Topic.....Date.....

CO-207

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"Modelling and Simulation"

Contents :

→ Tutorial 2 4 questions

→ Assignment 4 questions

Submitted to : Ms. Dipika Jain

Teacher's Sign .....

Topic: Tutorial 2 M&S Date:

Question no. 1 What is model? What are the components which help in the formation or illustration of a model?

→ Models are the replica of systems which can be represented physically or mathematically. It is a three-dimensional representation of a person or thing or of a proposed structure, typically on a smaller scale than original. Simulation modeling is the process of creating and analyzing a digital prototype of a physical model to predict its performance in the real world. eg:- weather forecasting, flight simulators, car crash modelling, etc. It tries to emulate a real life system through use of computer software.

Simulation of a system is the operation of a model in terms of time or space, which helps analyze the performance of an existing or a proposed system.

The components which help information of a model are :-

a) Entities: Entity is an object of interest in a system. An object whose value can be static or dynamic depending upon the process with other entities. They are created by the analyst, move around and are then disposed as they leave system. They represent real things in simulation. Determining the entities is one of the first things the analyst should do in construction of a simulation model.

b) Events: Events are the occurences that alter the

Teacher's Sign .....

system state. Here the events are the something that happens at an instant of simulated time that may change attributes, variables or statistical accumulators. In discrete systems, the changes in the system state are discontinuous and each change in the state of system is called event.

c) Groupings: Similiar entities are grouped in meaningful ways. Sometimes an ordering of entities within a group is relevant. It is also called as attribute. It is a common characteristic of all entities

d) but with a specific value that can differ from one entity to another. eg:- attribute for an entity could be arrival time, due date, colour, etc.

d) variables: variable also known as (global variable) is a variable that reflects a characteristic of the system regardless of the number of or what kinds of entities may be in the model. With global variables, the value of variable can change during simulation run.

e) Resources: Entities often compete for service from resources, such as personnel, machines, equipment or space in storage area. In everyday life, a resource, such as worker seizes an entity, performs some activity and then releases the entity to next operation when finished.

f) Queues: The purpose of queue is to hold an entity that needs to seize a resource in a temporary waiting area, but the resource is currently tied up

Teacher's Sign .....

with another entity. All queues have names and the names are typically the name of the process followed by a queue, such as assembly queue.

g) Simulation clock: The variable called simulation clock stores the current value of simulated time during the simulation run.

Question 02) Difference between static and dynamic simulations

	static simulation	dynamic simulation
→	A static simulation model, represents a system at a particular point in time.	→ A dynamic simulation model represents systems as they change over time.
→	It cannot be changed in real time and this is why they are referred as static modelling.	→ It is flexible and can change with time as it shows what an object does with many possibilities that might arise in time
→	Static models are more structural than behavioral.	→ Dynamic model's representation of the behaviour of static components of system
→	It includes class diagram, object diagrams and help in depicting static constituents of system	→ It consists of sequence of operations, state change, activities, interactions and memory.
→	absence of differential equations.	→ uses differential equations

Teacher's Sign.....

Topic.....Date.....

Topic Tut 2 M4S Date.....

Question 10.3) What are the advantages and disadvantages of simulation?

⇒ Advantages:

i) System behaviour analysis:

Simulation softwares analyze the behaviour of a system without building actual prototypes. Engineers can work on alternative solutions and simulate various designs. Therefore, simulation during the product design has advantage of finalizing the best solution for prototyping before actually building it. It helps in reducing the number of iterations.

ii) Reduces manufacturing cost

Simulation softwares help engineers in iterating and testing designs very quickly. As a result we can reduce number of errors and hence manufacturing and testing costs are decreased.

iii) Understanding "Why?": we can understand why certain phenomena is happening in real life by reconstructing and taking microscopic examination of system to find out the cause.

iv) explore possibilities: One of the greatest advantage is that once we have developed a valid simulation model, we can explore new policies, operating procedures, methods without the expense and disruption of experimenting with the real system.

Teacher's Sign .....

Topic.....Date.....

v) visualization of plan: Taking the designs beyond CAD drawings by using the animation features offered by simulation packages allow us to see the facility or organization actually running.

vi) wise investment: The typical cost of simulation study is less than 1% of the total amount being expended for the implementation of a design or redesign.

disadvantages:

i) model building requires special training: It is an art learned over time and through experiences.

ii) Accurate Boundary conditions and input data: Simulation results accurately depends on input data and boundary conditions. System boundary conditions include environmental temperature, pressure and material. Therefore, boundary conditions need to be defined accordingly and accurately to achieve accurate results.

iii) Simulation results are difficult to interpret.

iv) Time consuming and expensive with higher initial investment

v) not 100% accurate: There is some discrepancies in simulation results and tested products.

Teacher's Sign .....

Topic..... Date.....

Question 4) what are factors which affect the simulation of any system?

⇒ factors which affect simulation of any systems are:

i) unclear objective ii) using simulation when an analytical solution is appropriate iii) invalid model iv) bugs in simulation program v) initial bias in output data vi) using wrong input probability distribution vii) erroneous assumptions viii) method used and simulation parameters such as initial step size and tolerance

Teacher's Sign .....

Assignment no. 1 M&S

Topic..... Date.....

assignment

Q No 1. When is simulation appropriate tool and when not:

Ans = Simulation is an appropriate tool when:

i) it enables one to study internal interactions of a complex system or of a subsystem with in a complex system.

ii) it can be used to verify analytical solutions

iii) the effect of information, organization and environmental changes on the model's behaviour can be simulated and observed.

iv) simulation can be used to experiment with new designs or policies so as to estimate its effect

v) using animation we can visualize the system in a particular stage of operation.

vi) the interactions in modern complex system like factory, water fabrication, etc can be treated only through simulation.

vii) simulation models designed for training allow learning without any cost

Simulation is not appropriate tool when:

i) if system behaviour is too complex or cannot be defined

ii) problem is solvable by common sense

iii) problem can be solved mathematically

iv) if it is easier to perform the experiment directly.

v) simulation costs exceed the savings.

vi) simulation cannot be verified or validated.

vii) No i/p data available and simulation needs data.

Teacher's Sign

assignment

Question #2

What are Monte-Carlo simulation methods and when were they formed?

→ The monte carlo simulation methods were invented by John Von Neumann and Stanislaw Ulam during World war II to improve decision making under uncertain conditions. It was named after a well-known casino town, called Monaco because chance and random outcomes are central to this modeling techniques similiar to games of roulette. Monte Carlo methods maybe thought of as a collection of computational techniques for the (usually approximate) solution of mathematical problems, which make fundamental use of random samples. It is a model used to predict the probability of a variety of outcomes when the potential for random variables is present. This simulation requires assigning multiple values to an uncertain variable to achieve multiple results and then averaging the results to obtain an estimate.

Monte-Carlo simulations are also utilized for long-term predictions due to their accuracy. As the number of inputs increase, the number of forecasts also grows, allowing you to project outcomes farther out in time with more accuracy. When a Monte Carlo simulation is complete, it yields a range of possible outcomes with the probability of each result occuring.

One simple Example of a Monte Carlo Simulation is to consider calculating the probability of

Teacher's Sign .....

Topic..... Date.....

rolling two standard dice. There are 36 combination of dice rolls. Based on this, you can manually compute the probability of a particular outcome. Using a Monte Carlo simulation, you can simulate rolling the dice 10,000 times (or even more) to achieve more accurate/precision predictions.

assignment question 3. Give any five simulation applications in manufacturing and transporting systems.

=> Applications of simulations in manufacturing and transporting systems:

a) Assembly line balancing
- Discrete Event Simulation
- designing and balancing of assembly lines

The assembly line is a production line where material moves continuously through a series of workstations where assembly work is performed. Line balancing is a flow-oriented production strategy for improving productivity and cost efficiency in mass production processes. An optimal time frame is designated for the production of a particular product. In nutshell, production /assembly line balancing is simply the assignment of right number of workers and machines to each assembly line segment. This helps meet production rate targets with minimal idle time.

- It reduces the amount of idle time in work stations.

Teacher's Sign .....

- maximizes workforce utilization and production capacity
- reduces wastage

b) cellular planning

In cellular manufacturing, the placement of production workstations and equipment ensures that materials and components go smoothly through the production process with little movement or delay. Specific analytical methods are used in this one-piece flow method to evaluate present operations and create a new cell based production layout that will shorten cycle times and changeover time.

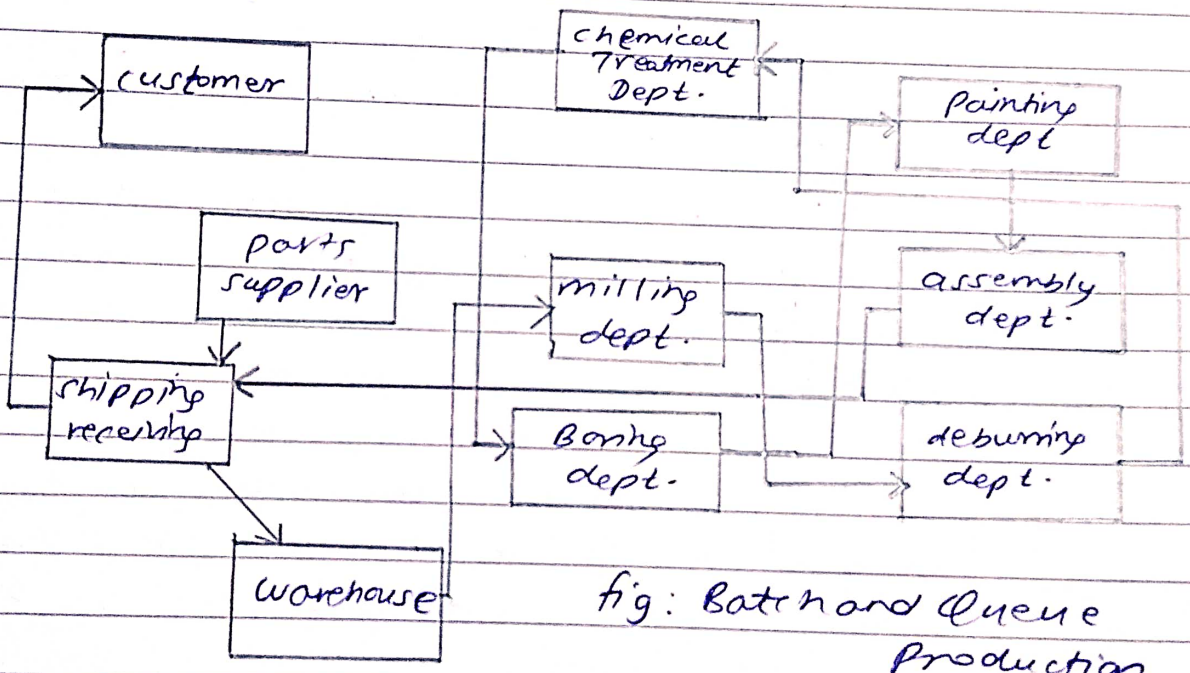

fig: Batch and Queue Production

c) Traffic simulation

The mathematical modelling of transportation system (such as freeway junctions, arterial routes, roundabouts, city grid systems, etc.) through the use of computer software is known as traffic simulation or the simulation of transportation systems.

Teacher's Sign .....

Topic Date

Simulation methods in transportation can employ a selection of theories, including probability and statistics differential equations and numerical methods.

- Monte Carlo method
- Cellular automata model
- discrete event and continuous-time simulation
- Car-following models: They model the behaviour of each individual vehicle ("microscopic") in order to see its implications on the whole traffic system ("macroscopic").

d) Roadway and ground transportation

Perhaps the most common application of simulation is in ground transportation, which includes both passenger and cargo movement. To study planning, design and operations such as delay, pollution and congestion, simulation can be done at level of a roadway grid network or at the level of a more complicated roadway corridor network. All forms of road travel, including cars, trucks, buses, bicycles and pedestrians, can be modelled for ground transportation. Aggregate representation of traffic is typically used in traditional road traffic models, where all vehicles of particular group adhere to the same rules of behaviour.

e) Inventory management

The process of ordering, storing, using and selling a company's inventory is referred to as inventory management. This covers the storage and processing of such commodities as well as the management of raw materials, components and completed goods.

Teacher's Sign .....

Topic..... Date.....

Simulation models enable the management and analysis of inventory and order data in the competitive economic environment of today. In order to create inventory ordering models based on ~~Econ~~ Economic order quantity and safety stock principles, inventory management solutions must assess previous sales. The aim of inventory management is to provide sufficient quantities of goods in the warehouse so that user requirements can be filled at moment. Considering the stochastic nature of demands, it is increasingly difficult to manage inventories. Depending on the time of delivery, ordering costs of holding, and lack of inventories this objective can be achieved by applying some of the inventory management strategies.

assignment question 4.

Name several entity, attributes, activities, events and state variables of a typical automatic teller machine (ATM).

→ Automatic teller machine (ATM):

- Entity = ATM card, ATM machine, CC camera, security guard, people,
- Attributes = fast, accurate, secure, empty, full, informative,
- Attributes of customers = in hurry, careful, skeptic, excited
- activities = arrival of people, departure of people, withdraw of cash, counting of cash, insertion of atm card, entering details

Teacher's Sign .....

Topic..... Date.....

deposition of cash, etc.

- events = arrival of new person, inadequate cash, faulty machine, atm card stuck

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"Modelling and Simulation"

Contents:

→ #Tutorial I 4 questions

Submitted to:
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modelling and simulation

Tutorial - 1

Question no. 1

what do you understand by simulation, give a real life example?

→ A simulation is a model that mimics the operation of an existing or proposed system, providing evidence for decision making by being able to test different scenarios or process changes. A simulation imitates the operation of real world processes or systems with the use of models. It is the re-creation of a real world process in a controlled environment. Simulations are typically conducted in a controlled environment that allows for modification or adjusting of variables as needed. Simulations work by developing models or systems to recreate real-world scenarios. A model refers to any setup, device, or representation used to describe or simulate a process when it cannot be experienced directly. The ability to modify and re-test a virtual design means you don't have to spend time (or money) building and testing multiple prototype iterations. You can settle on a design that satisfies the requirements in simulation before building an actual prototype.

Real-life examples of simulations include solar activity models, highway and street traffic models, war models, social and behaviour models, etc.

- Telecommunications: designers of 5G telecom equipments use simulation to design everything from base to antennas for maximum range to determine the placement of base stations. Designers also test new communications protocols by modeling base stations, mobile devices.

• geology: By understanding the mathematical relationships among various types of soils, rocks and subterranean structures, geologists and seismologists can use simulation to predict the effects of different types of earthquakes or amount of surface shaking that would occur.

Question no. 2

~~what do you~~ differentiate between deterministic and non-deterministic simulation event.

deterministic	non-deterministic
→ A simulation event is deterministic if its behaviour is entirely predictable.	→ A simulation event is non-deterministic if it has random variables as inputs and consequently also its outputs are random.
→ Deterministic simulation event/function always returns the same results if given the same input values.	→ A non-deterministic simulation returns different results everytime it is called, even when the same input values are provided.
→ Deterministic model does not include any randomness at all. Everything happens strictly with infinite accuracy according to original plan.	→ A non-deterministic model allows random variation in its probabilistic events resulting in an ever-changing system where the future is predictable only with limited accuracy.
→ A deterministic model allows to calculate a future event exactly without the involvement of randomness.	→ It has the capacity to handle uncertainties in the inputs applied.

→ variables are the functions of time only.	→ variables depend on time and probability.
→ Trajectory is fixed between simulations.	→ variability between simulations
→ examples: a system of differential equations representing a chemical reaction, simulation of a digital circuit, etc.	→ examples: queuing models, amount of time required to service a customer, etc.

Question no. 3

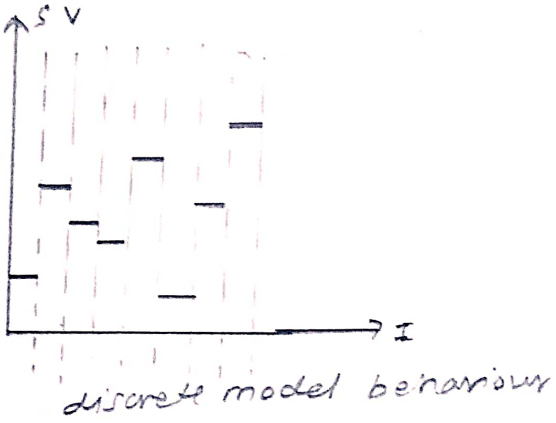
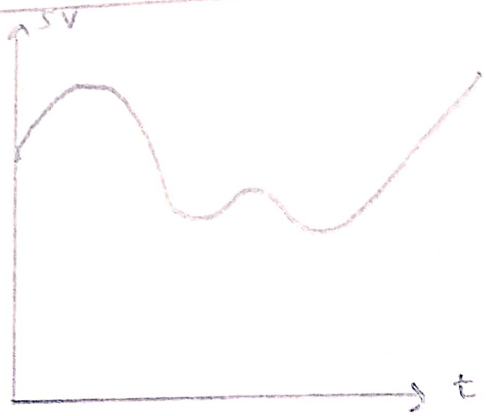
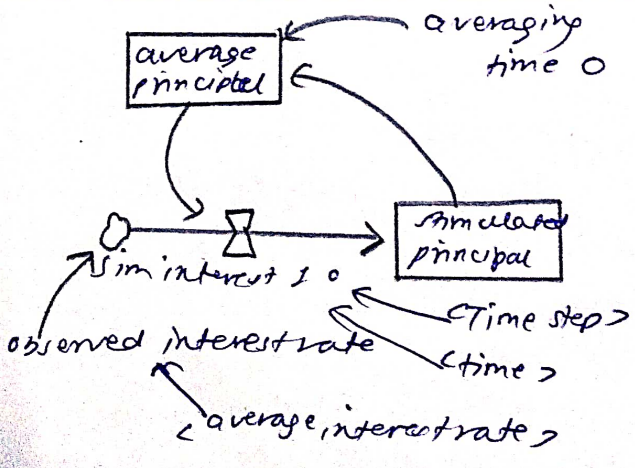
what do you understand by entity, system and how do these two terms form a relationship to perform simulation?

→ System is defined as a set of ideas or rules for organizing something; a particular way of doing something. System is the articulate object under definite conditions, which exists in the real world. It is a group of objects that are joined together in some regular interaction or interdependence towards the accomplishment of some purpose.

Entity is an object of interest in a system. Individual elements of the system that are being simulated and whose behaviour is being explicitly tracked. They are the dynamic objects in simulation. Each entity can be individually identified. Most entities represent real things in a simulation. A system is defined to be a collection of entities eg: people or machines, that act and interact together towards the accomplishment of some logical end.

an entity is an object of interest in the system where a system is defined to be collection of entities. Pair of non-similiar entities may be related. Eg:- A busy pump is related to the auto that is being served. Relationships can be indicated by including in the record for one of the entities in a pair linked to other entity.

4) differentiate between discrete and continuous system.

discrete	continuous
→ The state variables change only at a countable number of points in time. These points in time are the ones at which the event occurs / change in state.	→ The state variables change in a continuous way, and not abruptly from one state to another (infinite number of states.)
→ Time changes in incremental steps.	→ Time changes continuously.
→  discrete model behaviour	→  continuous model behaviour
→ made up of entities, attributes and events	→ changes expressed in terms of differential equations.
→ examples: queuing system, inventory models, machine shop models, etc.	→ examples: econometric models, system dynamics, classical mechanics, etc.
→ 	→