CMR INSTITUTE OF TECHNOLOGY

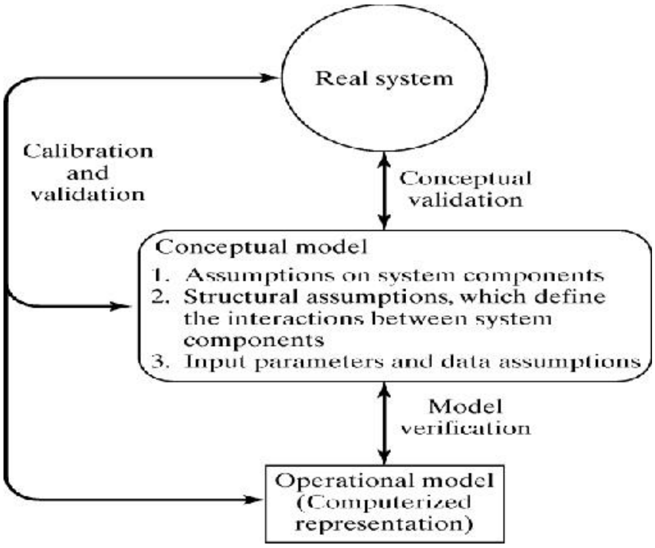
USN | | | | | | | | | |

Internal Assessment Test 2

Sub:	SYSTEM MODELING AND SIMULATION							Code:	10CS82
Date:	8/05/ 2017	Duration:	90 mins	Max Marks:	50	Sem:	VIII	Branch:	CSE-A ,B & ISE-A,B
Answer Any FIVE FULL Questions									

	Marks	OBE CO	OBE RBT
1. Discuss with the help of neat diagram model building,verification & validation.	[10]	CO6	L1

Sol:
Figure:3M, Explanation:7M



The first step in model building consists of observing the real system and the interactions among their various components and of collecting data on their behavior. But observation alone seldom yields sufficient understanding of system behavior. Persons familiar with the system, or any subsystem, should be questioned to take advantage of their special knowledge. Operators, technicians, repair and maintenance personnel, engineers, supervisors, and managers understand certain aspects of the system that might be unfamiliar to others. As model development proceeds, new questions may arise and the model developers will return to this step of learning true system structure and behavior.

The second step in model building is the construction of a conceptual model-a collection of assumptions about the components and the structure of the system, plus hypotheses about the values of model input parameters. As is illustrated by Figure, conceptual validation is the comparison of the real system to the conceptual model.

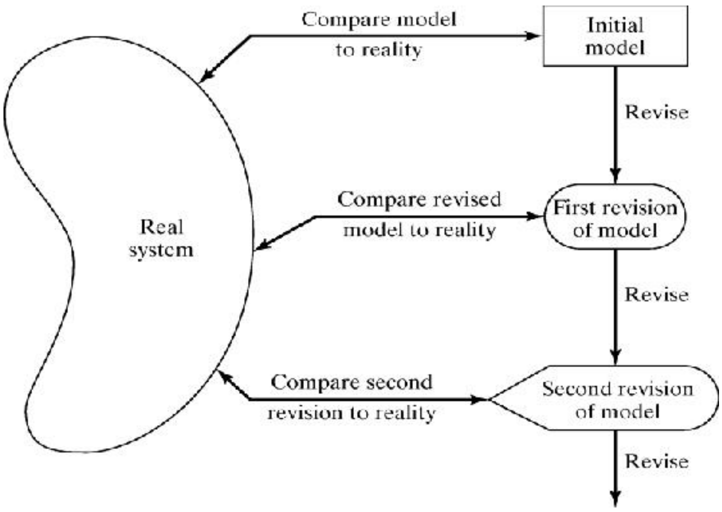
The third step is the implementation of an operational model, usually by using simulation software and incorporating the assumptions of the conceptual model into the worldview and concepts of the simulation software. In actuality, model building is not a linear process with three steps. Instead; the model builder will return to each of these steps many times while building, verifying, and validating the model.

The above figure, depicts the ongoing model building process, in which the need for· verification and validation causes continual comparison of the real system to the conceptual model and to the operational model and induces repeated modification of the model to improve its accuracy.

Question	Marks	CO	Level
2. Describe the three steps approach to validate by Naylor & Finger in the validation process.	[10]	CO6	L1

Sol:

Figure:3M, Explanation:7M



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 behavior to the real system and its behavior.

• Calibration is the iterative process of comparing the model to the real system, making adjustments to the model, comparing again and so on.

• The figure above shows the relationship of the model calibration to the overall validation process.

• The comparison of the model to reality is carried out by variety of test.

• Tests are subjective and objective.

• Subjective test usually involve people, who are knowledgeable about one or more aspects of the system, making judgments about the model and its output.

• Objective tests always require data on the system's behavior plus the corresponding data produced by the model.

As an aid in the validation process, **Naylor and Finger** formulated a **three step approach** which has been widely followed:-

1. Build a model that has high face validity.
2. Validate model assumptions.
3. Compare the model input-output transformations to corresponding input-output transformations for the real system.

3. The time required for 50 different employees to compute and record the number of hours during the week was measured with the following results in minutes. Use Chi-square test to test the hypothesis that these service times are exponentially distributed. Assume k=6, λ=1.206, α = 0.05.Use $\chi^2_{0.05,\,4}$ = 9.49. [10]	CO3	L3

1.88	1.54	1.90	0.15	0.02	2.81	1.50	0.53	2.62	2.67
3.53	0.53	1.80	0.79	0.21	0.80	0.26	0.63	0.36	2.03
1.42	1.28	0.82	2.16	0.05	0.04	1.49	0.66	2.03	1.00
0.39	0.34	0.01	0.10	1.10	0.24	0.26	0.45	0.17	4.29
0.80	5.50	4.91	0.35	0.36	0.90	1.03	1.73	0.38	0.48

Sol:

- Finding P value **– 1Mark**
  - P=1/k = 1/6 = 0.1667
- Finding Expected Values – **1 Mark**
  - Ei=nPi=50*0.1667 = 8.33
- Finding A0,A1,….values **– 2 Marks**

  Ai=-1/λln(1-iP)
  A0=-1/1.206(1-0*0.1667)=0
  A1=-1/1.206ln(1-1*0.1667) = 0.1512
  A2= -1/1.206 ln(1-2*0.1667) = 0.3362
  A3= -1/1.206 ln(1-3*0.1667) = 0.5749
  A4= -1/1.206 ln(1-4*0.1667) = 0.9112
  A5 = -1/1.206 ln(1-5*0.1677) = 1.4865

- Chi-square table **– 5 Marks**

Interval	Oi	Ei	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
0- 0.1512	6	8.33	2.33	5.428	0.6517
0.1512 - 0.3362	6	8.33	2.33	5.428	0.6517
0.3362 - 0.5749	10	8.33	1.67	2.788	0.334
0.5749 - 0.9112	7	8.33	1.33	1.768	0.2123
0.9112 - 1.4865	5	8.33	3.33	11.088	1.331
1.4865 - ∞	16	8.33	7.67	58.82	7.0622
				Total	**10.24**

- Justification of acceptance **– 1 Mark**

- 10.24 > 9.49 so the data given are rejected.

4. Explain Chi–square goodness of fit test. Apply it to Poisson assumption with α=3.64.Datasize=100 and observed frequency Oi=12,10,19,17,10,8,7,5,5,3,3,1(Use $\chi^2_{0.05,5} = 11.1$).	[10]	CO3	L3

For Poisson distribution $P(x) = e^{-\alpha}\alpha^{x} / x!$ for x=0,1,2,…..

Compute P(0),P(1),P(2),……P(11) as follows **– 2 Marks**
$P(0)= e^{-3.64}(3.64)^{0} / 0! = 0.026$
$P(1)= e^{-3.64}(3.64)^{1} / 1! = 0.096$
$P(2)= e^{-3.64}(3.64)^{2} / 2! = 0.174$
$P(3)= e^{-3.64}(3.64)^{3} / 3! = 0.211$
……till P(11) as follows

- Chi-square test Table- **7 Marks**

$P(4) = \frac{e^{-3.64}(3.64)^4}{4!} = 0.192$

$P(5) = \frac{e^{-3.64}(3.64)^5}{5!} = 0.140$

$P(6) = \frac{e^{-3.64}(3.64)^6}{6!} = 0.085$

$P(7) = \frac{e^{-3.64}(3.64)^7}{7!} = 0.044$

$P(8) = \frac{e^{-3.64}(3.64)^8}{8!} = 0.020$

$P(9) = \frac{e^{-3.64}(3.64)^9}{9!} = 0.008$

$P(10) = \frac{e^{-3.64}(3.64)^{10}}{10!} = 0.003$

$P(11) = \frac{e^{-3.64}(3.64)^{11}}{11!} = 0.001$

chi-square test table

x_i	observed frequency O_i		Expected frequency E_i $(n \times p_i)$		(Oi
0	12	22	$100 \times 0.026 = 2.6$	12.2	=
1	10		$100 \times 0.096 = 9.6$		
2	19		$100 \times 0.174 = 17.4$		C
3	17		$100 \times 0.211 = 21.1$		O
4	10		$100 \times 0.192 = 19.2$		L
5	8		$100 \times 0.140 = 14.0$		2
6	7		$100 \times 0.085 = 8.5$		(
7	5	17	$100 \times 0.044 = 4.4$	7.6	
8	5		$100 \times 0.020 = 2.0$		
9	3		$100 \times 0.008 = 0.8$		
10	3		$100 \times 0.003 = 0.3$		
11	1		$100 \times 0.001 = 0.1$		

– Always we have to see that the expected freq values should be >5. If not then combine w[ith] previous (or) next value until it becomes >5.

Here $X^2_{\alpha,K-S-1 = 7-1-1 =5}$

K = No of intervals divided, S= No of parameters estimated i.e only α is given

$X^2_{0.05,5}$ = 11.1

- Justification of acceptance **– 1 Mark**

The computed value 27.61 > 11.1 so the hypothesis is rejected

5. Consider the following 60 values. Test whether $2^{nd}, 9^{th}, 16^{th}$,........,numbers in correlated for α=0.05.(Consider the tabular value $Z_{0.025}$ = 1.96). [10] CO3 L3

0.30	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	0.91	0.79	0.57	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	0.23	0.72
0.60	0.84	0.76	0.30	0.26	0.38	0.05	0.19	0.73	0.44

Finding the autocorrelation value along with steps– **10 Marks**

The marks split up is as follows.

- Finding the M value **– 2 Mark**

  i.e. i+(M+1)l <= N

- Here i=2, l= 7 and N=60

  2+(M+1)7 <= 60.For M=8 this condition won't satisfy so the previous value is M=7.

- Finding the ρ_{im} value **– 4 Marks**

  i.e. ρ_{im} =

1/M+1[R2.R9+R9.R16+R16.R23+R23.R30+R30.R37+R37.R44+R44.R51+R51.R58] - 0.25

=1/8[(0.48)(0.61)+(0.61)(0.37)+(0.37)(0.37)+(0.37)(0.99)+(0.99)(0.09)+(0.09)(0.55)+(0.55)(0.60)+(0.60)(0.19)] – 0.25

=1/8(1.6043) – 0.25 = -0.494

- Finding the $\sigma_{\rho im}$ = 13M+7 / 12(M+1**)** value **– 1 Mark**

  = 13*7+7 / 12(8) = 0.1031

- Finding Z_0 value **- 1 Mark**

- i.e. Z_0 = -0.0494/0.1031 = -0.4791

Justification of acceptance **– 2 Marks**

i.e. $-Z_{\alpha/2} <= Z_0 <= Z_{\alpha/2}$

= -1.96 < -0.4791 <1.96.Hence the sequence of numbers given are accepted

6.a) What is acceptance –rejection technique? Generate three Poisson variates with mean 0.2 by taking these random numbers 0.4357, 0.4146, 0.8353, 0.9952, 0.8004. [5] CO3 L2

Explanation of acceptance rejection technique – **1 Mark**

Finding three poisson variates with Justification– **4 Marks**

- i.e. 1. Set n=0,p=1.
- 2. R1=0.4357,P=1*0.4357 = 0.4357
- 3. Since P=0.4357 < $e^{-0.2}$ = 0.8187, accept N=0
- Steps 1-3.(R1=0.4146 leads to N=0),accept N=0
- 1.Set n=0,P=1
- 2. R1=0.8353,P=1*0.8353=0.8353
- 3.Since 0.8353 >0.8187,reject n=0 and return to step 2 with n=1
- Step 2. R2= 0.9952,P=R1R2=0.8353*0.9952 = 0.8313
- 3.Since 0.8313 > 0.8187,reject n=1 and return to step 2 with n=2
- Step 2. R3=0.8004,P=R1R2R3 = 0.8313 * 0.8004 = 0.6654
- 3. Since 0.6654 < 0.8187 accept N=2.
- The three Poisson Variates are 0.4357, 0.4146, 0.6654

b) Using suitable frequency test find out whether the random numbers generated are uniformly distributed on the interval [0, 1] can be rejected. Assume α=0.05 and Dα=0.565.the random numbers are 0.44, 0.81, 0.14, 0.05, 0.93 . [5] CO3 L2

Rank the data from smallest to largest.Finding the R_i - **1 Mark**

- i.e. R_i 0.11 0.54 0.68 0.73 0.98

Finding the D^+ and D^- values – **2 Marks**

- i.e. $D^+ = i/N-R_i = 0.09$
- $D^- = R_i-(i-1)/N = 0.34$

Finding D value – **1 Mark**

- i.e. $D = \max(D^+,D^-) = 0.34$

Justification of the data accept or reject – **1 Marks**

- i.e. The tabular value $D_{\alpha,n}$= 0.565.Since $D < D_\alpha$ i.e 0.34 < 0.565 the sequence of numbers given are accepted.

7. Use the Chi-square test with $\alpha=0.05, n=10, x^{2}_{0.05.9}=16.9$ to test for whether the data shown are uniformly distributed. [10] CO3 L3

0.34	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	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	0.17	0.99	0.46	0.05	0.66	0.10	0.42	0.18	0.49
0.37	0.51	0.54	0.01	0.81	0.28	0.69	0.34	0.75	0.49
0.06	0.43	0.56	0.97	0.30	0.94	0.96	0.58	0.73	0.05
0.06	0.39	0.84	0.24	0.40	0.64	0.40	0.19	0.79	0.62
0.18	0.26	0.97	0.88	0.64	0.47	0.60	0.11	0.29	0.78

- Dividing into no of intervals-**1 Mark**
- Finding Ei value – **1 Mark**

  Ei= N/n = 100/10 =10
- Chi-Square test computation table – **7 Marks**

Interval No	Interval range	Oi	Ei	Oi-Ei	(Oi-Ei)²	(Oi-Ei)²/Ei
1	0-0.1	8	10	-2	4	0.4
2	0.1-0.2	8	10	-2	4	0.4
3	0.2-0.3	10	10	0	0	0
4	0.3-0.4	9	10	-1	1	0.1
5	0.4-0.5	12	10	2	4	0.4
6	0.5-0.6	8	10	-2	4	0.4
7	0.6-0.7	10	10	0	0	0
8	0.7-.0.8	14	10	4	16	1.6
9	0.8-0.9	10	10	0	0	0
10	0.9-1.0	11	10	1	1	0.1
Total						**3.4**

- Comparing with α value and justifying for acceptance/rejection **– 1 Mark**

  i.e.3.4 < 16.9 so the above values are accepted

8. Consider the loading times, weighing times and travelling times as follows. [10] CO2 L2

Loading Time	10	5	5	10	15	10	10
Weighing Time	12	12	12	16	12	16	
Travelling Time	60	100	40	40	80		

Assume 5 trucks are at loaders and 1 on scale at time 0.Using time advance algorithm simulate by considering stopping time after 10 iterations.

Sol:

-For Simulation table for dump-truck problem-10 M

***The Marks split up is as shown below**

-For defining the system states like LQ(t),L(t),WQ(t),W(t)-4M

- For defining the lists like loader queue and weighing queue-2M

-For Defining the Future event list-2M

-For updating the cumulative statistics and counters-2M

Clock	System State				Lists		FEL	Cumulative Statistics	
	LQ(t)	L(t)	WQ (t)	W (t)	Loader Queue	Weighing Queue		BL	BS
0	0	5	0	1	-	-	(EW,12,D1) (EL,10,D2) (EL,5,D3) (EL,5,D4) (EL,10,D5) (EL,15,D6)	0	0
5	0	3	2	1	-	D3 D4	(EL,10,D2) (EL,10,D5) (EL,15,D6) (EW,12,D1)	25	5
10	0	1	4	1	-	D3,D4, ,D2,D5	(EL,15,D6) (EW,12,D1)	40	10
12	0	1	3	1	-	D4,D2,D5	(EL,15,D6) (EW,12+12,D3) (ALQ,12+60,D1)	42	12
15	0	0	4	1		D4,D2,D5,D6	(EW,24,D3) (ALQ,72,D1)	45	15
24	0	0	3	1		D2,D5,D6	(EW,36,D4) (ALQ,24+100,D3) (ALQ,72,D1)	45	24
36	0	0	2	1		D5,D6	(EW,48,D2) (ALQ,72,D1) (ALQ,124,D3) (ALQ,36+40,D4)	45	36
48	0	0	1	1		D6	(ALQ,72,D1) (ALQ,124,D3) (ALQ,76,D4) (ALQ,48+40,D2) (EW,48+16,D5)	45	48
64	0	0	0	1	-	-	(ALQ,72,D1) (ALQ,124,D3) (ALQ,76,D4) (ALQ,48+40,D2) (ALQ,64+80,D5) (EW,64+12,D6)	45	64
72	0	1	0	1	-	-	(ALQ,124,D3) (ALQ,76,D4) (ALQ,88,D2) (ALQ,144,D5) (EW,76,D6) (EL,D1,72+10)	45	72

Average Loader Utilization = (45/2) / 72 =0.31
Average Scale Utilization = 72/72 =1