ALVA'S INSTITUTE OF ENGINEERING & ECHNOLOGY
Shobhavana Campus, Mijar, Moodbidri, D.K – 574225
Phone: 08258-262725, Fax: 08258-262726

COURSE - FILE

Information Science and Engineering

Course Name : System Modelling & Simulation (18CS834)

Class : 8th Sem

Academic Year : 2020-21 (Even Sem)

Mr.Jayantkumar A Rathod
Associate Professor

Alva's Institute of Engineering & Technology
Shobhavana Campus, Mijar, Moodbidri, D.K - 574225
Phone: 08258 262725, Fax: 08258-262726

INSTITUTION VISION STATMENT and MISSION STATMENT

VISION STAMENT

"Transformative education by pursuing excellence in engineering and management through enhancing skills to meet the evolving needs of the community"

MISSION STATMENTS

- To bestow quality technical education to imbibe knowledge, creativity and ethos to students community
- To inculcate the best engineering practices through transformative education.
- To develop a knowledgeable individual for a dynamic industrial scenario.
- To inculcate research, entrepreneurial skills and human values in order to cater the needs of the society.

HOD 22/6
H. O. D.
Dept. Of Information Science & Engineering
Alva's Institute of Engg. & Technology
Mijar, MOODBIDRI - 574 225

Dr. Dattathreya
NBA Coordinator

Dr. Peter Fernandes
Principal

PRINCIPAL
Alva's Institute of Engg. & Technology,
Mijar, MOODBIDRI - 574 225, D.K.

Alva's Institute of Engineering & Technology

Shobhavana Campus, Mijar, Moodbidri, D K - 574225

Phone: 08258 262725, Fax: 08258 262726

PEOs and PSOs

DEPARTMENT OF INFORMATION SCIENCE & ENGINEERING

Program Educational Objectives (PEOs)

Graduates of the program will be able to,

1. Apply the principles of fundamental mathematics and Information Science & engineering to provide solutions to the real time problems.
2. Pursue higher education and engage in research to meet the challenges of the latest technologies.
3. Design and develop reliable software systems to satisfy the industrial needs through multidisciplinary projects.
4. Able to work in various IT related fields and contribute to the society.

Program Specific Outcomes (PSOs)

1. Apply the knowledge of computer networking, database and computations to provide the solutions to the real-world engineering problems.
2. Design, develop, test and maintain the software systems that satisfy the needs of the IT industry.
3. Develop programs and projects using modern software tools for industrial & scientific applications.

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ALVA'S INSTITUTE OF ENGINEERING & TECHNOLOGY

(A Unit of Alva's Education Foundation)

Shobhavana Campus, Mijar-574225, Moodbidri, D.K

Phone: 08258-262725, Fax: 08258-262726

Affiliated to VTU Belagavi and Approved by AICTE, New Delhi, Recognized by Govt. of Karnataka

CALENDAR OF EVENTS (EVEN SEMESTER 2020-21) BE & MBA

VISION

"Transformative education by pursuing excellence in Engineering and Management through enhancing skills to meet the evolving needs of the community"

MISSION

- To bestow quality technical education to imbibe knowledge, creativity and ethos to students community
- To inculcate the best engineering practices through transformative education
- To develop a knowledgeable individual for a dynamic industrial scenario
- To inculcate research, entrepreneurial skills and human values in order to cater the needs of the society

Week	Month	Days							Activities
		Mon	Tue	Wed	Thu	Fri	Sat	Sun	
1	APR				1	2	3	4	19th : Commencement of IV, VI,VIII - Sem BE 5TH : Commencement of IV - Sem MBA 2nd : Good Friday 13th : Ugadi 14th : Ambedkar Jayanthi
2		5	6	7	8	9	10	11	
3		12	13	14	15	16	17	18	
4		19	20	21	22	23	24	25	
5		26	27	28	29	30			
6	MAY						1	2	1ST: May Day/ Labour Day. 10th, 11th, 12th: Project Evaluation – Phase-II. 14th: Khutub-E-Ramzan. 24th, 25th, 26th: I-IA Test for IV, VI, VIII–Sem BE & IV - Sem MBA. 31st: Submission of Review Paper.
7		3	4	5	6	7	8	9	
8		10	11	12	13	14	15	16	
9		17	18	19	20	21	22	23	
10		24	25	26	27	28	29	30	
11		31							
11	JUNE		1	2	3	4	5	6	17th, 18th, 19th: II-IA Test for VIII–Sem BE and IV - Sem MBA. 24th, 25th, 26th: Project Evaluation – Phase-III. 30th: Last date for Draft copy of Project Report Submission.
12		7	8	9	10	11	12	13	
13		14	15	16	17	18	19	20	
14		21	22	23	24	25	26	27	
15		28	29	30					
15	JULY				1	2	3	4	1st, 2nd, 3rd: Final Year Project Exhibition. 1st, 2nd,3rd : II-IA Test for IV, VI–Sem BE. 5th: Last date for Final Project Report Submission. 15th, 16th, 17th : III- IA test for VIII–Sem BE & IV sem MBA. 20th : Last Working Day - VIII - Sem BE. 21th : Bakrid 24th : Last working day for IV - Sem MBA.
16		5	6	7	8	9	10	11	
17		12	13	14	15	16	17	18	
18		19	20	21	22	23	24	25	
19		26	27	28	29	30	31		
20	AUG							1	2nd, 3rd , 4th : III-IA Test for IV, VI–Sem BE 7th : Last Working Day - IV,VI- Sem BE 20th : Last Day of Moharam
21		2	3	4	5	6	7	8	
22		9	10	11	12	13	14	15	
23		16	17	18	19	20	21	22	
24		23	24	25	26	27	28	29	
25		30	31						

Approved by IQAC Chairman

ALVA'S INSTITUTE OF ENGINEERING & TECHNOLOGY

Shobhavana Campus, Mijar, Moodbidri, D.K – 574225
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DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

ONLINE TIME TABLE

Academic Year	Scheme			Semester	Section		Room No	Class Coordinator	
2020-21	2015/2017			VIII	A		ONLINE	MR. PRADEEP NAYAK	
Time / Day	9.00 To 9.55	9.55 To 10.50	10.50 To 11.10	11.10 To 12.05	12.05 To 01.00	1.00 To 2.00	2.00 To 3.00	3.00 To 4.00	4.00 To 5.00
MON	IOT	SMS	BREAK	SEMINAR		LUNCH	BDA	PROJECT	
TUE	SMS	BDA		PROJECT			IOT	PROJECT	
WED	BDA	SMS		PROJECT			IOT	INTERNSHIP	
THU	SMS	IOT		SEMINAR			BDA	SEMINAR	
FRI	IOT	SMS		PROJECT			SEMINAR		
SAT	SEMINAR				BDA				

Allocation of Subjects

Subjects			NAME OF THE FACULTY	FACULTY CODE
15/17CS 81	IOT	Internet of Things and Applications	Mr. Nagesh U B	NUB
15/17CS 82	BDA	Big Data Analytics	Dr. Kiran Malagi	KM
15/17CS 834	SMS	System Modeling and Simulation	Mr. Jayantkumar A R	JAR
15/17IS84	INT	Internship/Professional Practice	Mr. Sharan L Pais	SLP
15/17ISP 85	PWP	Project Work Phase II	Dr. Kiran Malagi	KM
15/17ISS 86	SM	Seminar	Mr. Jayantkumar A R	JAR
		Project	Project Guide	

TIME TABLE COORDINATOR H.O.D. ACCADEMIC COORDINATOR PRINCIPAL

Dept. Of Information Science & Engineering
Institute of Engg. & Technology

SYSTEM MODELLING AND SIMULATION
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2017 - 2018)
SEMESTER – VIII

Subject Code	17CS834	IA Marks	40
Number of Lecture Hours/Week	3	Exam Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Module – 1	**Teaching Hours**
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	**08 Hours**
Module – 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,	**08 Hours**
Module – 3	
Random-NumberGeneration: Properties of random numbers; Generation of pseudo-random numbers, Techniques for generating random numbers,Tests for Random Numbers, **Random-Variate Generation:** ,Inverse transform technique Acceptance-Rejection technique.	**08 Hours**
Module – 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..**	**08 Hours**
Module – 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.	**08 Hours**
Course outcomes: The students should be able to:	
• Explain the system concept and apply functional modeling method to model the	

activities of a static system

- Describe the behavior of a dynamic system and create an analogous model for a dynamic system;
- Illustrate the operation of a dynamic system and make improvement according to the simulation results.

Question paper pattern:

The question paper will have ten questions.
There will be 2 questions from each module.
Each question will have questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation, 5 th Edition, Pearson Education, 2010.

Reference Books:

1. Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006.
2. Averill M. Law: Simulation Modeling and Analysis, 4 th Edition, Tata McGraw-Hill, 2007

ALVA'S Education Foundation

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Department of Information Science and Engineering

SEMESTER VIII

Course Code: **17CS834** | Course Name: **System Modelling and Simulation**

Course Teacher: **Mr.Jayantkumar A Rathod**

Course Outcomes: After studying this course, students will be able to:

CO Numbers	Course Outcomes	Blooms Level	Target Level
17CS834.1	**Understand** the system concept and apply functional modeling method to model the activities of a static system	Understand (L2)	2
17CS834.2	**Explain** the behavior of a dynamic system and create an analogous model for a dynamic system;	Understand (L2)	2
17CS834.3	**Experiment with** the operation of a dynamic system and make improvement according to the simulation results.	Apply (L3)	2

CO-PO/CO-PSO Mapping Matrix:

CO Numbers	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
17CS834.1	2	2	1	1										2	1
17CS834.2	2	2	1	1										2	1
17CS834.3	2	2	2	1	2									2	1
Average	2	2	1.3	1	2									2	1

CO-PO/CO-PSO Mapping Matrix Justification : The students should be able

CO Numbers	PO/ PSO Numbers	Justification
17CS834.1	PO1	To apply the knowledge of mathematics and engineering fundamentals moderately to model the activities of a static system
	PO2	To identify and model the behaviour of a static system moderate
	PO3	To design model for both static systems moderately
	PO4	To explain the functional modeling method to model the activities of a static system by investigating complex problems
	PSO2	To solve real world problems by suitable modelling method in high level
	PSO3	To develop moderate level skills needed to pursue career in IT sector
17CS834.2	PO1	To apply the knowledge of mathematics and engineering fundamentals moderately to model the activities of a dynamic system
	PO2	To moderately identify and model the behaviour of a dynamic system
	PO3	To design model for dynamic systems moderately
	PO4	To explain the functional modeling method to model the activities of a dynamic system by investigating complex problems
	PSO2	To solve real world problems by suitable modelling method in high level
	PSO3	To develop moderate level skills needed to pursue career in IT sector

17CS834.3	PO1	To apply the knowledge of mathematics and engineering fundamentals moderately to perform the simulation
	PO2	To identify and model the operation of a dynamic system moderate
	PO3	To design model for the operation of a dynamic system and make improvement according to the simulation results
	PO4	To explain the operation of a dynamic system and make improvement according to the simulation results by investigating complex problems
	PO5	To use simulation tool to moderately Experiment with the operation of a dynamic system
	PSO2	To solve real world problems by suitable modelling method in high level
	PSO3	To develop moderate level skills needed to pursue career in IT sector

Course Teacher
Signature with date

IQAC Member
Signature with date

IQAC Chairman
Signature with date

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DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

Student List VIII Semester Academic Year 2020-21

SN	USN	NAME	SCHEME
1	4AL15IS014	MANTHAN A.B	2015
2	4AL15IS028	PRATHIKSHA PATKAR	2015
3	4AL15IS034	REKHA HALLI	2015
4	4AL16IS004	ANJU D R	2015
5	4AL16IS022	KEERTHANA S	2015
6	4AL16IS058	VARADA	2015
7	4AL16IS064	MAHIMA R	2015
8	4AL17IS001	AHIMSA JAIN	2017
9	4AL17IS002	AKSHATA L HEGDE	2017
10	4AL17IS003	AKSHATHA A M	2017
11	4AL17IS004	AKSHITA A POOJARY	2017
12	4AL17IS005	ALBIN GEORGE	2017
13	4AL17IS006	AMIN VISHAK DINESH	2017
14	4AL17IS007	ANJALI C J	2017
15	4AL17IS009	ASHWINI	2017
16	4AL17IS010	ASHWITHA R SALIAN	2017
17	4AL17IS012	DANUSH KUMAR	2017
18	4AL17IS014	DIKSHIT GOVIND KOTIAN	2017
19	4AL17IS015	DIVYASHREE	2017
20	4AL17IS016	GANGOTHRI N V	2017
21	4AL17IS021	KARUNA N	2017
22	4AL17IS022	KAVYASHREE S	2017
23	4AL17IS023	KSHAMA	2017
24	4AL17IS024	KUNDER MAYURESH RAGHUNATHA	2017
25	4AL17IS025	LOKESH P	2017
26	4AL17IS026	MANISH R	2017
27	4AL17IS027	MELODY NAOREM	2017
28	4AL17IS028	METHISH R	2017
29	4AL17IS030	NANDA KISHORE V	2017
30	4AL17IS031	NAVYA POOJARY	2017
31	4AL17IS032	NIKITHA SHETTY	2017

32	4AL17IS033	PAVAN Y N	2017
33	4AL17IS034	PRASHANTH REDDY C	2017
34	4AL17IS035	PRIYA	2017
35	4AL17IS036	RACHANA SHETTY	2017
36	4AL17IS037	RACHITHA SHETTY	2017
37	4AL17IS040	ROOPASHREE J	2017
38	4AL17IS043	SHETTY RACHANA CHANDRASHEKAR	2017
39	4AL17IS045	SHREYAS H E	2017
40	4AL17IS048	SRIHARI B	2017
41	4AL17IS050	T K HARSHITH PRASAD	2017
42	4AL17IS051	THANGSABAM BIKUMAR SINGH	2017
43	4AL17IS053	ZEENAL MANOLA LOBO	2017
44	4AL17IS054	CHAITANYA B N	2017
45	4AL17IS055	NAGASHREE S	2017
46	4AL17IS056	MELISHA D SOUZA	2017

HoD, Dept. of ISE
(Prof. Sudheer Shetty)

USN | | | | | | | | | | |

Alva's Institute of Engineering & Technology, Moodbidri

Department of Information Science & Engineering

Continuous Internal Evaluation Test-I EVEN Semester 2020-21

Course Title : SYSTEM MODELLING & SYMULATION		Course Code: 17CS834
Date: 19/06/2021	Time: 10.00 AM- 11.00 AM	Semester: VIII
Faculty: Mr.Jayantkumar A Rathod		Max. Marks: 30

Note: Answer ALL the questions.

Q. No.		Questions	Marks	COs	BTL
		Module 1 & 3			
1	a)	i) Consider the activity times required for Dump-Truck problem as shown below.	08	CO1	L2

Loading Time	10	5	10	10	5	10	5
Weighing Time	12	16	12	12	16	12	12
Travel Time	40	60	40	80	100	40	

Six dump trucks are used to haul coal from entrance of a small mine to a railroad. Assume that there are three trucks at the loader queue and two trucks at the loader. One truck is at the scale for weighing purpose. After weighing a truck begins a travel time and then returns to the loader queue. Show the simulation table and estimate the loader and scale utilization. Stop the simulation after 8 iteration are completed.

		b)	Explain the Kolmogorov-Smirnov test with steps. Consider the sequence of random numbers generated : 0.54 , 0.73 , 0.98 , 0.11 , 0.68 . Use Kolmogorov-Smirnov test with α=0.05 to determine if the hypothesis that the numbers are uniformly distributed or not. Take D_α=0.565.	07	CO1	L3
		Module 1 & 3			
2	a)	Consider the inter arrival times and service times as shown below for a single-channel counter simulation.	08	CO2	L3

Inter arrival Times	1	2	4	5	6	3	7	4	2
Service Times	3	3	4	5	2	1	2	6	3

Calculate the parameters S , N_D & F. Determine the average response time and proportion of customers who spent 5 or more minutes in the system.

		b)	What is Acceptance-Rejection technique ? Write the steps for generating Poisson variates. Generate three Poisson variates with mean α=0.2. The random numbers are 0.434 ,0.4146, 0.8353 , 0.9952, 0.8004 , 0.7945 , 0.1530.	07	CO2	L3

Levels of Bloom's Taxonomy

No.	L1	L2	L3	L4	L5	L6
Level	Remember	Understand	Apply	Analyze	Evaluate	Create

Course Outcomes

CO1	Explain the system concepts and apply functional modeling method to model the activities of a static system.	L3
CO2	Describe the behavior of a dynamic system and create an analogous model for a dynamic system.	L3
CO3	Illustrate the operations of a dynamic system and make improvement according to the simulation results.	L3

~~STATS · ASSIGNMENT ~~

STATS QA-1 Scheme & Evaluation

1 B] Kolmogorov - Smirnov test.

Steps : 1) Rank the data from smallest to largest. Let R(i) denote the i th smallest observation, so that

$$R(1) \quad R(2) \ldots . \quad R(N)$$

2) Compute

$$D^+ = \max_{1 \le i \le n} \left\{ \frac{i}{N} - R(i) \right\}$$

$$D^- = \max_{1 \le i \le n} \left\{ R(i) - \frac{i-1}{N} \right\}$$

3) Compute $D = \max(D+, D-)$

4) Determine the critical value D, from table for the specified specificance level and the given sample size N.

5) $D \le Da$ Accept : No difference b/w $S_N(x)$ and $F(x)$.

$D > Da$ Reject : No difference b/w $S_N(x)$ and $F(x)$.

i	Ri	$\frac{i}{N}$	$\frac{i-1}{N}$	D+ $\frac{i}{N} - Ri$	D- $Ri - \left(\frac{i-1}{N}\right)$
1	0.11	0.20	0	0.09	0.11
2	0.54	0.40	0.20	-	0.34
3	0.68	0.60	0.40	-	0.28
4	0.73	0.80	0.60	0.07	0.13
5	0.98	1	0.80	0.02	0.18

Compute $D = \max(D^+, D^-)$

$D = \max(0.09, 0.34)$

$D = 0.34$

Check = $D > Da$, if reject

$= 0.34 < 0.565$.

As $D < Da$, Hypothesis is accepted.

2.

b) Acceptance - Rejection technique.

Step 1 → Generate a random number $R \sim U[0,1]$

Step 2 → If $R \geq 1/4$, accept $X = R$.

Step 3 → If $R < 1/4$, reject R, return to step 1.

Poison Distribution: A poisson random variable, N, with mean $a > 0$ has pmf.

$$P(n) = P(N = n) = \frac{e^{-a} \alpha^n}{n!}, \quad n = 0, 1, 2, \ldots$$

a)

$$N = n \iff \sum_{i=1}^{n} A_i \leq 1 < \sum_{i=1}^{n+1} A_i.$$

$$\sum_{i=1}^{n} A_i \leq 1 < \sum_{i=1}^{n+1} A_i \iff \sum_{i=1}^{n} -\frac{1}{\alpha} \ln R_i \leq 1 < \sum_{i=1}^{n+1} -\frac{1}{\alpha} \ln R_i$$

$$\iff \prod_{i=1}^{n} R_i \geq e^{-a} > \prod_{i=1}^{n+1} R_i.$$

Steps:

1> Set $n = 0$, and $P = 1$.

2> Generate a random number R_{n+1} and let $P = P \cdot R_{n+1}$

3> If $P < e^{-}$, then accept $N = n$. Otherwise reject current n, increase n by one, and return to step

Mean $\alpha = 0.2$.

Step 1 : Set $n = 0$, $P = 1$.

Step 2 : $R_1 = 0.435$, $P = 1 * R_1 = 0.4357$.

Step 3 : Since $P = 0.435 < e^{+} = 0.8187$, accept $N = 0$,

Repeat Above procedure.

n	R_{n+1}	P	accept/reject	Result
0	0.435	0.435	$P < e^{-\alpha}$ (accept)	N = 0
0	0.4146	0.4146	$P < e^{-\alpha}$ (accept)	N = 0
0	0.8353	0.8353	$P \geq e^{-\alpha}$ (reject)	
1	0.9952	0.8313	$P \geq e^{-\alpha}$ (reject)	
2	0.8004	0.6654	$P < e^{-\alpha}$ (accept)	N = 2.

Loading Time	10	5	10	10	5	10	5
weighing Time	12	16	12	12	16	12	12
Travel time	40	60	40	80	100	40	

LQ(t) : No. of trucks in loader queue.

L(t) : No. of trucks being loaded

WQ(t) : No. of trucks in weighing queue.

w(t) : No. of trucks being weighted.

ALQ : Arrives at loader queue.

EL : End loading

DT : Dump trucks

EW : End weighing

CLK	LQ(t)	L(t)	WQ(t)	W(t)	FEL	BL	BS
0	3	2	0	1	(EW, 12, T1) (EL, 10, T2) (EL, 5, T3)	0	0
5	2	2	1	1	(EW, 12, T1) (EL, 10, T2) (EL, 15, T4)	10	5
10	1	2	2	1	(EW, 12, T1) (EL, 15, T4) (EL, 20, T5)	20	10
12	1	2	1	1	(EW, 12+16, T3) (EL, 15, T4) (EL, 20, T5) (ALQ, 52, T1)	24	12
15	0	2	2	1	(EL, 20, T5) (EW, 28, T3) (ALQ, 52, T1) (EL, 15+5, T6)	30	15
20	0	1	3	1	(EL, 20, T6) (EW, 28, T3) (ALQ, 52, T1)		
20	0	0	4	1	(EW, 28, T3) (ALQ, 52, T1)		
28	0	0	3	1	(ALQ, 52, T1) (ALQ, 80, T3) (EW, 32, T2)		

USN | | | | | | | | | | |

Alva's Institute of Engineering & Technology, Moodbidri

Department of Information Science & Engineering

Continuous Internal Evaluation Test-II EVEN Semester 2020-21

Course Title : SYSTEM MODELLING & SYMULATION		Course Code: 17CS834
Date: 10/07/2021	Time: 10.00 AM- 11.00 AM	Semester: VIII
Faculty: Mr.Jayantkumar A Rathod		Max. Marks: 30

Note: Answer ALL the questions.

Q. No.		Questions	Marks	COs	BTL
		Module 4 & 5			
1	a)	Let X_1 represent the average lead time (in months) to deliver, and X_2 represent the annual demand for industrial robots. The following data are available on demand and lead time for the last ten years : Lead Time: 7.3, 6.8, 4.7, 5.7, 3.8, 4.9, 6.3, 7.4, 5.3, 3.5 Demand: 98, 83, 78, 101, 107, 92, 89, 109, 96, 112 Determine Covariance and Correlation for above shown multivariate input model.	08	CO3	L3
	b)	Describe the 3-step approach for validation process as formulated by Naylor and Finger.	07	CO3	L3
		Module 4 & 5			
2	a)	Describe the iterative process of calibrating a model with neat diagram.	08	CO2	L3
	b)	The following data are generated randomly from a Gamma distribution : 1.691, 1.437, 8.221, 5.976, 1.116, 4.435, 2.345, 1.782, 3.810, 4.589, 5.313, 10.90, 2.649, 2.432, 1.581, 2.675, 1.843, 3.765, 4.876, 3.210. Compute the maximum –likelihood estimator β θ.	07	CO2	L3

Levels of Bloom's Taxonomy

No.	L1	L2	L3	L4	L5	L6
Level	Remember	Understand	Apply	Analyze	Evaluate	Create

Course Outcomes

CO1	Explain the system concepts and apply functional modeling method to model the activities of a static system.	L3
CO2	Describe the behavior of a dynamic system and create an analogous model for a dynamic system.	L3
CO3	Illustrate the operations of a dynamic system and make improvement according to the simulation results.	L3

2nd IA

Scheme & Evaluation

1.

a) Correlation co-efficient $\rho = \frac{cov(x,y)}{\sigma_x \sigma_y}$

$$cov(x,y) = \frac{1}{n-1}\left[\Sigma xy - n.\bar{x}\bar{y}\right]$$

$$\sigma_x = \frac{\sqrt{\Sigma x^2 - n\bar{x}^2}}{n-1} \qquad \sigma_y = \frac{\sqrt{\Sigma y^2 - n\bar{y}^2}}{n-1}$$

$\rho = 0$ then x and y are Independent.

ρ = close to -1 and $+1$, stronger is the relation b/w x and y.

Lead Time (x)	Demand (y)	xy	x^2	y^2
7.3	98	715.4	53.29	9604
6.8	83	564.4	46.24	6889
4.7	78	366.6	22.9	6084
5.7	101	575.7	32.49	10201
3.8	107	406.6	14.44	11449
4.9	92	450.8	24.01	8464
6.3	89	560.7	39.69	7921
7.4	109	806.6	54.76	11881
5.3	96	508.8	28.09	9216
3.5	112	392	12.25	12544.

$\Sigma x = 55.7$ $\Sigma y = 965$ $\Sigma xy = 5347.6$ $\Sigma x^2 = 328.16$

$\Sigma y^2 = 94253$

$$\bar{x} = \frac{\Sigma fx}{n} = \frac{55.7}{10} = 5.57$$

$$\bar{y} = \frac{\Sigma fy}{n} = \frac{965}{10} = 96.5$$

$$Cov(x, y) = \frac{1}{10-1}\left[5347.6 - (10 \times 5.57 \times 96.5)\right]$$

$$= -\frac{27.45}{9} = -3.05$$

$$\sigma x = \sqrt{\frac{328.16 - (10 \times 31.0249)}{9}} = \sqrt{1.9901} = 1.4107$$

$$\sigma y = \sqrt{\frac{94.253 - (10 \times 9312.85)}{9}} = \sqrt{1130.5} = 11.207$$

$$\text{Correlation} = \frac{-3.05}{1.4107 \times 3.7259} = -0.5803 \simeq -1.$$

∴ The lead time and demand time are dependent on each other.

b) As an aid in the validation process, Naylor fi

1. Build a model that has high face validity.
2. Validate model assumption.
3. Compare the model input - output transformati to corresponding input - output transformation for t real system.

Face validity:

* The first goal of the simulation modeler is to construct a model that appears reasonable on its face to model users and others who are knowledgeable about the real system being simulated.

* The users of a model should be involved in model construction from its conceptualization to its implementation to ensure that high degree of realism is built into the model through reasonable assumptions regarding system structure and reliable data.

* Based on experience and observations on the real system the model user and model builder would probably have some notation atleast of the direction of change in model output when an input variable is increased or decreased.

Validating Model Assumption:

This is of two types; Structure assumption and data assumption.

* Structural assumptions involves question of how the system operates.

Ex: Consider ~~cars~~ customers queuing and service facility in a bank. Number of queues may be 1 or 2 or 3 etc customers may be moving from

Calibration and validation of models.

* Verification and validation although are conceptually distinct, usually are conducted simultaneously by the modeler.
* Validation is the overall process of comparing the model and its behaviour to the real system and its behaviour.
* Calibration is due iterative process of comparing the model to the real system, making adjustments to the model, comparing again and so on.
* The below fig. shows the relationship of the model calibration to the over all validation process.
* The comparision of the model to reality is carried out by variety of test are subjective and objective.
* Subjective test usually involve people, who are knowledgable about one / more aspects of the system, making judgements about the model and its o/p.
* Objective tests always require data on the system's behaviour plus the corresponding data produced by this model.

01

a)

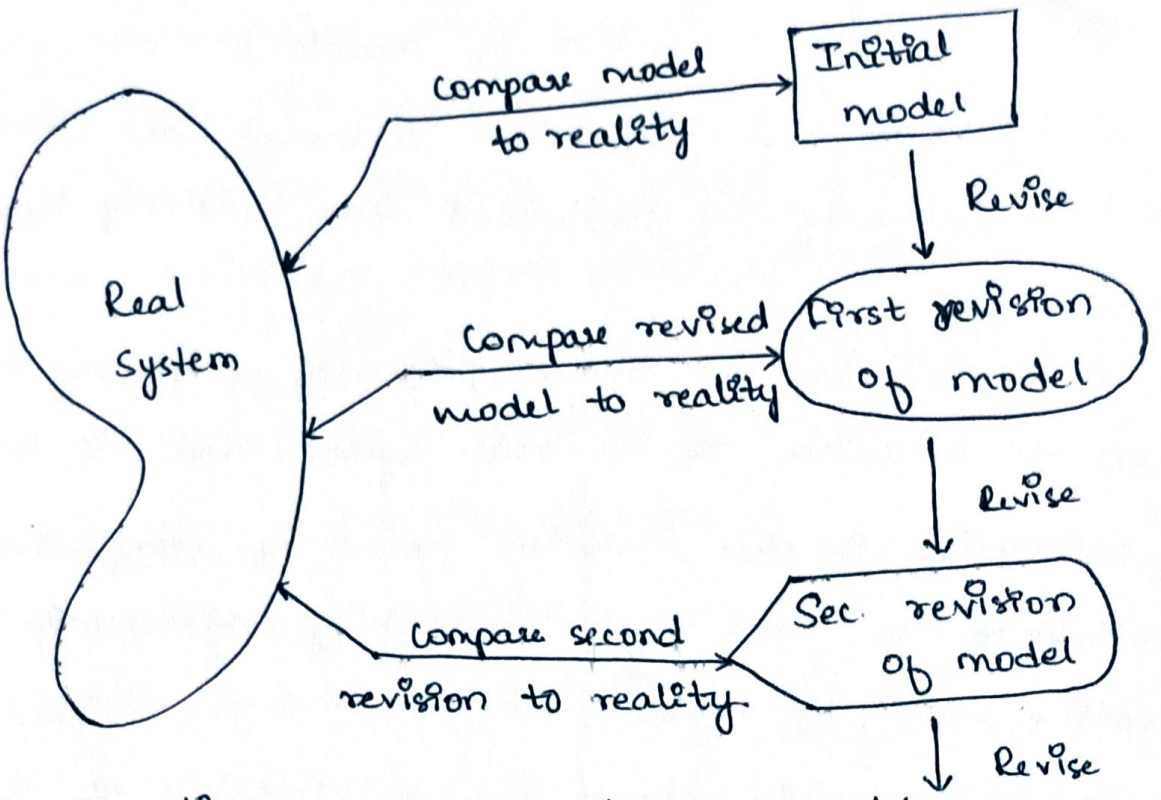

Fig: Iterative process of calibration model.

b)

$$P(x = K) = \frac{\lambda^k e^{-\lambda}}{K!}$$

$$\Sigma x = 74.636$$

$$\log \alpha(\lambda) = \frac{\Sigma x \log x - \log(e^{-i\lambda}) - \log(i)}{K!}$$

$$= 74.636 \log \lambda - 20\lambda - \log(x)$$

$$\frac{\partial \log \alpha(\lambda)}{\partial \lambda} = 74.636 \frac{1}{\lambda} - 20$$

$$\lambda = \frac{74.636}{20} = 3.7313$$

$\therefore$ Max. likelihood estimat^n = ?

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Alva's Institute of Engineering & Technology, Moodbidri

Department of Information Science & Engineering

Continuous Internal Evaluation Test-III EVEN Semester 2020-21

Course Title : System Modelling & Simulation		Course Code: 17CS834/15CS834
Date: 20/07/2021	Time: 3.00 PM- 4.30 PM	Semester: VIII
Faculty: Mr.Jayantkumar A Rathod		Max. Marks: 30

Note: Answer ONE question from each Module.

Q. No.		Questions	Marks	COs	BTL
		Module 2 ,3, 4			
1	a)	Describe the various Queueing Notations.	8	CO2	L2
	b)	Describe the four steps in the development of useful input model.	7	CO1	L2
		OR			
2	a)	Explain the Kolmogorov – Smirnov test with example.	8	CO2	L2
	b)	Suggest a step by step procedure to generate random variates using inverse transform technique for exponential distribution.	7	CO1	L2
		Module 1,4,5			
3	a)	Describe event scheduling / time advance algorithm.	8	CO2	L3
	b)	What is simulation? Explain with flow chart the steps in simulation study.	7	CO1	L3
		OR			
4	a)	Describe the calibration and validation process.	8	CO2	L3
	b)	The time required for 30 different employees to compute and record the number of hours worked during week days are as given below : 1.88 2.62 1.49 0.35 0.82 2.03 1.54 0.21 0.39 2.03 2.16 0.90 1.90 0.63 0.17 0.03 0.45 0.31 0.15 2.03 4.29 0.04 1.73 0.92 2.81 0.05 5.5 2.16 0.48 0.18. Use Chi-square to test the hypothesis that service times are exponentially distributed at 5% of level of significance. Let the number of intervals be K=6 and critical value 9.49.	7	CO1	L3

Levels of Bloom's Taxonomy

No.	L1	L2	L3	L4	L5	L6
Level	Remember	Understand	Apply	Analyze	Evaluate	Create

Course Outcomes

CO1	Explain the system concepts and apply functional modeling method to model the activities of a static system.	L3
CO2	Describe the behavior of a dynamic system and create an analogous model for a dynamic system.	L3
CO3	Illustrate the operations of a dynamic system and make improvement according to the simulation results.	L3

~~Internal 03~~ 3-DA ~~02-07-2021~~

Scheme & Evaluation

01.

a) * P_n → Steady state probability of n no of customers in the system.

* $P_n(t)$ → Steady state probability of n no of customers in the system at time t.

* λ → Arrival time

* λ_e → Effective Arrival time

* μ → Server rate at one server.

* τ → Server utilization.

* A_n → Inter arrival time between the customer n-1 and n

* S_n → Server time of the n^{th} customer.

* w_n → waiting time of the customer n.

* $L(t)$ → No of customers in the system at time t.

* $L_q(t)$ → No of customers in the queue of time t.

* $W(t)$ → Average time spent by the customer in the system.

* $W_q(t)$ → Average time spent by the customer in the queue.

b) Four steps in development of useful input model.

* Data collection
* Identifying the distribution with data
* Selecting distribution
* Parameter Estimation

= 3

Data collection:

This is initial step of the development of useful input model.

Here, in this stage the input raw data will be collected in the model and then undergoes for the further process.

The data will be collected initially because to continue with further procedure will be easier.

The data required for the input model development will be collected <or> gathered from various sources in the model.

Identifying the distribution with data:

This is the general next step which is used to be held in the development of useful input model.

This method is conducted because to identify the distribut° with help of the data.

Historical procedure;

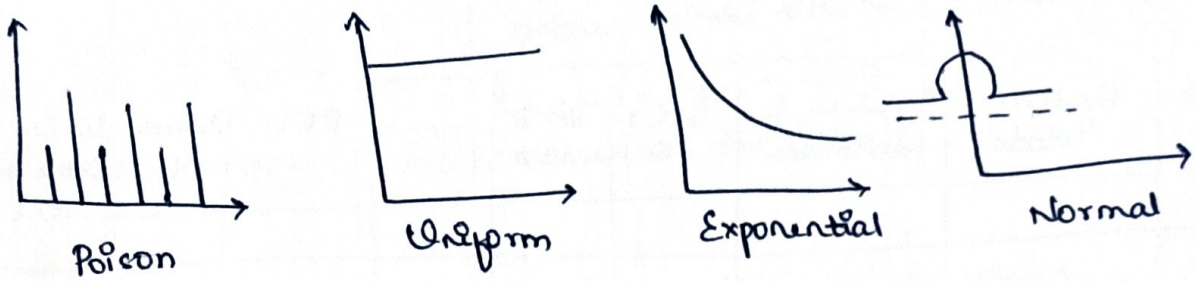
* Divide the range into the various intervals which has equal width.
* Label the horizontal axis to conform the selected interval.
* Find the frequencies of each intervals.
* Label the vertical axis.
* Plot the frequencies of the vertical axis.

Selecting distribution:

This is the third stage of the development of useful input model.

This stage has been conducted because after the identification of the distribution, selection should be done.

Selection is done on the basis of graphs / frequencies plotted to the distribution.



The other graphs are also there;

* Poison
* Uniform
* Exponential
* Normal
* Gamma
* Beeta
* Emperical.

Parameter Estimation:

$$\bar{x} = \begin{cases} \sum_{i=1}^{n} \frac{x_i}{n} & \text{(Ungrouped data)} \\ \sum_{i=1}^{k} \frac{f_i x_i}{n} & \text{(Grouped data)} \end{cases}$$

$$S^2 = \begin{cases} \sum_{i=1}^{n} \dfrac{x_i^2 - n\bar{x}^2}{n-1} & \text{(Ungrouped data)} \\ \sum_{i=1}^{k} \dfrac{f_i x_i^2 - n\bar{x}^2}{n-1} & \text{(Grouped data)} \end{cases}$$

03.

a) Event Scheduling / time advance algorithm.

Here, in this algorithm the event is calculated accordingly on the time.

Clock	System state	Entities & Attributes	Set 1	Set 2	.....	FEL	Commulative statistics & counters
t	(x, y, z)					$(3, t_{s1})$ Event type 3 occur at time t_1. $(1, t_2)$ Event type 1 occur at time t_2. ⋮	

* Initially, the clock will be set to the time t. <or> on any particular time.

* The system state will be analyzed <or> assumed as x, y, 3 for the time being.

* In the FEL step i.e; future event list, the event will be occurred to the corresponding time.

$(3, t_1)$ ⟶ Type 3 event occurs at the time t_1.

$(1, t_2)$ → Type 1 event occurs at the time t_2.

For ex :

Clock	System state	....	FEL	...
t	(5, 1, 6)		(3, t_1) - type 3 event occur at the time t_1.	
			(1, t_2) - type 1 event occur at the time t_2.	
			(1, t_3) - type 1 event occur at the time t_3.	
			(4, t_n) - type 4 event occur at the time t_n.	

* Consider the time t at the clock in the step 1.
* Let us assume the values of system state as 5, 1, 6.
* At the future event list (FEL) the event of various types will occur on the basis of the time scheduled.

  (3, t_1) → type 3 event occur at the time 1 (t_1)

  (1, t_2) → type 1 event occurs at the time 2 (t_2)

  (1, t_3) → type 1 event occurs at the time 3 (t_3)

  (4, t_n) → type 4 event occurs at the time n (t_n)

* After all this steps it again undergoes for future event list (FEL) for the steps to be easier.
* To go to FEL step again the steps should be followed from step 1.

Clock	System state	.....	FEL	.....
t_1	(5, 1, 5)		$(1, t_2)$ - type 1 event occurs at the time t_2	
			$(4, t^*)$ - type 4 event occurs at the time t^*	
			$(1, t_3)$ - type 1 event occurs at the time t_3	
			$(4, t_n)$ - type 4 event occurs at the time t_n	

* In the step 1, let us consider the clock as t_1 of the time.
* We can assume the values of system state as 5, 1, 5.
* In the FEL - future event list, the event occurs at the corresponding time.

$(1, t_2)$ → type 1 event occurs at the time t_2.

$(4, t^*)$ → type 4 event occurs at the time t^*.

$(1, t_3)$ → type 1 event occurs at the time t_3.

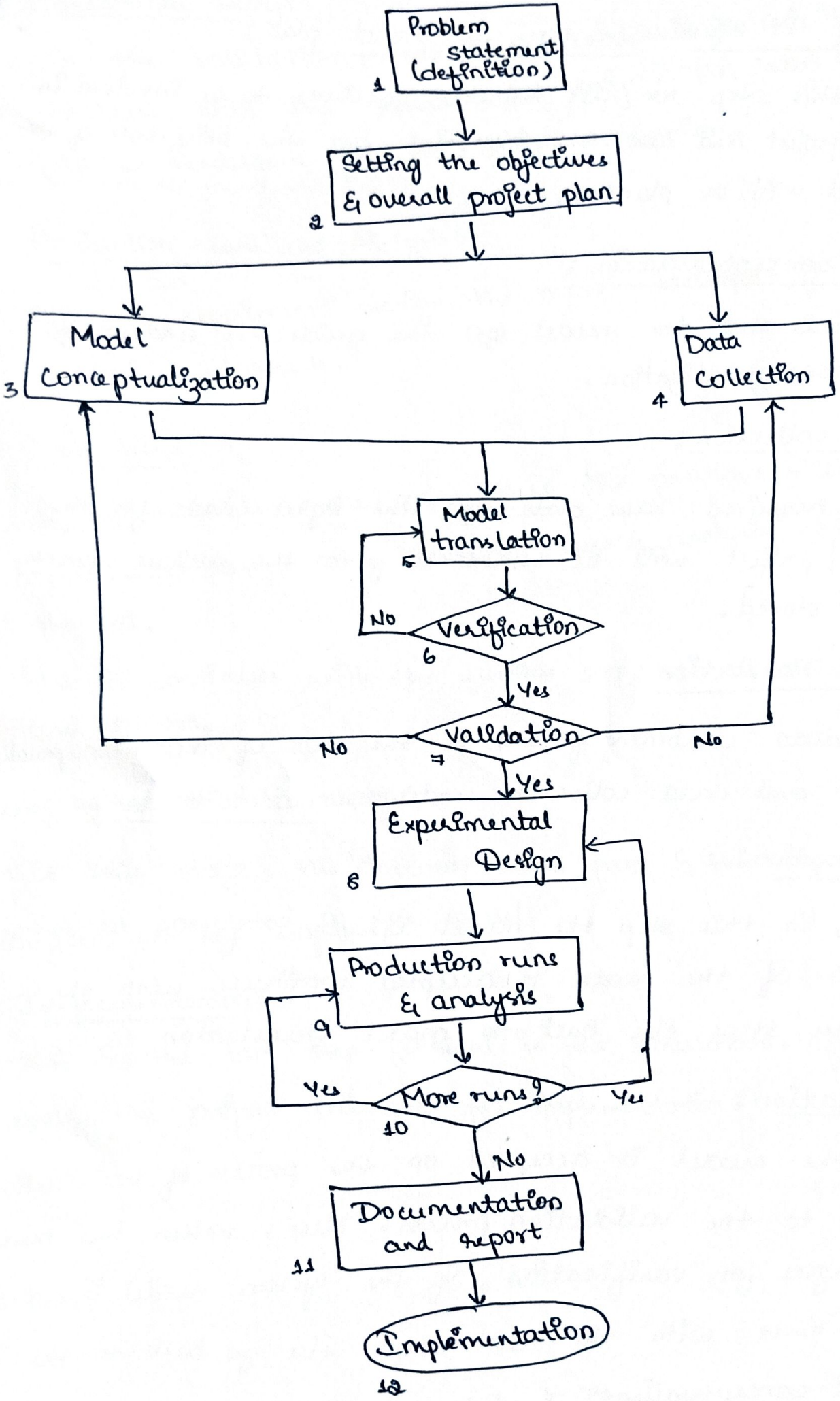
$(4, t_n)$ → type 4 event occurs at the time t_n.

b> Simulation and its flow chart.

Simulation is the initiation of the any situation <or> process.

Problem Statement:

The definition <or> the problem of the model on which basis the project is held is defined in one line is called as problem definition <or> statement.


Problem statement (definition)
1
Setting the objectives & overall project plan
2
Model Conceptualization
3
Data Collection
4
Model translation
5
Verification
6
No
Yes
Validation
7
No
No
Yes
Experimental Design
8
Production runs & analysis
9
More runs?
10
Yes
Yes
No
Documentation and report
11
Implementation
12

Alvas Institute of Engineering & Technology

Faculty Name: Jayantkumar. A Rathod

Assignment No. 1 Date: 1/5/2021

Subject Name: System Simulation & Modeling (17CS834)

(1) What do you mean by simulation. Describe the steps in a simulation study with flow chart. (12)

(2) What is model. Describe different types of models. (8)

(3) Consider the Able-Baker problem with following data. (10)

Customer Number	1	2	3	4	5	6	7	8	9	10
Arrival Time	0	1	4	6	7	9	10	12	14	18
Service Time	3	4	2	5	1	2	4	3	6	4

Simulate the system for 10 customers.

Calculate (i) Average service time of Able & Baker

(ii) Average customer time in system.

(4) Consider a single server queuing system with inter arrival and service time details as shown below. (8)

BA	1	1	6	3	7	5	2	4	1	
ST	4	2	5	4	1	5	4	1	4	

Stop the simulation when clock reaches 23.

Alva's Institute of Engineering & Technology
Department of Information Science & Engg

Assignment No-2

Faculty Incharge: Jayanthkumar.A.R 17/5/2021
Subject Name & Code - 17CS834 (SMS)

(1) Briefly explain (M,N) inventory system. - (4M)

(2) A news dealer buys papers for 25 cents each and (10M)
sells them for 45 cents each. Newspapers not sold at the end of the day are sold as scrap for 7 cents each. Newspapers can be purchased in bundle of 10 each. The demand for 15 days is as shown below.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Demand	60	70	80	50	90	100	80	40	70	90	60	50	80	60	70

Assume that the news dealer buys daily 70 newspapers. Calculate the profit for 15 days.

(3) A company selling refrigerators maintains inventory by (10M)
conducting a review after a fixed number of days say N. The order up to level say M. Consider the order-up-to level M is 13 refrigerators, and the review period N is 5 days, and the ending inventory on day 5 is 3 refrigerators, then on the fifth day of the cycle 10 refrigerators will be ordered from the supplier. Consider the demand for 20 days as (3,2,4,2,6,3,1,6,5,4,2,3,6,4,2,1,3,2,4,3) Calculate the average ending inventory.

(4) Describe Event scheduling / Time advance algorithm (8M)

(5) Explain the different orientation or strategies a modeler may adopt for developing a model. (8M)

(6) Consider the interarrival times and service times as shown for ~~th~~ single-channel counter simulation. (12M)

Interarrival Times	1	2	4	5	6	3	7	4	2	...
Service Times	3	3	4	5	2	1	2	6	3	...

Estimate the parameters B & MQ. Stop the simulation when the clock reaches 33.

(7) Consider the same interarrival and service time as shown in above question no-6. ~~Est~~ Calculate the parameters like S, N_D, F. Hence determine the average response time and proportion of customers who spent 5 or more minutes in the system. (12M)

Alvas Institute of Engineering & Technology
Department of Information Science & Engg
Assignment No-3

Faculty Name: Jayanthkumar. A R 14/6/2021
Subject Name:- SSM (17CS834)

(7M)

(1) Consider the activity times required for various Dump-Truck problem as shown below.

Loading Time	10	5	10	10	5	10	5
Weighing Time	12	16	12	12	16	12	12
Travel Time	40	60	40	80	100	40	

Six dump trucks are used to haul coal from entrance of a small mine to the railroad. There are two loaders and one scale. Both follow FCFS. After being weighed, a truck begins a travel time (during which the truck unloads) and then returns to the loader queue. Assume there are three trucks at the loader queue, one at scale and two are at loading point (loader). Show the simulation table and estimate the loader and scale utilization. Stop the simulation when 8 iterations gets completed.

(8M)

(2) Explain the following continuous distribution:

(i) Exponential Distribution (ii) Triangular Distribution
(iii) Uniform Distribution

(3) Use the linear congruential method to generate a sequence of 6 random numbers with $X_0 = 27$, $a = 17$, $c = 43$, and $m = 100$. Write 3 ways of achieving maximal period. (7M)

(4) Explain Kolmogorov-Smirnov test along with the steps required for testing against a uniform CDF. The sequence of random numbers 0.54, 0.73, 0.98, 0.11, 0.68 has been generated. Use Kolmogorov Smirnov test with $\alpha = 0.05$ to determine if the hypothesis that the numbers are uniformly distributed or rejected. Take $D_\alpha = 0.565$. (8M)

(5) a) Explain step by step procedure to generate random variates using inverse transform technique for exponential distribution.

(6) What is acceptance-rejection technique? Generate three Poisson variates with mean $\alpha = 0.2$. The random numbers are 0.4357, 0.4146, 0.8353, 0.9952, 0.8004, 0.7945, 0.1530.

(6) Explain with example Empirical Continuous Distribution (7M)

(7) Explain the test used for checking the dependence between the numbers in a sequence. Consider the following numbers read from left to right. (8M)

0.12, 0.01, 0.23, 0.28, 0.89, 0.31, 0.64, 0.28, 0.83, 0.93
0.99, 0.15, 0.33, 0.35, 0.91, 0.41, 0.60, 0.27, 0.75, 0.88
0.68, 0.49, 0.05, 0.43, 0.95, 0.58, 0.19, 0.36, 0.69, 0.87

Consider $i = 3$, $l = 5$, $\alpha = 0.05$ $(Z_{\alpha/2} = 1.96)$

Alva's Institute of Engineering & Technology

Shobhavana Campus, Mijar, Moodbidri, D.K – 574225

Phone: 08258-262725, Fax: 08258-262726

DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERNG

Subject : System Simulation & Modelling (18CS834) **Sem :** 8th

Faculty Incharge : Mr. Jayantkumar A Rathod **Academic Year :** 2020-21(Even Sem

Consolidated Internal Assessment Marks List

SL.NO	USN	NAME	IA-1 (15)	IA-2 (15)	IA-3 (15)	AVERAGE MARKS	ASSIGNMENT MARKS (05)	FINAL IA MARKS
1	4AL15IS014	Manthan	13	13	AB	13	5	18
2	4AL15IS028	Prathiksha Patkar	13	13	AB	13	5	18
3	4AL15IS034	Rekha Halli	13	13	AB	13	5	18
4	4AL16IS004	Anju D R	11	13	AB	12	5	17
5	4AL16IS022	Keerthana	12	13	AB	13	5	18
6	4AL16IS058	Varada	11	12	AB	12	5	17
7	4AL16IS064	Mahima R	13	8	AB	11	5	16
	USN	NAME	IA-1 (30)	IA-2 (30)	IA-3 (30)	AVERAGE MARKS	ASSIGNMENT MARKS (10)	FINAL IA MARKS
8	4AL17IS001	Ahimsa Jain	28	27	28	28	10	38
9	4AL17IS002	Akshata L Hegde	28	27	30	28	10	38
10	4AL17IS003	Akshatha A M	27	25	26	26	10	36
11	4AL17IS004	Akshitha	27	25	25	26	10	36
12	4AL17IS005	Albin George	27	23	25	25	10	35
13	4AL17IS006	Vishak Amin	27	26	27	27	10	37
14	4AL17IS007	Anjali Cj	15	21	26	21	10	31
15	4AL17IS009	Ashwini	29	24	28	27	10	37
16	4AL17IS010	Ashwitha R Salian	29	26	26	27	10	37
17	4AL17IS012	Danush Kumar	29	26	25	27	10	37
18	4AL17IS014	Dikshit Kotian	28	23	27	26	10	36
19	4AL17IS015	Divyashree	28	27	28	28	10	38
20	4AL17IS016	Gangothri N V	27	23	27	26	10	36
21	4AL17IS021	Karuna Nagaraj	29	26	28	28	10	38
22	4AL17IS022	Kavyashree S	28	27	27	27	10	37
23	4AL17IS023	Kshama	28	27	28	28	10	38
24	4AL17IS024	Mayuresh R Kunder	29	25	26	27	10	37
25	4AL17IS025	Lokesh P	27	24	25	25	10	35

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Phone: 08258-262725, Fax: 08258-262726

26	4AL17IS026	Manish R	24	24	25	24	10	34
27	4AL17IS027	Melody Naorem	27	26	28	27	10	37
28	4AL17IS028	Methish R	20	23	25	23	10	33
29	4AL17IS030	Nanda Kishore	23	25	27	25	10	35
30	4AL17IS031	Navya Poojary	27	23	26	25	10	35
31	4AL17IS032	Nikitha Shetty	25	26	26	26	10	36
32	4AL17IS033	Pavan Y N	29	24	27	27	10	37
33	4AL17IS034	Prashanth Reddy	26	26	28	27	10	37
34	4AL17IS035	Priya	29	22	26	26	10	36
35	4AL17IS036	Rachana Shetty	28	27	27	27	10	37
36	4AL17IS037	Rachitha Shetty	27	26	29	27	10	37
37	4AL17IS040	Roopashree J	26	24	27	26	10	36
38	4AL17IS043	Shetty Rachana C	29	27	27	28	10	38
39	4AL17IS045	Shreyas He	25	25	23	24	10	34
40	4AL17IS048	Srihari B	28	25	22	25	10	35
41	4AL17IS050	T K Harshith Prasad	30	26	22	26	10	36
42	4AL17IS051	Thangsabam Bikumar S	24	25	24	24	10	34
43	4AL17IS053	Zeenal Manola Lobo	27	26	28	27	10	37
44	4AL17IS054	Chaitanya Bn	28	26	28	27	10	37
45	4AL17IS055	Nagashree S	24	26	27	26	10	36
46	4AL17IS056	Melisha Dsouza	26	26	25	26	10	36

CBCS SCHEME

USN

15CS834

Eighth Semester B.E. Degree Examination, Aug./Sept.2020
System Modeling and Simulation

Time: 3 hrs. Max. Marks: 80

Note: i) For Regular Students: Answer any FIVE full questions irrespective of modules.
ii) For Arrear Students : Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. What is simulation? Explain with flowchart, the steps involved in simulation study. **(08 Marks)**

b. A grocery store has only one checkout counter. Customer arrives at this checkout counter at random from 1 to 5 minutes apart with equal probability. The service time varies from 1 to 6 minutes with probability 0.30, 0.25, 0.05, 0.10, 0.10 and 0.20. Develop a simulation table for 10 customers and find the following:
(i) Average waiting time of customer
(ii) Average service time
(iii) Average time between arrivals
(iv) The probability that server being idle.
Use the following set of random numbers for arrivals 84, 10, 74, 53, 17, 79, 03, 87, 27. Random digit for service time 23, 35, 65, 81, 54, 03, 87, 27, 73, 70. **(08 Marks)**

2 a. Explain the major concepts in discrete event simulation. Write the flowchart for arrival and departure events. **(08 Marks)**

b. Six dump trucks are used to have coal form the entrance of a mine to a rail road. Each truck is loaded by one of the two loaders. After loading, a truck immediately moves to the scale, to be weighted as soon as possible. Both the loaders and scale have first come first serve weighing time for trucks. Travel from loaders to scale is considered negligible. After being weighed, a truck begins travel time (during which time truck unloads) and then afterwards returns to loader queue. The activities of loading, weighing and travel time are given in the table.

Loading time	:	10	5	5	10	15	10	10
Weighing time	:	12	12	12	16	12	16	
Travel time	:	60	100	40	40	80		

End of simulation is completion of two weighing from the scale. Depict simulation table and estimate the loader and scale utilizations. **(08 Marks)**

Module-2

3 a. Explain the characteristics of queueing systems. List different queuing notations. **(08 Marks)**

b. Define discrete and continuous random variable. Explain the binomial and Poisson distribution. **(08 Marks)**

4 a. Explain the following continuous distributions:
(i) Uniform distribution
(ii) Exponential distributions **(08 Marks)**

b. Explain steady state parameters of M/G/1 queue. **(08 Marks)**

Module-3

5 a. What is the role of maximum density and maximum period in generating random numbers? With given seed 45, constant multiplier 21, increment 49 and modulus 40, generate a sequence of fire random numbers. **(08 Marks)**

b. The sequence of numbers 0.54, 0.73, 0.98, 0.11, 0.08 has been generated. Use Kolmogorov Simirnov test with $\alpha = 0.05$ to determine if the hypothesis that the numbers are uniformly distributed on the interval [0, 1] can be rejected. Compare F(X) and $S_N(X)$ on a graph. $D_{0.05} = 0.565$. **(08 Marks)**

OR

6 a. Explain the inverse transformation technique for exponential distribution. Show the corresponding graphical interpretation. Explain the acceptance rejection technique. **(08 Marks)**

b. Use the Chi-Square test with $\alpha = 0.05$ to test for whether the data shown are uniformly distributed. The test uses n = 10 intervals of equal length. $\chi^2_{0.05,9} = 16.9$.

0.41	0.52	0.73	0.99	0.02	0.47	0.30	0.17	0.82	0.56
0.05	0.45	0.31	0.78	0.05	0.79	0.71	0.23	0.19	0.82
0.93	0.65	0.37	0.39	0.42	0.99	0.90	0.25	0.89	0.87
0.44	0.12	0.21	0.46	0.67	0.83	0.76	0.79	0.64	0.70
0.81	0.94	0.74	0.22	0.74	0.96	0.99	0.77	0.67	0.56

(08 Marks)

Module-4

7 a. List the steps involved in development of a useful model of input data and explain. **(08 Marks)**

b. Explain how the method of histograms can be used to identify the shape of a distribution. With an example, also mention drawbacks of histogram and advantages of Q-Q plot. **(08 Marks)**

OR

8 a. Customers arriving at a busy bank counter in a 5 minutes period between 10 to 2 pm was recorded for days given below:

Arrival/period	0	1	2	3	4	5	6	7	8	9	10
Frequency	15	12	10	10	8	7	5	4	3	2	4

Use Chi-Square test to check whether the data follows Poisson distribution at 5% level of significance. $\chi^2_{0.05,4} = 9.49$. **(08 Marks)**

b. The time required for 30 different employs to compute and record the number of hours worked during week days given:

1.88	2.62	1.49	0.35	0.82	2.03	1.54	0.21	0.39	2.03	2.16	0.90	1.90
0.63	0.17	0.03	0.45	0.31	0.15	2.03	4.29	0.04	1.73	0.92	2.81	0.05
5.5	2.16	0.48	0.18									

Use the Chi-Square to test the hypothesis that these service times are exponentially distributed at 5% of level of significance. Let the number of intervals be K = 6 and critical value 9.49. **(08 Marks)**

Module-5

9 a. Explain the types of simulation with respect to output analysis. Give atleast two examples. **(08 Marks)**

b. Explain the concepts of point estimation and interval estimation. **(08 Marks)**

OR

10 a. Explain in detail about the model building, verifying and validation in the model building process through a diagram. **(08 Marks)**

b. Explain 3-steps approach to validation of simulation models by Naylor and Finger. **(08 Marks)**

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