GX585

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NATIONAL UNIVERSITY OF IRELAND, GALWAY

SEMESTER II EXAMINATIONS 1999-2000

3rd INDUSTRIAL ENGINEERING AND INFORMATION SYSTEMS

SYSTEMS SIMULATION IE 324

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Instructions:

Time Allowed: 2 Hours.
Attempt: 3 Questions. Show all your work clearly. All Questions carry equal marks. Random Variates from the Uniform Distribution on [0,1] included. Maths Tables and Cambridge Elementary Statistical Tables Supplied.

Question | **Marks**

Q.1 The Harassed Booking Officer **33.33***

A football ground employs a booking officer (BO) during the day. The BO is employed to sell tickets for the ground's matches and to answer any queries that may arise. Seat bookings are accepted only if the customer turns up in person at the ground and pays for the tickets. Enquiries can come either from someone there in person or from someone phoning the ground. The BO is instructed to give priority to personal customers – after all, they may hand over some cash. Thus if the phone rings just as a customer arrives in person, then the personal enquirer is served first. Thanks to a sophisticated phone system, incoming calls can queue on a FIFO basis until answered. Phone callers never ring off in frustration.

Develop an event-based model of this scenario. Use verbal descriptions (pseudocode) and flowcharts where appropriate to illustrate your answer.

Q.2 Write short notes on **four** of the following: **8.33*x4**

- Steps in computer simulation
- Manufacturing issues that simulation is used to address
- Measures of performance used in manufacturing simulation studies
- Verification and validation of computer simulation models
- The relative advantages and disadvantages of the Independent Replications and One Long Run methods of data collection for steady state simulations
- Possible sources of error when simulation output is analysed

Q.3 (a) Write short notes on: **16.66***

- The Poisson Distribution
- The Exponential Distribution
- The Erlang Distribution

(b) The number of take-offs at Tuam Local Airport is Poisson with mean 3 per hour. Use the antithetic technique to estimate the mean number of take-offs per hour. Clearly demonstrate the advantages of the antithetic technique in reducing the sampling error. **16.66***

Q.4 There are three stations on an assembly line and the service time at each station is exponentially distributed with a mean of 10. Items flow down the assembly line from server 1 to server 2 to server 3. A new unit is provided to server 1 every 15-time units. If any server has not completed processing its current unit within 15 minutes, the unit is diverted to one of two off-line servers who complete the remaining operations on the job diverted from the assembly line. One time unit is added to the remaining time of the operation that was not completed. Any following operations not performed are done so by the off-line servers in an exponentially distributed time with a mean of 16. One unit can be stored between each assembly line server. **33.33***

Draw a MicroSaint Network for the above system clearly indicating the presence of queues and decision points. List and define Variables, Functions and Scenario events as appropriate. Include information on Task, Job and Decision descriptions in your answer.

Q.5 (a) Describe the following modelling components in MicroSaint: **8.33***

- Variable catalog
- Function library
- Event queue

- Snapshots
- Execution monitor

(b) We are interested in using the chi-square test to check the fit of the Erlang distribution (with k=2 and λ=1) to the data below. **25**

3.20, 3.87, 2.51, 2.64, 2.97
3.09, 1.56, 3.12, 3.04, 2.37
1.93, 3.70, 3.62, 3.95, 1.71
1.75, 1.02, 3.17, 1.58, 3.88
2.39, 2.81, 3.81, 2.80, 1.35
2.10, 1.49, 1.50, 3.10, 1.12

We will do this without explicitly computing bin endpoints. Using 10 bins, we work with the following table:

Data Point Xi	CDF F(xi)	Bin Number
3.20	0.83	9
3.09	0.81	9
1.93	0.57	6
1.75		
2.39		

- Fill in the fourth and fifth lines of the table. Recall that the Erlang distribution is defined as follows:

$$F(x) = \begin{cases} 1 - \sum_{i=0}^{k-1} \frac{(x\lambda)^i e^{-\lambda x}}{i!} & x \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

Suppose that we completed the table and obtained the following bin counts:

Bin	1	2	3	4	5	6	7	8	9	10
Count	0	0	0	1	4	4	2	5	9	6

- Would you reject the null hypothesis at the $\alpha = 0.025$ level?

Table 1. Random Numbers

	1	2	3	4	5	6	7	8	9	10	11	12
1	18	20	84	29	91	73	64	33	15	67	54	07
2	25	19	05	64	26	41	20	09	88	40	73	34
3	73	57	80	35	04	52	81	48	57	61	29	35
4	12	48	37	09	17	63	94	08	28	78	51	23
5	54	92	27	61	58	39	25	16	10	46	87	17
6	96	40	65	75	16	49	03	82	38	33	51	20
7	23	55	93	83	02	19	67	89	80	44	99	72
8	31	96	81	65	60	93	75	64	26	90	18	59
9	45	49	70	10	13	79	32	17	98	63	30	05
10	01	78	32	17	24	54	52	44	28	50	27	68
11	41	62	57	31	90	18	24	15	43	85	31	97
12	22	07	38	72	69	66	14	85	36	71	41	58

Table 2. Normally Distributed Random Numbers

	1	2	3	4	5	6	7	8	9	10
1	1.46	0.09	-0.59	0.19	-0.52	-1.82	0.53	-1.12	1.36	-0.44
2	-1.05	0.56	-0.67	-0.16	1.39	-1.21	0.45	-0.62	-0.95	0.27
3	0.15	-0.02	0.41	-0.09	-0.61	-0.18	-0.63	-1.20	0.27	-0.50
4	0.81	1.87	0.51	0.33	-0.32	1.19	2.18	-2.17	1.10	0.70
5	0.74	-0.44	1.53	-1.76	0.01	0.47	0.07	0.22	-0.59	-1.03
6	-0.39	0.35	-0.37	-0.52	-1.14	0.27	-1.78	0.43	1.15	-0.31
7	0.45	0.23	0.26	-0.31	-0.19	-0.03	-0.92	0.38	-0.04	0.16
8	2.40	0.38	-0.15	-1.04	-0.76	1.12	-0.37	-0.71	-1.11	0.25
9	0.59	-0.70	-0.04	0.12	1.60	0.34	-0.05	-0.26	0.41	0.80
10	-0.06	0.83	-1.60	-0.28	0.28	-0.15	0.73	-0.13	-0.75	-1.49