

**Lecture Plan 1**

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -A

| <b>S. No.</b> | <b>Topic :- Introduction to Simulation</b>   | <b>Time Allotted:-</b> |
|---------------|--|------------------------|
| 1.            | <b>Introduction</b><br>System simulation is a set of techniques that use computers to imitate the operations of various real world tasks or processes through simulation.. | <u>5 -10 min</u>       |
| 2             | <b>Division of the Topics</b><br>Introduction to Simulation: System & System Environment, Components of a System   | <u>25-30 min</u>       |
| 3.            | <b>Conclusion</b><br>A simulation is essentially the imitation of a real world system.   | <u>5 min</u>           |
| 4             | <b>Question / Answer</b><br>Define System Simulation.  | <u>5 min</u>           |

Assignment to be given:- NILReference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
3. K S Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Application", PHI

## Lecture Plan 2

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -A

| S. No. | Topic :- Discrete and Continuous Systems, Model of a System and Types of Models   | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br>System like the factory, in which changes are predominantly discontinuous is known as <i>discrete system</i> . | <u>5-10 min</u>  |
| 2      | <b>Division of the Topics</b><br>-Discrete and Continuous Systems, Model of a System and Types of Models                              | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>A discrete system is a system with a countable number of states.   | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1.Define Discrete system.  | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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## Lecture Plan 3

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -A

| S. No. | Topic:- Model of a System and Types of Models,. Discrete Event System Simulation                                    | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction:</b><br>A mathematical model is a description of a system using mathematical concepts and language. | <u>5-10 min</u>  |
| 2      | <b>Division of the Topics</b><br>Model of a System and Types of Models,. Discrete Event System Simulation,          | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>Mathematical models use symbolic notation and mathematical equations to represent a system.    | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1.Define Mathematical Model.   | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
3. K S Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Application", PHI

## Lecture Plan 4

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -B

| S. No. | Topic :- Advantages and Disadvantages of Simulation, Areas of Application.  | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br>One of the primary advantages of simulators is that they are able to provide users with practical feedback when designing real world system. | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>- Advantages and Disadvantages of Simulation,<br>- Areas of Application.  | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>This permits the system designer to study problem at several different levels of abstraction   | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1. Describe the areas of application of simulation   | <u>5 min</u>     |

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Reference Readings:-

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## Lecture Plan 5

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -B

| S. No. | Topic :- Techniques of Simulation: Monte Carlo Method, Types of System Simulations  | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br>Monte Carlo simulation, also known as the Monte Carlo method, originated in the 1940s at Los Alamos National Laboratory. Physicists Stanislaw Ulman, Enrico Fermi, John von Neumann, and Nicholas Metropolis had to perform repeated simulations of their atomic physics models to understand how these models would behave given the large number of uncertain input variable values. | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>- Techniques of Simulation: Monte Carlo Method,<br>-Types of System Simulations,  | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b>   | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1.Define Monte Carlo Simulation.   | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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## Lecture Plan 6

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -B

| S. No. | Topic :- Real Time Simulation, Stochastic Variables   | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br><b>Real-time simulation</b> refers to a computer model of a physical system that can execute at the same rate as actual "wall clock" time..                | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>- Real Time Simulation,<br>- Stochastic Variables,  | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>Real-time simulation occurs commonly in computer gaming, but also is important in the industrial market for operator training and off-line controller tuning | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1.Define Real Time Simulation  | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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**Lecture Plan 7**

Semester:-VII

Class:-ECS

Course Code:-EC-

711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -B

| S. No. | Topic :- Discrete Probability Functions General Principles: Concepts in Discrete Event Simulation  | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <b>Introduction</b><br>The concepts of discrete event simulation is described as follows:<br><b>Model:</b> An abstract representation of a system, usually containing structural, logical or mathematical relationships that describe a system in terms of state, entities and their attributes, sets, processes, events, delays and activities. | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>- Discrete Probability Functions<br>-General Principles: Concepts in Discrete Event Simulation   | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>A duration of time of unspecified indefinite length which is not known until it ends.   | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1. Define Discrete Probability Functions  | <u>5 min</u>     |

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## Lecture Plan 8

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -B

| S. No. | Topic :- Event Scheduling /Time Advance Algorithm, List Processing,                        | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <b>Introduction</b><br>Event scheduling is used in system simulation and modeling.         | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Event Scheduling /Time Advance Algorithm, List Processing, | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>Event scheduling is used in system simulation and modeling.<br>.      | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q. Define Event scheduling.                                    | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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## Lecture Plan 9

Faculty:-Mr. K . K . Singh  
Course Code:-EC-711-F

Semester:-VII

Class:-ECS

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -B

| S. No. | Topic :- Using Dynamic Allocation & Linked List Simulation Software: History of Simulation Software  | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <p><b>Introduction</b></p> <p style="color: blue;"><u>History of Simulation Software (not comprehensive)</u></p>   | <u>5-10 min</u>  |
| 2      | <p><b>Division of the Topic</b></p> <ul style="list-style-type: none"> <li>- Using Dynamic Allocation &amp; Linked List</li> <li>- Simulation Software: History of Simulation Software.</li> </ul> | <u>25-30 min</u> |
| 3.     | <p><b>Conclusion</b></p> <p>Various Simulation software are used in industry</p>   | <u>5 min</u>     |
| 4      | <p><b>Question / Answer</b></p> <p>Q1.Define Linked List</p>   | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
3. K S Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Application", PHI

## Lecture Plan 10

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -B

| S. No. | Topic :- Selection of Simulation Software, Simulation in C++, GPSS, Simulations Packages, Trends in simulation Software   | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br><u>Trends in Simulation Software</u> <ul style="list-style-type: none"> <li><input type="checkbox"/> High-fidelity               <ul style="list-style-type: none"> <li>○ excellent graphics, virtual reality, accurate emulation</li> </ul> </li> <li><input type="checkbox"/> Data exchange standards               <ul style="list-style-type: none"> <li>○ SDX (layout of building blocks)</li> <li>○ XML</li> </ul> </li> <li><input type="checkbox"/> The Internet               <ul style="list-style-type: none"> <li>○ client: GUI, server: simulation machine</li> <li>○ models distributed on many computers</li> </ul> </li> </ul> | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Selection of Simulation Software,<br>Simulation in C++, GPSS,<br>Simulations Packages,<br>Trends in simulation Software   | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>system providers contribute models of their components   | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1. Describe various simulation software.   | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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**Lecture Plan 11**

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -C

| S. No. | Topic :- Statistical Models in Simulation  | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <b>Introduction</b><br>If the random variable $X$ can assume any value within an interval, $X$ is called a continuous random variable.   | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Useful Statistical Models,<br>Discrete Distribution s,<br>Continuous Distributions   | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>The random variable $X$ is said to be a <b>discrete random variable</b> if $X$ can take on only a finite number of values in any finite observation interval. An example of an experiment which yields such a discrete random variable is the rolling of a die. | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1 Define discrete random variable.  | <u>5 min</u>     |

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1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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## Lecture Plan 12

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -C

| S. No. | Topic :- Poisson Process, Empirical Distributions  | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <b>Introduction</b><br>The Poisson distribution arises in some problems involving counting. The number of phone calls arriving at a switching center in various time intervals.  | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>- Poisson Process<br>-Empirical Distributions  | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>In digital communication, the Poisson distribution is pertinent to the problem of the transmission off many data bits when the error rates are low. The binomial distributioin becomes awkward to handle such case. | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1. Define Poisson Process.  | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
3. K S Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Application", PHI

## Lecture Plan 13

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -C

| S. No. | Topic Queuing Models: Characteristics of Queuing systems, Queuing Notation, Long Run Measures of performance of Queuing Systems  | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <b>Introduction</b><br>The combination of all entities in the system, those being served and those waiting for service will be called queue.                                       | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Characteristics of Queuing systems<br>Queuing Notation<br>Long Run Measures of performance of Queuing Systems                                      | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>A queueing system is described by its calling population, the nature of the arrivals, the service mechanism, the system capacity and the queueing discipline. | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1.Define queuing system.  | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
3. K S Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science

**Lecture Plan 14**

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -C

| S. No. | Topic :- Steady State Behavior of infinite Population Markovian Models, Steady State Behavior of finite Population Models.   | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <b>Introduction</b><br>The basic queuing systems discussed in this section are characterized by birth-death process where the system state can change to an adjacent state only in the next transition . | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Steady State Behavior of infinite Population Markovian Models,<br>Steady State Behavior of finite Population Models.   | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>The steady-state solutions for birth-death systems can be derived by changing the birth and the death rate coefficients in the “Product Form” solution for a specific system.       | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1. Define Steady State behavior of infinite.  | <u>5 min</u>     |

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1. Gordon G, “System Simulation”, PHI 2nd Edition 1998.
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**Lecture Plan15**

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -D

| S. No. | Topic :- Networks of Queues Random Number Generation.   | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br>A Random number is a number generated by a process, whose outcome is unpredictable and which cannot be subsequentials reliably reproduced. | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Properties of Random Numbers<br>Generation of Pseudo-Random Numbers   | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>A Random number is a number generated by a process, whose outcome is unpredictable and which cannot be subsequentials reliably reproduced.   | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1.List the properties of Random Number Generation  | <u>5 min</u>     |

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1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
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## Lecture Plan 16

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -D

| S. No. | Topic :- Techniques for Generating Random Numbers,  | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br>Random numbers are widely used ingredient in the simulation of almost all discrete systems. Simulation languages generate random numbers that are used to generate event times and other random variables. | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Techniques for Generating Random Numbers  | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>Simulation languages generate random numbers that are used to generate event times and other random variables  | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1.write down the various techniques for generating random number.  | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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**Lecture Plan 17**

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -D

| S. No. | Topic :- TESTS FOR RANDOM NUMBER   | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <b>Introduction</b><br>To check on whether these desirable properties have been obtained, a number properties have been obtained, a number of test can be performed. | <u>5 min</u>     |
| 2      | <b>Division of the Topic-</b><br>TESTS FOR RANDOM NUMBER   | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>The tests can be placed in two categories based on the properties of interest:<br>Uniformity and independence.                                  | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1. Write down the test for random number.   | <u>5 min</u>     |

Assignment to be given:- NILReference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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## Lecture Plan 18

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -D

| S. No. | Topic :- Inverse transform Techniques, Convolution Methods, and Acceptance – Rejection Techniques Input Modeling: Data Collection   | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br>Hypothesis testing or significance testing is a method for testing a claim or hypothesis about a parameter in a population, using data measured in a sample. | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Inverse transform Techniques, Convolution Methods, and Acceptance –Rejection Techniques Input Modeling: Data Collection                             | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>So in tie set current in any branch of a graph can be found by using link currents and its directions.   | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q.1The experiment is to be repeated until five outcomes have occurred. What is expected number of repetitions required? What is the variance?           | <u>5 min</u>     |

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Doc. No.: DCE/0/15  
Revision :00

## Lecture Plan 19

Semester:-VII  
Course Code:-EC-711-F

Class:-ECS

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -D

| S. No. | Topic :- Identifying the Distribution with Data, Parameter Estimation, Chi – Square Test  | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br>The oldest goodness of fit hypothesis test is the chi-square test.   | <u>5 min</u>     |
| 2      | <b>Division of the Topic</b><br>Identifying the Distribution with Data, Parameter Estimation, Chi – Square Test   | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>This test is valid for large sample sizes and for both discrete and continuous distributional assumptions when parameters are estimated by maximum likelihood. | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1.Define Chi-Square test.  | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, “System Simulation”, PHI 2nd Edition 1998.
2. Deo Narsingh, “System Simulation with Digital Computers”, PHI, New Delhi 1993.
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**Lecture Plan 20**

Semester: - VII

Class:-ECS

Course Code:-EC-711-F

Subject:- SYSTEM SIMULATION AND MODELING

SECTION -D

| S. No. | Topic :- <b>Selecting Input Models with Data Verification &amp; Validation of simulation Modeling: Model Building</b>  | Time Allotted:-  |
|--------|--|------------------|
| 1.     | <b>Introduction</b><br>Data collection and model building often consume the majority of the time required for completion of a simulation project.  | <u>5 min</u>     |
| 2      | <b>Division of the Topic</b><br>Selecting Input Models with Data Verification & Validation of simulation Modeling: Model Building  | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>Data modeling spans the evolution of the high-level model that displays the data entities in a given business domain into a model that shows details of how the data is stored, for example, in a database management system. | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q1. Define data verification & Validation of simulation modeling   | <u>5 min</u>     |

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1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
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## Lecture Plan 21

Semester:-VII

Class:-ECS

Course Code:-EC-711-F

Subject:-SYSTEM SIMULATION AND MODELING

SECTION -D

| S. No. | Topic :- Verification & Validation, Verification of simulation Models, Calibration & Validation of Models.  | Time Allotted:-  |
|--------|---|------------------|
| 1.     | <b>Introduction</b><br>One of the most important and difficult tasks facing a model developer is the verification and validation of the simulation model.                   | <u>5-10 min</u>  |
| 2      | <b>Division of the Topic</b><br>Verification & Validation,<br>Verification of simulation Models,<br>Calibration & Validation of Models.                                     | <u>25-30 min</u> |
| 3.     | <b>Conclusion</b><br>Verification, which consists in determining that a computer simulation program performs as intended and is concerned with building the model properly. | <u>5 min</u>     |
| 4      | <b>Question / Answer</b><br>Q.1.Define steps in system model building<br>.  | <u>5 min</u>     |

Assignment to be given:- NIL

Reference Readings:-

1. Gordon G, "System Simulation", PHI 2nd Edition 1998.
2. Deo Narsingh, "System Simulation with Digital Computers", PHI, New Delhi 1993.
3. K S Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Application", PHI