicate this behaviour. (60% marks)

2. Design a goal seeking stock and flow model that captures the dynamics of a claims processing service organisation, and has the following features
- The model should represent customer demand, order backlog and the rate of order fulfilment. (10% marks)
 - The order fulfilment is determined by the capacity of the system, which is a product of the average productivity and the number of resources (workers) in the system. (10% marks)
 - The goal seeking resource acquisition is modelled using a stock management structure, and the quit rate is 10% of the experienced workers. (40% marks)
 - New hires go through a training period that can be modelled using a first order exponential delay with an average delay of 20 time units. (10% marks)
 - The productivity of trainees is half that of experienced workers. (10% marks)
 - The model should capture the loss in productivity of experienced workers when they have to provide training and advice to workers being trained. (20% marks)
3. (a) Describe the fundamental dynamic mode of behaviour known as *overshoot and collapse*. (25% marks)
- (b) Based on the following causal loop diagram, generate a stock and flow model. Assume that the capacity is a renewable resource, where the time delay is second order with an average time of 50 time units. (50% marks)



- (c) Draw a graph of how you would expect the system to behave over time where (1) the replenishment delay is 5 units and (2) where the replenishment delay is 100 time units. (25% marks)

4. (a) Describe, using examples to support your answer, what is meant by the terms *feedback* and *counter-intuitive behaviour*. (50% marks)

(b) Develop causal loop diagrams, and describe the overall loop polarity, based on the following descriptions. (50% marks)

- For an undergraduate university computer science programme, a decrease in places offered leads to an increase in points. An increase in points improves the programme's attractiveness, which in turn leads to an increase in demand. Increasing demand leads to a higher level of points.
- "This is a time period where now there's a broad awareness that Windows NT is by far the highest-volume general purpose server platform. The growth there continues to amaze us, and it's a positive feedback loop. As we got more applications, NT Servers got more popular. As it's gotten more popular, we've got more applications." [Bill Gates *Computer Reseller News*, Sept. 1996]

5. Review the following behaviour for the inflow (heavy shaded line) and outflow to a Stock and:

(a) Graph the Net Flow (using graph paper), and predict the Stock's value using graphical integration. (50% marks)

(b) Predict the value of the stock using Euler's Equation with $DT = 5$ time units. (25% marks)

(c) Comment on how a modeler would select the most suitable value for DT for a particular problem. (25% marks)

