Ref No:

Sri Krishna Institute of Technology,
Bangalore

# COURSE PLAN

## Academic Year 2019-2020

| | |
|---|---|
| Program: | B.E. - Information Science and Engineering |
| Semester : | VIII |
| Course Code: | 15CS834 |
| Course Title: | System Modelling and Simulation |
| Credit / L-T-P: | 3/3-0-0 |
| Total Contact Hours: | 40 |
| Course Plan Author: | Veena M Naik |

Academic Evaluation and Monitoring Cell

Sri Krishna Institute of Technology
#29,Chimney hills,Hesaraghata Main road, Chikkabanavara Post
Bangalore – 560090, Karnataka, INDIAPhone / Fax :08023721477/28392221/23721315
Web: www.skit.org.in , e-mail: skitprinci@gmail.com

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# A. COURSE INFORMATION

## 1. Course Overview

| | | | |
|---|---|---|---|
| Degree: | BE | Program: | IS |
| Semester: | 8 | Academic Year: | 2019-2020 |
| Course Title: | System Modeling and Simulation | Course Code: | 15CS834 |
| Credit / L-T-P: | 3/ 3-0-0 | SEE Duration: | 180 Minutes |
| Total Contact Hours: | 50 Hours | SEE Marks: | 80 Marks |
| CIA Marks: | 20 Marks | Assignment | 1 / Module |
| Course Plan Author: | Veena M. Naik | Sign .. | Dt: |
| Checked By: | | Sign .. | Dt: |
| CO Targets | 60 | SEE Target: | 65 |

**Note:** Define CIA and SEE % targets based on previous performance.

## 2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute.

| Module | Content | Teaching Hours | Blooms Learning Levels |
|---|---|---|---|
| 1 | **Introduction:** When simulation is the appropriate tool and when it is not appropriate, Advantages and disadvantages of Simulation; Areas of application, Systems and system environment; Components of a system; Discrete and continuous systems, Model of a system; Types of Models, Discrete-Event System Simulation Simulation examples: Simulation of queuing systems. **General Principles, Simulation Software:** Concepts in Discrete-Event Simulation. The Event-Scheduling / Time-Advance Algorithm, Manual simulation Using Event Scheduling | 10 | L4 |
| 2 | **Statistical Models in Simulation** :Review of terminology and concepts, Useful statistical models, Discrete distributions. Continuous distributions, Poisson process, Empirical distributions. **Queuing Models:** Characteristics of queuing systems, Queuing notation, Long-run measures of performance of queuing systems, Long-run measures of performance of queuing systems cont….,Steady-state behavior of M/G/1 queue, Networks of queues. | 10 | L4 |
| 3 | **Random-Number Generation:** Properties of random numbers; Generation of pseudo-random numbers, Techniques for generating random numbers, Tests for Random Numbers, **Random-Variate Generation:** ,Inverse transform technique<br>Acceptance-Rejection technique. | 10 | L4 |
| 4 | **Input Modeling:** Data Collection; Identifying the distribution with data, Parameter estimation, Goodness of Fit Tests, Fitting a non-stationary Poisson process, Selecting input models without data, Multivariate and Time-Series input models. **Estimation of Absolute Performance:** Types of simulations with respect to output analysis ,Stochastic nature of output data, Measures of performance and their estimation, **Contd..** | 10 | L4 |
| 5 | Measures of performance and their estimation, Output analysis for terminating simulations Continued..,Output analysis for steady-state simulations. **Verification, Calibration And Validation:** Optimization: Model building, verification and validation, Verification of simulation models, Verification of simulation models, Calibration and validation of models, Optimization via Simulation.. | 10 | L4 |
| - | **Total** | **50** | |

## 3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).
1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

| Modules | Details | Chapters in book | Availability |
|---|---|---|---|
| **A** | **Text books (Title, Authors, Edition, Publisher, Year.)** | **-** | **-** |
| 1,2,3,4,5 | Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation, 5 th Edition, Pearson Education, 2010. | Available | In Lib/ In dept |
| | | | |
| **B** | **Reference books (Title, Authors, Edition, Publisher, Year.)** | **-** | **-** |
| 1,2,3,4,5 | Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006. | Available | Not Available |
| 3,4 | Averill M. Law: Simulation Modeling and Analysis, 4 th Edition, Tata McGraw- Hill, 2007. | Available | In lib |
| | | | |
| **C** | **Concept Videos or Simulation for Understanding** | **-** | **-** |
| C1 | Discrete-Event System Simulation https://www.youtube.com/watch?v=21WQB0E-6-M | | |
| C2 | Event-Scheduling https://www.youtube.com/watch?v=jX2QCDiWgWI | | |
| C3 | Statistics on Objects https://www.youtube.com/watch?v=Fu12LgDDV-0 | | |
| C4 | Predictive Modeling https://www.youtube.com/watch?v=hK5EJRfmpb0 | | |
| C5 | Random numbers https://www.youtube.com/watch?v=9VwiXU7WPvQ | | |
| C6 | Random-Variate https://www.youtube.com/watch?v=mpQI4il-OCI | | |
| C7 | Predicting of objects https://www.youtube.com/watch?v=YdbxIDvid1I | | |
| C8 | Estimating accuracy on Hypothesis https://www.youtube.com/watch?v=hNDlqAYRDyg | | |
| C9 | Steady-state simulations https://www.youtube.com/watch?v=-N-9sSgVTGk | | |
| C10 | Optimization https://www.youtube.com/watch?v=rp6kJv8gvR8 | | |
| | | | |
| **D** | **Software Tools for Design** | **-** | **-** |
| 1 | MATLAB | | |
| 2 | Simulink | | |
| **E** | **Recent Developments for Research** | **-** | **-** |
| | http://www.site.uottawa.ca/~oren/pubs/D83_Future_of_MaS.pdf | | |
| | | | |
| **F** | **Others (Web, Video, Simulation, Notes etc.)** | **-** | **-** |
| 1 | https://eduladder.com/viewnotes/1857/10IS82-SYSTEM-MODELING-AND-SIMULATION-ssm-notes | | |
| | | | |
| | | | |

## 4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

| Modules | Course Code | Course Name | Topic / Description | Sem | Remarks | Blooms Level |
|---|---|---|---|---|---|---|
| 1 | 15CS834 | System Modeling & Simulation | constructive and virtual modeling and simulation of UAVs. | 8 | Seminar | L2 |
| 2 | 15CS834 | System Modeling & Simulation | strong C++/C# and Matlab experience | 8 | Hands on Sessions | L4 |
| 3 | 15CS834 | System Modeling & Simulation | able to create top level briefings using MS PowerPoint to support management and customer presentations on simulation experiment results | 8 | Hands on Sessions | L4 |
| 4 | 15CS834 | System Modeling & Simulation | 3D physics, embedded software and systems simulation | 8 | Seminar | L2 |
| 5 | 15CS834 | System Modeling & Simulation | Validate and optimize product design, operations and service | 8 | Seminar and Hands on Sessions | L4 |

## 5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.
Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

| Modules | Topic / Description | Area | Remarks | Blooms Level |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# B. OBE PARAMETERS

## 1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs.

| Modules | Course Code.# | Course Outcome **At the end of the course, student should be able to . . .** | Teach. Hours | Instr Method | Assessment Method | Blooms' Level |
|---|---|---|---|---|---|---|
| 1 | 15CS834.1 | Apply the concepts in discrete-event simulation using time scheduling algorithm. | 10 | Learning / class discussion | Q & A (Oral) | L4 |
| 2 | 15CS834.2 | Analyze the queuing models using queuing systems. | 10 | Learning / class discussion | Employ Problem Set | L3 |
| 3 | 15CS834.3 | Generate and test random numbers and random variants and apply them to develop Simulation models. | 10 | Learning / class discussion | Test (Take Home) | L4 |
| 4 | 15CS834.4 | Distinguish between modeling methods that are suitable for discrete-event, and hybrid systems, and apply these methods to simple systems | 10 | Learning / class discussion | Test (Take Home) | L4 |
| 5 | 15CS834.5 | Analyze validation and verification of simulation models using different validation models for model building | 10 | Learning / class discussion | Test (Take Home) | L4 |
| - | - | **Total** | **50** | - | - | **L3-L4** |

## 2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to . . .

| Modules | Application Area<br>Compiled from Module Applications. | CO | Level |
|---|---|---|---|
| 1 | Used in manufacturing industry, military, airports, health care, super markets. | CO1 | L4 |
| 2 | Networking, Graph Theory, queuing techniques | CO2 | L3 |
| 3 | Computer programming, Testing of hypothesis, Statistics | CO3 | L4 |
| 4 | Military applications, Organizations | CO4 | L4 |
| 5 | Operations Research | CO5 | L4 |

## 3. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

| - | - | Course Outcomes | Program Outcomes | | | | | | | | | | | | | | - |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Modules | CO.# | **At the end of the course student should be able to . . .** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | Level |
| 1 | 15CS834.1 | Apply the concepts in discrete-event simulation using time scheduling algorithm. | 2.65 | 2.65 | 2.65 | 2.65 | - | 2.5 | - | - | 2.65 | - | - | 2.65 | 2 | | | L4 |
| 2 | 15CS834.2 | Analyze the queuing models using queuing systems. | 2.65 | 2.65 | 2.65 | 2.65 | 2.15 | 2.5 | - | - | 2.65 | - | - | 2.65 | | 2 | | L3 |
| 3 | 15CS834.3 | Generate and test random numbers and random variants and apply them to develop Simulation models. | 2.65 | 2.65 | 2.65 | 2.65 | - | 2.5 | - | - | 2.65 | - | - | 2.65 | | | | L4 |
| 4 | 15CS834.4 | Distinguish between modeling methods that are suitable for discrete-event, and hybrid systems, and apply these methods to simple systems | 2.65 | 2.65 | 2.65 | 2.65 | - | 2.5 | - | - | 2.65 | - | - | 2.65 | | | 2 | L4 |
| 5 | 15CS834.5 | Analyze validation and verification of simulation models using different validation models for model building | 2.65 | 2.65 | 2.65 | 2.65 | - | - | 2.5 | - | 2.65 | - | - | 2.65 | | | 2 | L4 |
| **-** | **15EE662.** | Average | **2.65** | **2.65** | **2.65** | **2.65** | **2.15** | **2.5** | **2.5** | **-** | **2.65** | **-** | **-** | **2.65** | **2** | **2** | **2** | **L3-L4** |
| - | *PO, PSO* | *1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design* | | | | | | | | | | | | | | | | |

## 4. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

| Modules | Gap Topic | Actions Planned | Schedule Planned | Resources Person | PO Mapping |
|---|---|---|---|---|---|
| 1 | Optimizing Automotive Manufacturing Processes with Discrete-Event Simulation | Seminar | 2nd week of May 2020 | Concerned faculty | |
| 2 | Integrating Discrete- | Seminar | 2nd week of May | Concerned faculty | |

| | | | | | |
|---|---|---|---|---|---|
| | Event and Time-Based Models with Optimization for Resource Allocation | | 2020 | | |
| 3 | Modeling Control Logic and Event-Driven Behavior for Early Detection of Communication Latencies | Seminar | 3rd week of May 2020 | Concerned faculty | |
| 4 | Modeling System Architecture and Resource Constraints Using Discrete-Event Simulation | Seminar | 3rd week of May 2020 | Concerned faculty | |
| 5 | Optimizing Automotive Manufacturing Processes with Discrete-Event Simulation | Seminar | 4th week of May 2020 | Concerned faculty | |

# C. COURSE ASSESSMENT

## 1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation.

| Modules | Title | Teach. Hours | No. of question in Exam | | | | | | CO | Levels |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | CIA-1 | CIA-2 | CIA-3 | Asg | Extra Asg | SEE | | |
| 1 | Introduction | 10 | 2 | - | - | 1 | - | 2 | CO1 | L4 |
| 2 | Statistical Models in Simulation | 10 | 2 | - | - | 1 | - | 2 | CO2 | L3 |
| 3 | Random-Number Generation | 10 | - | 2 | - | 1 | - | 2 | CO3 | L4 |
| 4 | Input Modeling | 10 | - | 2 | | 1 | - | 2 | CO4 | L4 |
| 5 | Estimation of Absolute Performance | 10 | - | - | 4 | 1 | - | 2 | CO5 | L4 |
| **-** | **Total** | **50** | **4** | **4** | **4** | **5** | **-** | **10** | **-** | **-** |

## 2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

| Modules | Evaluation | Weightage in Marks | CO | Levels |
|---|---|---|---|---|
| 1, 2 | CIA Exam – 1 | 15 | CO1, CO2 | L4.L3 |
| 3, 4 | CIA Exam – 2 | 15 | CO3, CO4 | L4 |
| 5 | CIA Exam – 3 | 15 | CO5 | L5 |
| | | | | |
| 1, 2 | Assignment - 1 | 05 | CO1, CO2 | L4.L3 |
| 3, 4 | Assignment - 2 | 05 | CO3, CO4 | L4 |
| 5 | Assignment - 3 | 05 | CO5 | L5 |
| | | | | |
| 1, 2 | Seminar - 1 | | - | - |
| 3, 4 | Seminar - 2 | | - | - |
| 5 | Seminar - 3 | | - | - |
| | | | | |
| 1, 2 | Quiz - 1 | | - | - |
| 3, 4 | Quiz - 2 | | - | - |
| 5 | Quiz - 3 | | - | - |
| | | | | |
| 1 - 5 | Other Activities – Mini Project | - | | |

| | Final CIA Marks | | 40 | - |
|---|---|---|---|---|

# D1. TEACHING PLAN - 1

## Module - 1

| Title: | Introduction | Appr Time: | 10 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | **CO** | **Blooms** |
| 1 | Apply the concepts in discrete-event simulation using time scheduling algorithm. | CO2 | L4 |
| | | | |
| **b** | ***Course Schedule*** | - | - |
| **Class No** | **Portion covered per hour** | **-** | **-** |
| **1** | **Introduction:** When simulation is the appropriate tool and when it is not appropriate, Advantages and disadvantages of Simulation; Areas of application | CO1 | L2 |
| 2 | Systems and system environment; Components of a system; Discrete and continuous systems. | CO1 | L2 |
| 3 | Model of a system; Types of Models | CO1 | L4 |
| 4 | Discrete-Event System Simulation Simulation examples: Simulation of queuing systems. | CO1 | L2 |
| 5 | Examples on Simulation of queuing systems. | CO1 | L3 |
| 6 | **General Principles, Simulation Software:** Concepts in Discrete-Event Simulation. | CO1 | L3 |
| 7 | The Event-Scheduling / Time-Advance Algorithm | CO1 | L2 |
| 8 | Problems Using Event-Scheduling / Time-Advance Algorithm | CO1 | L2 |
| 9 | Manual simulation Using Event Scheduling | CO1 | L2 |
| 10 | Problems using Manual simulation | CO1 | L2 |
| | | | |
| **d** | **Review Questions** | | |
| 1 | How can we offset the disadvantages of simulation? | CO1 | L2 |
| 2 | List the application areas/Industry domains of simulation? | CO1 | L2 |
| 3 | What is System and System Environment? | CO1 | L1 |
| 4 | Explain the terms: (a) entity (b) attribute (c) activity (d) event & (e) state in the system simulation context? | CO1 | L2 |
| 5 | Explain and give an example each of continuous and discrete system? | CO1 | L3 |
| 6 | What is Model and Component of the system? | CO1 | L4 |
| 7 | Explain Discrete-event System simulation and Steps in a Simulation Study. | CO1 | L4 |
| | | | |
| **e** | **Experiences** | - | - |
| 1 | | | |
| 2 | | | |

## Module – 2

| Title: | Statistical Models in Simulation | Appr Time: | 10 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | **CO** | **Blooms** |
| 1 | Analyze the queuing models using queuing systems. | CO2 | L3 |
| | | | |
| **b** | ***Course Schedule*** | - | - |
| **Class No** | **Portion covered per hour** | **-** | **-** |
| 11 | **Statistical Models in Simulation** :Review of terminology and concepts, Useful statistical models | | L2 |
| 12 | Discrete distributions. | | L3 |
| 13 | Continuous distributions, Poisson process | | L3 |

| | | | |
|---|---|---|---|
| 14 | Empirical distributions | | L3 |
| 15 | **Queuing Models:** Characteristics of queuing systems | | L3 |
| 16 | Queuing notation | | L3 |
| 17 | Long-run measures of performance of queuing systems | | L3 |
| 18 | Long-run measures of performance of queuing systems cont… | | L3 |
| 19 | Steady-state behavior of M/G/1 queue | | L3 |
| 20 | Networks of queues | | L3 |
| | | | |
| **c** | **Application Areas** | **-** | **-** |
| - | Students should be able employ / apply the Module learnings to . . . | - | - |
| 1 | Usage of Statistical models in Queuing systems for calculating different factors. | CO2 | L3 |
| 2 | Usage of Statistical models in Inventory and supply-chain systems for calculating different factors. | CO2 | L3 |
| | | | |
| **d** | **Review Questions** | - | - |
| 1 | How can we offset the disadvantages of simulation? | CO2 | L2 |
| 2 | List the application areas/Industry domains of simulation? | CO2 | L4 |
| 3 | What is System and System Environment? | CO2 | L2 |
| 4 | Explain the terms: (a) entity (b) attribute (c) activity (d) event & (e) state in the system simulation context? | CO2 | L3 |
| 5 | Explain and give an example each of continuous and discrete system? | CO2 | L2 |
| 6 | What is Model and Component of the system? | CO2 | L4 |
| 7 | Explain Discrete-event System simulation and Steps in a Simulation Study. | CO2 | L2 |
| **e** | **Experiences** | - | - |
| 1 | | | |
| 2 | | | |

# E1. CIA EXAM – 1

## a. Model Question Paper - 1

| Crs Code: | 15CS834 | Sem: | VIII | Marks: | 20 | Time: | 60 Minutes |
|---|---|---|---|---|---|---|---|

Course: System Modeling and Simulation

| - | - | **Note: Answer all questions, each carry equal marks. Module : 1, 2** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | Define the following terms used in simulation :<br>i) Discrete System ii) Continuous System iii) Stochastic System<br>iv) Deterministic System v) Entity vi) Attribute. | 7 | CO1 | L1 |
| | b | What is Simulation? Explain the flowchart of steps involved in simulation study. | 8 | CO1 | L2 |
| | | OR | | | |
| 2 | a | Name the entities, attributes, activities, events and state variables for the systems: i) Rapid Rail ii) Production iii) Communications iv) Inventory | 8 | CO1 | L2 |
| | b | List any four situations when simulation is the appropriate tool and not appropriate tool. | 7 | CO1 | L2 |
| | | OR | | | |
| 3 | a | Describe queuing system with respect to arrival and service mechanisms, system capacity, queue discipline, flow diagrams of arrival and departure events. | 7 | CO2 | L3 |
| | b | Consider the grocery store with one checkout counter. Customer arrives at this checkout counter at random from 1 to 10 mins apart. Service time vary from 1 to 6 mins with probability as shown below. Prepare the simulation table for 10 customers and find out average waiting time of customer in queue, idle time of server and average service time.<br>Service Time : 1,2,3,4,5,6 Probability : 0.05,0.10,0.20,0.30,0.25,0.10<br>RD for arrival: 91,72,15,94,30,92,75,23,30<br>RD for service:84,10,74,53,17,79,91,67,89,38.<br>Assume first customer arrives at t =0 | 8 | CO2 | L4 |

| | | | | | |
|---|---|---|---|---|---|
| | | OR | | | |
| 4 | a | Explain different characteristics of queuing system | 5 | CO2 | L2 |
| | b | What is Poison process? With example explain the properties of poison process. | 10 | CO2 | L3 |

## b. Assignment -1

| Model Assignment Questions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 15CS834 | Sem: | VIII | Marks: | 5 | Time: | |
| Course: | System Modeling and Simulation | | | | | | |

| SNo | Assignment Description | Marks | CO | Level |
|---|---|---|---|---|
| 1 | Define Simulation. Explain when simulation is an appropriate tool . | 5 | CO1 | L2 |
| 2 | Name the entities, attributes, activities, events and state variable for system shown below: a. Library b. Bank | 5 | CO1 | L2 |
| 3 | With a neat flow chart explain in detail about the steps in simulation study. | 5 | CO1 | L1 |
| 4 | Discuss the types of models in a system. | 5 | CO1 | L2 |
| 5 | Define the following<br>i)system ii)entity iii)activity<br>iv)Endogenous event v)Exogenous event vi)State | 5 | CO1 | L3 |
| 6 | A Company uses 6 trucks to haul manganese are from kolar to industry. There are two loaders, to load each truck. After loading, a truck moves to the weighing scale to be weighted. The queue discipline is FIFO. When it is weighted, a truck travels to the industry and returns to the loader queue. The distribution of the loading time, weighing time and travel.<br>Loading time: 10, 5, 5, 10, 15, 10, 10<br>Weigh time: 12, 12, 12, 16, 12, 16<br>Travel time: 60, 10, 40, 40, 80<br>Calculate the total busy time of both loaders, the scale, average loader and scale utilization. Assume 5 trucks are at the loader and one is at the scale, at time "0". Stopping event time TE=64 min. | 6 | CO1 | L4 |
| 7 | The time to failure of a light bulb is weibull distributed with V=1.8·10³ hours. i. What fraction of bulbs are expected to last longer than mean lifetime? ii. What is the Median lifetime of a light bulb? | 5 | CO1 | L4 |
| 8 | Using event scheduling/time advance algorithm generate the system snapshot for the following. Consider a single server queuing system with inter arrival and service time details as shown below.<br>IAT: 3, 2, 6, 2, 4, 5<br>ST: 2, 5, 5, 8, 4, 5<br>Stop simulation when simulation clock reaches 20. | 5 | CO1 | L3 |
| 9 | List the steady state parameters of M\|M\|1 queue | 5 | CO2 | L2 |
| 10 | Explain the queuing notation of the form A\|B\|C\|N\|K | 5 | CO2 | L2 |
| | | | | |

# D2. TEACHING PLAN - 2

## Module – 3

| Title: | Random-Number Generation | Appr Time: | 10 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | **CO** | **Blooms** |
| - | At the end of the topic the student should be able to . . . | - | **Level** |

| | | | |
|---|---|---|---|
| 1 | Generate and test random numbers and apply them to develop Simulation models. | CO3 | L4 |
| | | | |
| **b** | ***Course Schedule*** | | |
| **Class No** | **Portion covered per hour** | **-** | **-** |
| 1 | **Random-Number Generation:** Properties of random numbers, | CO3 | L2 |
| 2 | Generation of pseudo-random numbers | CO3 | L3 |
| 3 | Generation of pseudo-random numbers continued... | CO3 | L3 |
| 4 | Techniques for generating random numbers | CO3 | L4 |
| 5 | Tests for Random Numbers | CO3 | L4 |
| 6 | Tests for Random Numbers Continued | CO3 | L5 |
| 7 | **Random-Variate Generation:** Inverse transform technique, | CO3 | L4 |
| 8 | Inverse transform technique continued | CO3 | L4 |
| 9 | Acceptance-Rejection technique. | CO3 | L4 |
| 10 | Acceptance-Rejection technique. continued | CO3 | L4 |
| | | | |
| **c** | **Application Areas** | **-** | **-** |
| - | Students should be able employ / apply the Module learnings to . . . | - | - |
| 1 | Usage of random numbers in Statistical sampling. | CO3 | L3 |
| 2 | Semiconductor Manufacturing. | CO3 | L4 |
| | | | |
| **d** | **Review Questions** | - | - |
| - | The attainment of the module learning assessed through following questions | - | - |
| 1 | Explain generation of pseudo random numbers with examples. Mention the important considerations in selecting a method for generating random numbers . | CO3 | L4 |
| **2** | Use Chi square test with α=0.05 to test whether data shown below is uniformly distributed or not.<br>Assume critical value $\chi^2_{0.05,9}$=**16.9**<br>*0.34 0.90 0.25 0.89 0.87 0.44 0.12 0.21 0.46 0.67*<br>*0.83 0.76 0.79 0.64 0.70 0.81 0.94 0.74 0.22 0.74*<br>*0.96 0.99 0.77 0.67 0.56 0.41 0.52 0.73 0.99 0.02*<br>*0.47 0.30 0.17 0.82 0.56 0.05 0.45 0.31 0.78 0.05*<br>*0.79 0.71 0.23 0.19 0.82 0.93 0.65 0.37 0.39 0.42*<br>*0.99 0.17 0.99 0.46 0.05 0.66 0.10 0.42 0.18 0.49*<br>*0.37 0.51 0.54 0.01 0.81 0.28 0.69 0.34 0.75 0.49*<br>*0.72 0.43 0.56 0.97 0.30 0.94 0.96 0.58 0.73 0.05*<br>*0.06 0.39 0.84 0.24 0.40 0.64 0.40 0.19 0.79 0.62*<br>*0.18 0.26 0.97 0.88 0.64 0.47 0.60 0.11 0.29 0.78* | CO3 | L4 |
| 3 | Use linear congruential method to generate a sequence of 5 random numbers, with given seed 27, increment 43,and constant multiplier 17, modulus 100. | CO3 | L4 |
| 4 | The sequence of random numbers,0.54, 0.73, 0.98, 0.11,and 0.68 has generated. Use K – S test with α=0.05 to determine if the hypothesis that the numbers are uniformly distributed on the interval [0,1] can be rejected. Take Dα=0.565. | CO3 | L4 |
| 5 | Explain the steps involved in the development of a useful model of input data. | CO3 | L4 |
| | | | |
| **e** | **Experiences** | - | - |
| 1 | | | |
| 2 | | | |

## Module – 4

| Title: | Input Modeling | Appr Time: | 10 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | **CO** | **Blooms** |
| - | At the end of the topic the student should be able to . . . | - | **Level** |
| 1 | Distinguish between modeling methods that are suitable for discrete-event, | CO4 | L4 |

| | | | |
|---|---|---|---|
| | and hybrid systems, and apply these methods to simple systems. | | |
| | | | |
| **b** | ***Course Schedule*** | | |
| **Class No** | **Portion covered per hour** | **-** | **-** |
| 1 | **Input Modeling:** Data Collection; Identifying the distribution with data | CO4 | L2 |
| 2 | Parameter estimation | CO4 | L2 |
| 3 | Goodness of Fit Tests | CO4 | L2 |
| 4 | Fitting a non-stationary Poisson process | CO4 | L3 |
| 5 | Selecting input models without data | CO4 | L4 |
| 6 | Multivariate and Time-Series input models | CO4 | L4 |
| 7 | **Estimation of Absolute Performance:** Types of simulations with respect to output analysis | CO4 | L4 |
| 8 | Stochastic nature of output data | CO4 | L4 |
| 9 | Stochastic nature of output data continued | CO4 | L4 |
| 10 | Measures of performance and their estimation, Contd. | CO4 | L4 |
| | | | |
| **c** | **Application Areas** | **-** | **-** |
| - | Students should be able employ / apply the Module learnings to . . . | - | - |
| 1 | Input models are required to test any simulation system. | CO4 | L2 |
| 2 | Construction Engineering | CO4 | L4 |
| | | | |
| **d** | **Review Questions** | - | - |
| - | The attainment of the module learning assessed through following questions | - | - |
| 1 | Explain the types of simulation with respect to output analysis. Give Examples. | CO4 | L4 |
| 2 | Briefly explain the confidence –interval estimation method. | CO4 | L4 |
| 3 | Explain output analysis for termination simulation. | CO4 | L2 |
| 4 | Explain different steps in the development of useful model of input data with example. | CO4 | L3 |
| 5 | i) Explain different ways to obtain information about a process even if data are not available.<br>ii) Explain different suggested estimates for distribution used in simulation. | CO4 | L2 |
| | | | |
| **e** | **Experiences** | - | - |
| 1 | | | |
| 2 | | | |

# E2. CIA EXAM – 2

## a. Model Question Paper - 2

| Crs Code: | 15CS834 | Sem: | VIII | Marks: | 20 | Time | 60 minutes |
|---|---|---|---|---|---|---|---|
| Course: | | | | | | | |

| - | - | **Note: Answer all questions, each carry equal marks. Module : 3, 4** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | Explain generation of pseudo random numbers with examples. | 5 | CO3 | L2 |
| | b | Use Chi square test with $\alpha$=0.05 to test whether data shown below is uniformly distributed or not.<br>Assume critical value $\mathbf{X^2_{0.05,9}=16.9}$<br>*0.34 0.90 0.25 0.89 0.87 0.44 0.12 0.21 0.46 0.67*<br>*0.83 0.76 0.79 0.64 0.70 0.81 0.94 0.74 0.22 0.74*<br>*0.96 0.99 0.77 0.67 0.56 0.41 0.52 0.73 0.99 0.02*<br>*0.47 0.30 0.17 0.82 0.56 0.05 0.45 0.31 0.78 0.05* | 10 | CO3 | L3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *0.79 0.71 0.23 0.19 0.82 0.93 0.65 0.37 0.39 0.42*<br>*0.99 0.17 0.99 0.46 0.05 0.66 0.10 0.42 0.18 0.49*<br>*0.37 0.51 0.54 0.01 0.81 0.28 0.69 0.34 0.75 0.49*<br>*0.72 0.43 0.56 0.97 0.30 0.94 0.96 0.58 0.73 0.05*<br>*0.06 0.39 0.84 0.24 0.40 0.64 0.40 0.19 0.79 0.62*<br>*0.18 0.26 0.97 0.88 0.64 0.47 0.60 0.11 0.29 0.78* | | | |
| | | | | | | | | | | | | |
| 2 | a | Use linear congruential method to generate a sequence of 5 random numbers, with given seed 27, increment 43,and constant multiplier 17, modulus 100. | | | | | | | | | 5 | CO3 | L2 |
| | b | The sequence of random numbers,0.54, 0.73, 0.98, 0.11,and 0.68 has generated. Use K – S test with α=0.05 to determine if the hypothesis that the numbers are uniformly distributed on the interval [0,1] can be rejected. Take Dα=0.565. | | | | | | | | | 10 | CO3 | L3 |
| | | | | | | | | | | | | |
| 3 | a | Explain acceptance-rejection technique. For poission distribution. Generate 5 poission variates with mean α=0.25 [The random numbers are 0.073 0.0693, 0.945 0.0739 0.014 0.0342 ] | | | | | | | | | 8 | CO4 | L4 |
| | b | Explain inverse transform techniqes of producing random variates for i)Exponential distribution. ii) weibull distribution. | | | | | | | | | 7 | CO4 | L4 |
| | | | | | | | | | | | | |
| 4 | a | Explain the different ways of selecting input model when data is not available | | | | | | | | | 8 | CO4 | L3 |
| | b | Explain the steps involved in the development of a useful model of input data | | | | | | | | | 7 | CO4 | L3 |

## b. Assignment – 2

| Model Assignment Questions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 15CS834 | Sem: | VIII | Marks: | 5 | Time: | |
| Course: | System Modeling and Simulation | | | | | | |

| SNo | Assignment Description | Marks | CO | Level |
|---|---|---|---|---|
| 1 | Explain generation of pseudo random numbers with examples. Mention the important considerations in selecting a method for generating random numbers | 5 | CO3 | L2 |
| 2 | Use linear congruential method to generate a sequence of 5 random numbers, with given seed 27, increment 43,and constant multiplier 17, modulus 100. | 5 | CO3 | L2 |
| 3 | The sequence of random numbers,0.54, 0.73, 0.98, 0.11,and 0.68 has generated. Use K – S test with α=0.05 to determine if the hypothesis that the numbers are uniformly distributed on the interval [0,1] can be rejected. Take Dα=0.565. | 5 | CO3 | L4 |
| 4 | Test whether the 2nd,9th,16th.....Numbers in the following sequence are auto correlated by taking α=0.05.take $Z_{\alpha/2}$=1.96.<br>0.38 0.48 0.36 0.01 0.54 0.34 0.96 0.06 0.61 0.85 0.48 0.86 0.14 0.86 0.89, 0.37 0.49 0.60 0.04 0.83 0.42 0.83 0.37 0.21 0.90 0.89 0.79 0.77 0.99 0.95 0.27, 0.41 0.81 0.96 0.31 0.09 0.06 0.23 0.77 0.73 0.47 0.13 0.55 0.11 0.75 0.36 0.25,<br>0.23 0.72 0.60 0.84 ,070 0.30 0.26 0.38 0.05 0.19 0.73 0.44 | 5 | CO3 | L2 |
| 5 | Discuss different types of continuous distributions | 5 | CO3 | L2 |
| 6 | A Production process manufactures computer chips on | 5 | CO3 | L4 |

| | | | | |
|---|---|---|---|---|
| | the average at 2% non conforming. Everyday, a random sample of size 50 is taken from the process, if the sample contains more than two non conforming chips ,the process will be stopped .compute the probability that the process is stopped by the sampling scheme. | | | |
| 7 | Explain linear congruential method. Write three way of achieving maximal period | 5 | CO3 | L5 |
| 8 | The sequence of random number 0.54,0.73,0.98,0.11 and 0.68 has been generated. Use Kolmogorov—Smiron test with α=0.05 to determine if the hypothesis that the numbers are uniformly distributed on the interval [0,1]can be rejected. Take Dα=0.565. | 5 | CO3 | L2 |
| 9 | What is acceptance rejection technique? Generate three poission variates with mean α=0.2.The random numbers are 0.4347 0.4146 0.8353 0.9952 0.8004 0.7945 0.1530 | 5 | CO3 | L4 |
| 10 | What are pseudo random numbers? What are the problem that occurs while generating pseudo random numbers?Also list the important consideration during generation of random numbers. | 5 | CO3 | L3 |
| 11 | Briefly explain different techniques for generating random numbers. | 5 | CO3 | L4 |
| 12 | Consider the following sequence of five numbers: 0.44 0.81 0.14 0.05 0.93 are generated Kolmogorov—Smiron test with α=0.05 to test the uniformity property of random number generated. | 5 | CO4 | L2 |
| 13 | Explain inverse transform techniques of producing random variates for i)Exponential distribution. ii) weibull distribution. | 5 | CO4 | L3 |
| 14 | Generate three poission variates with mean α=0.2. [The random numbers are 0.4347 0.4146 0.8353 0.9952 0.8004 ] | 5 | CO4 | L2 |
| 15 | Explain the steps involved in the development of a useful model of input data. | 5 | CO4 | L4 |
| 16 | Explain the different ways of selecting input model when data is not available | 5 | CO4 | L4 |

# D3. TEACHING PLAN - 3

## Module – 5

| Title: | Verification, Calibration and Validation | Appr Time: | 10 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | **CO** | **Blooms** |
| - | At the end of the topic the student should be able to . . . | - | **Level** |
| 1 | Analyze validation and verification of simulation models using different validation models for model building | CO5 | L5 |
| | | | |
| **b** | ***Course Schedule*** | - | - |
| **Class No** | **Portion covered per hour** | **-** | **-** |
| 1 | Measures of performance and their estimation, | CO5 | L4 |
| 2 | Output analysis for terminating simulations Continued.., | CO5 | L4 |
| 3 | Output analysis for terminating simulations Continued.., | CO5 | L4 |
| 4 | Output analysis for steady-state simulations. | CO5 | L5 |
| 5 | **Verification, Calibration And Validation:** Optimization: Model building | CO5 | L2 |
| 6 | verification and validation | CO5 | L5 |
| 7 | Verification of simulation models | CO5 | L5 |
| 8 | Verification of simulation models | CO5 | L5 |
| 9 | Calibration and validation of models | CO5 | L5 |
| 10 | Optimization via Simulation | CO5 | L6 |
| | | | |
| **c** | **Application Areas** | **-** | **-** |
| - | Students should be able employ / apply the Module learning to . . . | - | - |
| 1 | Used in Supply chain management systems | CO5 | L4 |
| 2 | Used in inventory modeling systems, Transportation modeling system | CO5 | L5 |

| | | | |
|---|---|---|---|
| **d** | **Review Questions** | - | - |
| - | The attainment of the module learning assessed through following questions | - | - |
| 1 | Write a short note on Optimization via simulation | CO5 | L2 |
| 2 | Explain with neat diagram model building and validation and verification process. | CO5 | L4 |
| 3 | Describe the three steps approach to validation by Naylor and finger | CO5 | L3 |
| 4 | With a neat diagram explain iterative process of calibrating model. | CO5 | L4 |
| 5 | Explain different verification techniques. | CO5 | L4 |
| | | | |
| **e** | **Experiences** | - | - |
| 1 | | CO5 | L2 |
| 2 | | CO5 | L4 |

# E3. CIA EXAM – 3

## a. Model Question Paper - 3

| Crs Code | 15CS834 | Sem: | VIII | Marks: | 20 | Time: | 60 Minutes |
|---|---|---|---|---|---|---|---|
| Course: | | | | | | | |

| - | - | **Note: Answer all questions, each carry equal marks.** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | Test whether the following data follows Poisson distribution using chi-square test of goodness of fit. With mean α=0.05 .Take $\neg^2_{0.05,5}$=11.1 | 8 | CO5 | L3 |
| | b | Explain the suggestions given for use verification process | 7 | CO5 | L2 |
| | | OR | | | |
| 2 | a | Briefly explain the confidence –interval estimation method. | 8 | CO5 | L4 |
| | b | Explain different steps in the development of useful model of input data with example. | 7 | CO5 | L2 |
| | | | | | |
| 3 | a | Explain output analysis for steady-state simulations | 15 | CO5 | L5 |
| | | OR | | | |
| 4 | a | Explain with neat diagram model building and validation and verification process. | 8 | CO5 | L5 |
| | b | Describe the three steps approach to validation by Naylor and finger | 7 | CO5 | L5 |
| | | | | | |

## b. Assignment – 3

| Model Assignment Questions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 17IS63 | Sem: | VI | Marks: | 30 | Time: | 75 Minuts |
| Course: | | | | | | | |

| **SNo** | **Assignment Description** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|
| 1 | Explain acceptance - rejection technique. for Poisson distribution. Generate 5 Poisson variates with mean α=0.25 [The random numbers are 0.073 0.0693, 0.945 0.0739 0.014 0.0342 ] | 5 | CO5 | L5 |
| 2 | Test whether the following data follows Poisson distribution using chi-square test of goodness of fit. With mean α=0.05 .Take $\neg^2_{0.05,5}$=11.1 | 5 | CO5 | L3 |
| 3 | Describe initialization bias in steady state simulation. | 5 | CO5 | L3 |
| 4 | Explain with a neat diagram verification of simulation model.. | 5 | CO5 | L3 |
| 5 | Describe with a neat diagram iterative process of calibrating a model. | 5 | CO5 | L3 |

| Arrival/period | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 12 | 10 | 19 | 17 | 10 | 8 | 7 | 5 | 5 | 3 | 3 | 1 |

| | | | | |
|---|---|---|---|---|
| | Which are three steps that aid in the validation process? | | | |
| 6 | Explain with a neat diagram model building, verification and validation process | 5 | CO5 | L3 |
| 7 | Describe the three steps approach to validation by Naylor and Finger. | 5 | CO5 | L2,L3 |
| 8 | Explain with a neat diagram model building, verification and validation. | 5 | CO5 | L3 |
| 9 | Write short note on Optimization via simulation | 5 | CO5 | L3 |
| 10 | What is model reasonableness & explain how current contents and total count can verify it? | 5 | CO5 | L3 |
| 11 | Briefly explain the validation of input-output transformations of the model and the various techniques used? | 5 | CO5 | L3 |
| 12 | Explain calibration and validation of models | 5 | CO5 | L4 |

# F. EXAM PREPARATION

## 1. University Model Question Paper

| Course: | | System Simulation and Modeling | | | | | Month / Year | May /2020 | |
|---|---|---|---|---|---|---|---|---|---|
| Crs Code: | | 15CS834 | Sem: | VIII | Marks: | 80 | Time: | 180 minutes | |
| Module | | Answer all FIVE full questions. All questions carry equal marks. | | | | | **Marks** | **CO** | **Level** |
| 1 | a | *Define Simulation, Simulation model, entities, Measures-of-performance and activities.* | | | | | 06 | CO1 | L1 |
| | b | *List at least five circumstances where the simulation is appropriate tool and not appropriate* | | | | | 05 | CO1 | L2 |
| | c | *Explain the Concept of system with any one live Example.* | | | | | 05 | CO1 | L1 |
| | | or | | | | | | | |
| 2 | a | *Discuss the various types of models of a System* | | | | | 06 | CO1 | L4 |
| | b | *What is System and System environment? Explain the components of a system with Examples?* | | | | | 10 | CO1 | L4 |
| | | | | | | | | | |
| 3 | a | Six dump trucks are used to haul coal from the entrance of a mine to rail road. Each truck is loaded by one of two loaders. After loading, a truck immediately moves to the scale, to be weighed as soon as possible. Both the loaders and the scale have a first –come first served waiting line for trucks. Travel time from a loader to scale is considered negligible. After being weighed a truck begins travel time (during which time truck uploads) and then afterwards returns to the loader queue. The activities of loading time, weighing time and travel time are given in the following table.<br>Loading Time 10 5 5 10 15 10 10<br>Weighing Time 12 12 12 16 12 16<br>Travel Time 60 100 40 40 80<br>End of simulation is completion of two weightings from the scale. Depict the simulation table and estimate the loader and scale utilization. Assume that five of the trucks are at the loaders and one is at the scale at time 0. | | | | | 10 | CO2 | L2 |
| | b | What are the two categories of activities? Explain the three phases of activity scanning approach? | | | | | 06 | CO2 | L4 |
| | | or | | | | | | | |
| 4 | a | *For the above Dump Truck problem Calculate the Total busy time of both the loaders of the scale average loader and scale utilization. Assume 5 Trucks are at the loaders and one is at the scale at time '0' stopping time TE=64 min* | | | | | 12 | CO2 | L3 |
| | b | *Briefly define any five concepts used in discrete event simulation.* | | | | | 04 | CO2 | L4 |
| | | | | | | | | | |
| 5 | a | Consider the grocery store with one checkout counter. Customer arrives | | | | | 08 | CO3 | L2 |

| | | | | | |
|---|---|---|---|---|---|
| | | at this checkout counter at random from 1 to 10 mins apart. Service time vary from 1 to 6 mins with probability as shown below. Prepare the simulation table for 10 customers and find out average waiting time of customer in queue, idle time of server and average service time.<br>Service Time : 1,2,3,4,5,6 Probability : 0.05,0.10,0.20,0.30,0.25,0.10<br>RD for arrival: 91,72,15,94,30,92,75,23,30<br>RD for service:84,10,74,53,17,79,91,67,89,38.<br>*Assume first customer arrives at t =0.* | | | |
| | b | Discuss in detail about the various elements of any general Queuing system. Further explain the need for simulation in this environment and the various measures used to evaluate the system. | 08 | CO3 | L2 |
| | | or | | | |
| 6 | a | Use the Linear consequential method to generate a sequence of four two-digit random numbers with X0=27,α=17,C=43 and m=100. What the effect of FIFTH two digit random integer on the above numbers. | 10 | CO3 | L2,L2 |
| | b | Mention the important considerations for the selection of routines to generate random numbers | 06 | CO3 | L4 |
| | | | | | |
| 7 | a | Discuss how the sample mean is estimated under normal and POISSION distributions. | 10 | CO4 | L2 |
| | b | Explain how the method of histograms can be used to identify the shape of a distribution. | 06 | CO4 | L3 |
| | | or | | | |
| 8 | a | With Examples Explain output analysis. | 10 | CO4 | L5 |
| | b | Discuss in brief the output analysis for steady-state simulations. | 06 | CO4 | L3 |
| | | | | | |
| 9 | a | Explain the types of simulation with respect to output analysis. Give at least two Examples. | 10 | CO5 | L3 |
| | b | Briefly discuss the commonly used methods in the verification process. | 06 | CO5 | L3 |
| | | or | | | |
| 10 | a | Explain calibration and validation of models. | 06 | CO5 | L2,L3 |
| | b | Explain in Detail about the model building, Verifying and validation in the model building process through a diagram? | 10 | CO5 | L3 |
| | | | | | |

## 2. SEE Important Questions

| Course: | | System Simulation and Modeling | | | | | Month / Year | May/2020 | |
|---|---|---|---|---|---|---|---|---|---|
| Crs Code: | | 15CS834 | Sem: | VIII | Marks: | 80 | Time: | 180 Minutes | |
| | **Note** | Answer all FIVE full questions. All questions carry equal marks. | | | | | - | - | |
| Module | Qno. | Important Question | | | | | **Marks** | **CO** | **Year** |
| 1 | 1 | What is System and System Environment? | | | | | 04 | CO1 | 2016 |
| | 2 | What are advantages And Disadvantages of Simulation? | | | | | 05 | CO1 | 2016 |
| | 3 | Explain the terms: (a) entity (b) attribute (c) activity (d) event & (e) state in the system simulation context? | | | | | 10 | CO1 | 2017 |
| | 4 | Explain the concept of Discrete-Event Simulation. | | | | | 08 | CO1 | 2017 |
| | 5 | Explain in detail the event scheduling/time advance algorithm. | | | | | 10 | CO1 | 2017 |
| | | | | | | | | | |
| 2 | 1 | Find mean and variance of the die tossing experiment . Assume the die is loaded so that the probability that given face land up proportional to the number of spots showing . | | | | | 10 | CO2 | 2016 |
| | 2 | The time to failure of a light bulb is weibull distributed with V=1.8.$10^3$ hours.<br>i. What fraction of bulbs are expected to last longer than mean lifetime? | | | | | 10 | CO2 | 2016 |

| | | | | | |
|---|---|---|---|---|---|
| | | ii. What is the Median lifetime of a light bulb? | | | |
| | 3 | Explain the properties of poison process. | 6 | CO2 | 2018 |
| | 4 | Explain the characteristics of Queuing System. List different queuing notations. | 12 | CO2 | 2018 |
| | 5 | List the Steady State Parameters of M\|M\|1 queue | 05 | CO2 | 2018 |
| | | | | | |
| 3 | 1 | Explain the generation of Pseudo-random Numbers. | 06 | CO3 | 2016 |
| | 2 | Explain the combined linear congruential random number generation method? | 07 | CO3 | 2016 |
| | 3 | Generate a sequence of 15 random numbers for which seed is 342, constant multiplier is 20, increment is 45 and modulus is 30 | 08 | CO3 | 2017 |
| | 4 | What is inverse transform technique? Explain how it is used for producing random variants for exponential distribution and uniform distribution. | 08 | CO3 | 2014 |
| | 5 | With example explain the various types of discrete distributions. | 10 | CO3 | 2018 |
| | | | | | |
| 4 | 1 | State the four steps involved in the development of an input model? | 07 | CO4 | 2018 |
| | 2 | Explain identifying the distribution with data with example. | 08 | CO4 | 2014 |
| | 3 | Define co variance & correlation? | 05 | CO4 | 2016 |
| | 4 | What are the types of simulations with respect to output analysis? | 05 | CO4 | 2014 |
| | 5 | Explain stochastic nature of output data with example. | 10 | CO4 | 2017 |
| | | | | | |
| 5 | 1 | Explain how probabilities and quantiles can be estimated from summary data? | 07 | CO5 | 2016 |
| | 2 | With illustrative examples explain output analysis of steady-state simulations. | 10 | CO5 | 2017 |
| | 3 | How model can be build verification and validate? Explain with diagram. | 06 | CO5 | 2017 |
| | 4 | Describe in detail the three step approach for model validation? | 07 | CO5 | 2016 |
| | 5 | Briefly explain the validation of input-output transformations of the model and the various techniques used? | 06 | CO5 | 2015 |

# Course Outcome Computation

**Academic Year:**

**Odd / Even semester**

| **INTERNAL TEST** | | | **T1** | | | | | | **T2** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcome** | | **CO1** | | **CO2** | | **CO3** | | **CO4** | | **CO5** | | **CO6** | |
| **QUESTION NO** | | **Q1** | **LV** | **Q2** | **LV** | **Q3** | **LV** | **Q1** | **LV** | **Q2** | **LV** | **Q3** | **LV** |
| MAX MARKS | | | | | | | | | | | | | |
| USN-1 | | | | | | | | | | | | | |
| USN-2 | | | | | | | | | | | | | |
| USN-3 | | | | | | | | | | | | | |
| USN-4 | | | | | | | | | | | | | |
| USN-5 | | | | | | | | | | | | | |
| USN-6 | | | | | | | | | | | | | |
| Average Attainment | CO | 2.5 | | 2.75 | | 2.33 | | 3 | | 3 | | 1.5 | |

**LV Threshold : 3:>60%, 2:>=50% and <=60%, 1: <=49%**
**CO1 Computation :(2+2+2+3)/4 = 10/4=2.5**

# PO Computation

| Program Outcome | | PO1 | | PO3 | | PO3 | | PO1 | | PO12 | | PO12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weight of CO - PO | | 3 | | 1 | | 3 | | 2 | | 2 | | 3 | |
| Course Outcome | | CO1 | | CO2 | | CO3 | | CO4 | | CO5 | | CO6 | |
| Test/Quiz/Lab | | T1 | | | | | | T2 | | | | | |
| QUESTION NO | | Q1 | LV | Q2 | LV | Q3 | LV | Q1 | LV | Q2 | LV | Q3 | LV |
| MAX MARKS | | | | | | | | | | | | | |
| USN-1 | | | | | | | | | | | | | |
| USN-2 | | | | | | | | | | | | | |
| USN-3 | | | | | | | | | | | | | |
| USN-4 | | | | | | | | | | | | | |
| USN-5 | | | | | | | | | | | | | |
| USN-6 | | | | | | | | | | | | | |
| Average Attainment | CO | | | | | | | | | | | | |