DLSE-006

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY

FINAL YEAR FALL SEMESTER (SOFTWARE ENGINEERING)
EXAMINATIONS 2018
BATCH 2015-2016

Time: 3 Hours

Dated:07-02-2019
Max.Marks:60

Modeling & Simulation - SE-401

Instructions: Attempt all questions.

Q#1.

a. **Classify** the system w.r.t. interaction. [02]

b. **Differentiate** absolute performance and relative performance. [03]

c. Bill Youngdahl has been collecting data at the TU student grill. He has found that, between 5:00 P.M. and 7:00 P.M., students arrive at the grill at a rate of 25 per hour (Poisson distributed) and service time takes an average of 2 minutes (exponential distribution). There is only 1 server, who can work on only 1 order at a time. [06]

   i. What is the average time a student is in the grill area?

   ii. Suppose that a second server can be added and 2 servers act independently with each taking an average of 2 minutes. **Examine** the effect on the average time of a student in a system?

1.007
0.04

Q#2.

a. **Explain** techniques to generate random variates. [04]

b. Consider the ticket booth system with one ticketing counter is simulated. The system consists of those customers in waiting line plus the one checking out. A stopping time of 25 minutes is set for the model. The simulation analyst desires to estimate mean response time, mean proportion of customers who spend 5 or more minutes in the system and number of departures up to the current simulation time. **Outline** a table using event scheduling algorithm for the given IAT and ST. [05]

IAT	4	5	2	8	3	7
ST	5	3	4	6	2	7

41 4.6mm

Q#3.

a. **Explain** the steps of simulation study also depict through diagram. [03]

b. Records pertaining to monthly number of job related injuries at chemical plant were being studied by an NGO, the values for the past 120 months were as follows: [07]

Injuries/month	0	1	2	3	4	5	6
frequency	40	46	16	9	4	3	2

Figure out that underlying distribution is Poisson using chi-square goodness of fit test (Use the 0.05 level of significance and critical value = 5.99)

31.24

Q#4

a) **Discuss** types of validity and **explain** the techniques to validate a simulation model [04]

b) **Elaborate** Petri net and its initiative structures [03]

c) Assume that a man's profession can be classified as professional, skilled laborer, and unskilled laborer, assume that of the sons of professional men, 70% are professional, rest split evenly in other two categories. In case of skilled labors 60% are skilled laborers, 30% are professional and 10% are unskilled laborer. Finally in case of unskilled laborers 50% of sons are unskilled laborers, 25% are in other two categories. Set up transition matrix, **find** probability that randomly chosen grandson of unskilled laborer is a professional man. [03]

Q#5

a) **Give** list of the steps of input modeling [02]

b) **Clarify** any four characteristics of queueing systems [03]

c) Create a petri net from the following metrics, also draw a reachability graph, **Examine** is the petri net bounded and live? [05]

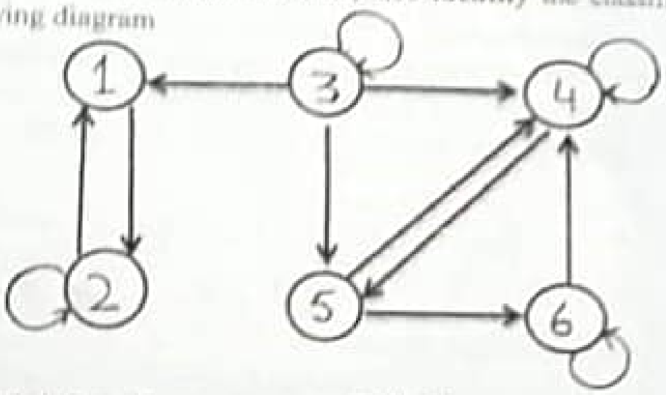
I⁻ =	T_1	T_2	T_3	T_4	T_5
P_1	1	1	0	0	0
P_2	0	1	0	1	0
P_3	0	0	1	0	0
P_4	0	0	0	0	1

I⁺ =	T_1	T_2	T_3	T_4	T_5
P_1	0	0	2	0	1
P_2	1	0	0	0	0
P_3	0	1	0	0	0
P_4	0	0	0	1	0

Mo =	
	2
	0
	0
	0

Q#6

a. Explain common markov models, also **identify** the classification of states of markov chain for following diagram [05]



b) **List and define** the components of DESM [03]

c) **Explain** stochastic processes and its classification [02]

——— x ———

MS:

2018 Q1c). $\lambda = 25/hr$

~~$\mu = 2\lambda$~~

$T_s = 2$ minutes

$$\mu = \frac{1}{2} \times 60 = 30/hr.$$

i) $W_s = ?$

ii). $c = 2$

$\mu = 30/hr.$

$W_s = ?$

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i) $W_s = \dfrac{1}{\mu-\lambda}$

$= \dfrac{1}{30-25} = \dfrac{1}{5} = 0.2\,hr$

ii). $\because \rho = \dfrac{\lambda}{c\mu} = \dfrac{25}{2(30)} = 0.41667.$

$c\rho = 0.833.$

$P_0 = \left\{ \left[\sum_{n=0}^{c-1} (c\rho)^n \right] + \left[\dfrac{(c\rho)^c}{c!(1-\rho)} \right] \right\}^{-1}$

$= \left\{ (1+0.833) + \dfrac{0.833^2}{2(1-0.41667)} \right\}^{-1}$

$= \left\{ 1.833 + 0.5951 \right\}^{-1} = 2.4284^{-1}$

$= 0.4117$

$L_s = c\rho + \dfrac{(c\rho)^{c+1} P_0}{c!\,c(1-\rho)^2} = 0.833 + \dfrac{0.833^3 (0.4117)}{4(1-0.41667)^2}$

$= 1.0083 = 1$ or 2 stds

$W_s = \dfrac{L_s}{\lambda} = \dfrac{1.0083}{25}$

$= 0.0403$ hrs.

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	c_1	c_2	c_3	c_4	c_5	c_6	c_7
IAT	0	4	5	2	8	3	7
ST	5	3	4	6	2	7	

2018

Q2b) $e_1 = 25$ mins

$S_{avg} = ?$

ND = ?

$F_{25\,avg} = ?$ no. of people in queue

no. of people in svc.

System state: $LQ(t)$, $LS(t) \to 0/1$

Event: Arrival A, Departure D

Entity: C_i (customers)

Event notice: (A, t, C_i)

(D, t, C_i)

clock	Sys states		Checkout time	FEL	Cumulative stats		
	$LQ(t)$	$LS(t)$			S	ND	F_{25}
0	0	1	$(C_1, 0)$	$(D,5,C_1)$ $(A,4,C_2)$	0	0	0
4	1	1	$(C_1,0)(C_2,4)$	$(D,5,C_1)$ $(A,9,C_3)$	0	0	0
5	0	1	$(C_2,4)$	$(D,8,C_2)$ $(A,9,C_3)$	5	1	1
8	0	0	-	$(A,9,C_3)$	9	2	1
9	0	1	$(C_3,9)$	$(D,13,C_3)$ $(A,11,C_4)$	9	2	1
11	1	1	$(C_3,9)(C_4,11)$	$(D,13,C_3)$ $(A,19,C_5)$	9	2	1
13	0	1	$(C_4,11)$	$(A,19,C_5)$ $(D,19,C_4)$	13	3	1
19	0	~~0~~ 1	$(C_5,19)$	$(D,21,C_5)$ $(A,22,C_6)$	21	4	2
21	0	0	-	$(A,22,C_6)$	23	5	2
22	0	1	$(C_6,22)$	$(D,29,C_6)$ $(A,29,C_7)$	23	5	2

$e_1 = 25$

$ND = 5.$

$S_{avg} = \frac{23}{5} = 4.6 \cdot min.$

$F_{25} = \frac{2}{5} = 0.4 \simeq 1$

2018

Q3b).

Injuries /month	0	1	2	3	4	5	6
Frequency.	40	46	16	9	4	3	2.

$\alpha = 0.05.$

~~DF = 5.99.~~ $DF = K - s - 1$

$= 4 - 1 - 1 = 2.$

x_i	O_i		$P_i = \frac{e^{-\lambda}(\lambda)^{x_i}}{x_i!}$	$e_i = 120 p_i$		$\chi_0^2 = \frac{(O_i - E_i)^2}{E_i}$
0	40		0.2922	35.064		0.6948
1	46		0.3595	43.14		0.1896
2	16		0.2211	26.532		4.1807
3	9		0.0906	10.3727		
4	4	18	0.0278.	3.336	15.1936	0.51635
5	3		6.857×10^{-3}	0.822		
6	2.		1.405×10^{-3}	0.1686		

$\Sigma \chi_0^2 = 5.5814$

$\bar{X} = \lambda = \frac{0(40) + 1(46) + 2(16) + 3(9) + 4(4) + 5(3) + 6(2)}{120}$

$= 1.23.$

$\chi_0^2 > \chi^2_{\alpha, DF}$

$5.5814 \not> 5.99$

Rejected.

$\chi^2_{\alpha, DF} = \chi^2_{0.05, 2} = 5.99.$

2018

Q4c)

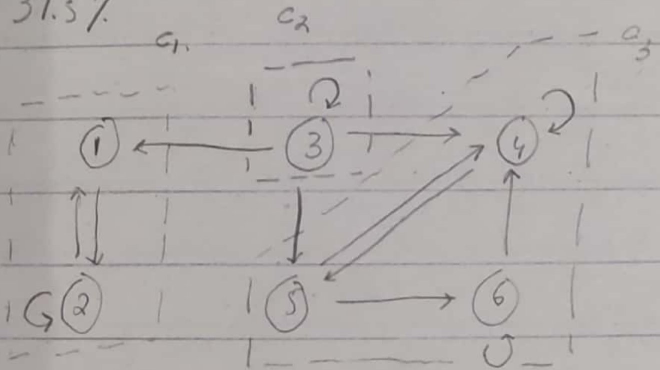
$$M = \begin{array}{c|ccc} & P & S & U \\ P & 0.7 & 0.15 & 0.15 \\ S & 0.3 & 0.6 & 0.1 \\ U & 0.25 & 0.25 & 0.5 \end{array}$$

$$M^2 \Rightarrow \begin{array}{c|ccc} & P & S & U \\ P & 0.5725 & 0.2325 & 0.195 \\ S & 0.415 & 0.43 & 0.155 \\ U & 0.375 & 0.3125 & 0.3125 \end{array}$$

$U \rightarrow P = 37.5\%$

2018

Q6a)



ACCESSIBLE	All states.
COMMUNICATING	1, 2, 4, 5
RECURRENT	C_1, C_3
TRANSIENT	C_2.
ABSORBING	C_1, C_3

C_1: (1) 1-2-1 (2)

(2) 2-1-2 (2,1)

2-2

gcd (1,2) = 1

AP

C_2: 0 AP

C_3: (4) 4-4 (1,3)

4-5-6-4

(5) 5-6-4-5 (3)

(6) 6-6 (1,3)

6-4-5-6

gcd = 1 AP.

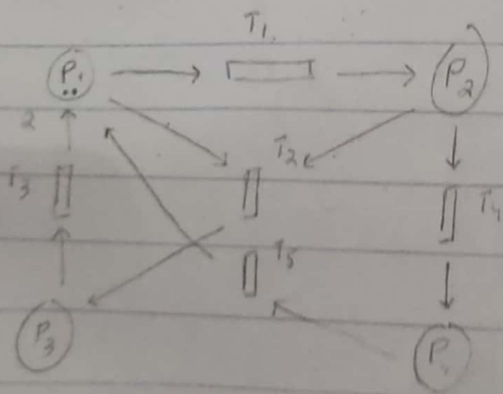
Dhaka
2018

Q5(c).

$$E^+ = \begin{array}{c|ccccc} & T_1 & T_2 & T_3 & T_4 & T_5 \\ \hline P_1 & 1 & 1 & 0 & 0 & 0 \\ P_2 & 0 & 1 & 0 & 1 & 0 \\ P_3 & 0 & 0 & 1 & 0 & 0 \\ P_4 & 0 & 0 & 0 & 0 & 1 \end{array}$$

$$E^- = \begin{array}{c|ccccc} & T_1 & T_2 & T_3 & T_4 & T_5 \\ \hline P_1 & 0 & 0 & 2 & 0 & 1 \\ P_2 & 1 & 0 & 0 & 0 & 0 \\ P_3 & 0 & 1 & 0 & 0 & 0 \\ P_4 & 0 & 0 & 0 & 1 & 0 \end{array}$$

$$M_0 = \begin{pmatrix} 2 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$



REACHABILITY GRAPH:

$[P_1^2] \xrightarrow{T_1} [P_1, P_2] \xrightarrow{T_5} [P_1, P_4] \xrightarrow{T_1} [P_2, P_4] \xrightarrow{T_5} [P_2, P_1]$

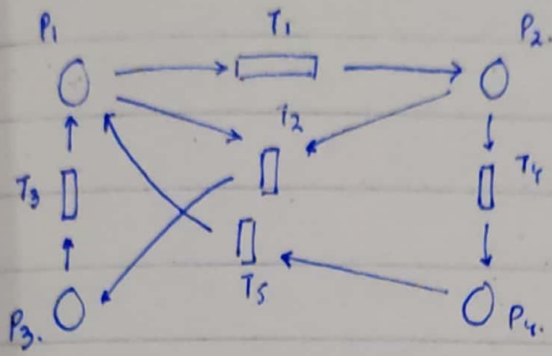
$[P_1, P_4] \xrightarrow{T_5} [P_1^2]$

$[P_2, P_4] \xrightarrow{T_4} [P_1^2] \xrightarrow{T_5} [P_1, P_4] \xrightarrow{T_5} [P_1^2]$

$[P_1, P_4] \xrightarrow{T_1} [P_2, P_4]$

$[P_1, P_2] \xrightarrow{T_2} [P_3] \xrightarrow{T_3} [P_1] \xrightarrow{T_1} [P_2] \xrightarrow{T_4} [P_4]$

$[P_1, P_2] \xrightarrow{T_1} [P_2^2] \xrightarrow{T_4} [P_2, P_4] \xrightarrow{T_5} [P_1, P_2] \xrightarrow{T_5} [P_2]$



$P_1 \rightarrow 2B$

$P_2 \rightarrow 2B.$

$P_3 \rightarrow$ safe.

$P_4 \rightarrow 2B$

$$
\begin{array}{cccc}
P_1 & P_2 & P_3 & P_4 \\
(2 & 0 & 0 & 0)
\end{array}
$$

$\downarrow T_1$

$(1\ 1\ 0\ 0) \xrightarrow{T_1} (0\ 2\ 0\ 0)$

$T_4 \swarrow \qquad \downarrow T_2$

$(1\ 0\ 0\ 1) \qquad (0\ 0\ 1\ 0)$

$\downarrow T_1 \qquad \downarrow T_3$

$(0\ 1\ 0\ 1) \xleftarrow{T_4} (1\ 0\ 0\ 0)$

$\downarrow T_4 \qquad \downarrow T_1$

$T_5\ (0\ 0\ 0\ 2) \qquad (0\ 1\ 0\ 0)$

$\downarrow T_4$

$(0\ 0\ 0\ 1)$

$\downarrow T_5$

$(1\ 0\ 0\ 0)$

SEAT NO. ______________

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY

FINAL YEAR FALL SEMESTER (SOFTWARE ENGINEERING) EXAMINATIONS 2019

BATCH 2016-2017

Time: 3 Hours

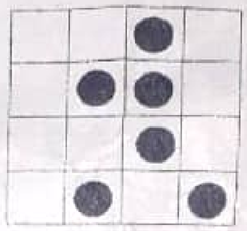
Dated:03-02-2020
Max.Marks:60

Modeling & Simulation - SE-405

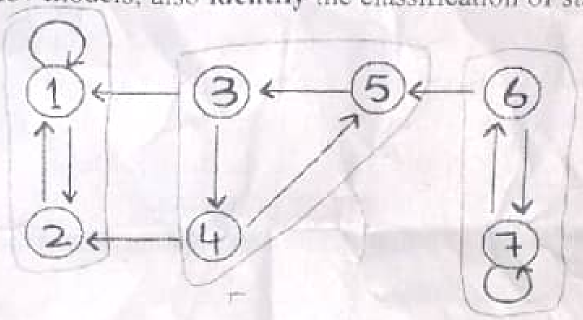
Instructions: Attempt All Questions

Q#1: CLO4

a. For the giving 4*4 grid, apply rule of life to **figure out** the transitions of next four generations. State rule 110 of elementary CA with example and classify elementary CA according to Wolfram. [05]



b. Explain common markov models; also **identify** the classification of states of markov chain for following diagram. [05]



Q#2: CLO3

a. The manager of a commercial mortgage department of a large bank has collected data during the past two years concerning the number of commercial mortgages approved per week. The results from these two years (107 weeks) indicated the following: [06]

Number of commercial mortgages approved	0	1	2	3	4	5	6	7
Frequency	14	24	33	18	8	7	2	1

Apply Chi-square test to find whether the distribution of commercial mortgages approved per week follow a Poisson distribution? (Use the 0.01 level of significance, critical value is 13.28.)

b. **Classify** types of system according to output analysis, discuss absolute measure of performance and its estimations also high light the concept of biased estimators. [04]

Q#3: CLO2

a. According to Kemeny, Snell, and Thompson, the Land of Oz is blessed by many things, but not by good weather. They never have two nice days in a row. If they have a nice day, they are just as likely to have snow or rain the next day with equal probabilities. If they have snow, they have an equal chance of having the rainy and nice day and 50% chance of snowy day. If there [03] is a rainy day, than 50% chance is of rainy day again, 30% chance is of snowy day. Set up transition matrix and **compute** measure for the next three days' weather

b. **Discuss** types of system according to uncertainties involved and according to degree of interconnection of events. Also differentiate stead state and transient models. [03]

c. Define random variate, **elaborate** different techniques to generate random variates [04]

Q#4: CLO3

a. **Create** a petri net from the following metrics, also **draw** a reachability graph, find out is the petri net bounded and live? [05]

$E^+=$				
P1	1	1	0	0
P2	0	0	1	0
P3	0	0	0	1
P4	0	0	1	0
P5	0	0	0	1

$E^-=$				
	0	0	1	0
	1	0	0	1
	0	1	0	0
	0	0	0	1
	0	0	1	0

$M_0=$	
	1
	0
	0
	1
	1

b. **Provide** definitions of the following : [05]

i. Geometric distribution
ii. Poisson process
iii. Calling population
iv. Next event time advance mechanism
v. List processing

Q#5: CLO5

a. Six dump trucks are used to haul coal from the entrance of a small mine to the railroad. Each truck is loaded by one of two loaders. After a loading, the truck immediately moves, this system is simulated. The system consists of those trucks in waiting line plus the one that is leaving. A stopping time of 24 minutes is set for the model. The simulation analyst desires to estimate mean response time, mean proportion of trucks that spend 5 or more minutes in the system and number of departures up to the current simulation time. **Outline** a table using event scheduling algorithm for the given IAT and ST. [06]

IAT	3 2	2 3	6 4	2 5	4 6	5 7
ST	2 1	5 2	5 3	8 4	4 5	5 6

b. Define markov chains also **Identify** the common markov models. [02]

c. **Explore** Petri net its uses and its initiative structures. [02]

Q#6: CLO2

a. A machine shop repairs small electric motors, which arrive according to a Poisson process at the rate 12 per week (5-day, 40-hour workweek). An analysis of past data indicates that engines can be repaired with service time of 2 hours. **Compute** a) service factor for this system? b) Average number of these motors in service? c) What impact on machines in service would there be if a 3 technicians are available? [04]

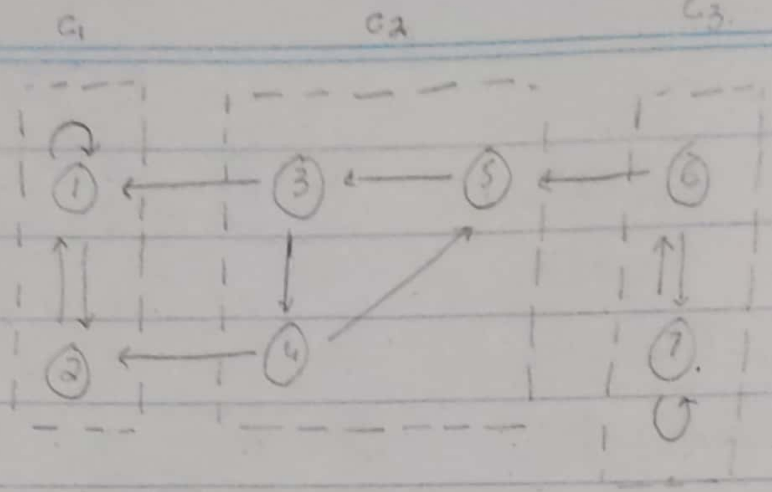
b. List the steps of input modeling, **Give** pitfalls of data collection how these pitfalls can be handled. [03]

c. **Describe** different techniques validation of a simulation model. [03]

—— x ——

2019

Q1b.



ACCESSIBLE: All states.

COMMUNICATING. 1-2, 6-7.

RECURRENT: C_1

TRANSIENT: C_2, C_3

ABSORBING: C_1

AP

C_1: 1. 1-1 (1)

1-2-1 (2)

~~gcd(1,2)=1~~

2 2-1-2 (2)

P

C_2: 3: 3-4-5-3 (3)

4: 4-5-3-4 (3)

5: 5-3-4-5 (3)

gcd = 3.

AP

C_3: 6 6-7-6. (2).

7 7-7 (1)

~~7-6-7 (2)~~

gcd = 1

2019

Q2a. $\alpha = 0.01$

$\chi^2_{\alpha, DF} = 13.28$

x_i	O_i	$p_i = \frac{e^{-\lambda}(\lambda)^{x_i}}{x_i!}$	$E_i = 107p_i$	$\chi_0^2 = \frac{(O_i - E_i)^2}{E_i}$
0	14	0.1166	12.4762	0.186
1	24	0.2505	26.803	0.293
2	33	0.2692	28.8044	0.611
3	18	0.192	20.544	0.315
4	8	0.1036	11.085	0.8585
5	7] 10	0.0445] 0.0217	4.7615] 6.9866	
6	2	0.0159	1.7013	1.299
7	1	4.896×10^{-3}	0.5233	

$\sum \chi_0^2 = 3.5625$

$\bar{x} = \lambda = (0 + 24 + 66 + 18(3) + 32 + 35 + 12 + 7)/107$

$= 2.149$

$DK = K - 3 - 1$

$= 6 - 1 - 1 = 4$

$\chi^2_{0.01, 4} =$

$\chi_0^2 > \chi^2_{\alpha, DF}$

$3.5625 \not> 13.28$

$\therefore$ Rejected

2019.

Q3

$$M = \begin{array}{c|ccc} & N & S & R \\ \hline N & 0 & 0.5 & 0.5 \\ S & 0.25 & 0.5 & 0.25 \\ R & 0.2 & 0.3 & 0.5 \end{array}$$

↳ TRANSITION MATRIX

Now for next 3 days.

$[M]^1$: Next day.

$[M]^2$: Day after tomorrow.

$[M]^3$: Day a/f. day. a/f tomorrow.

2019

Q5 $e_s = 24$ mins

$S_{avg} = ?$

$F_{25} = ?$

$ND = ?$

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
IAT	0	3	2	6	2	4	5
ST	2	5	5	8	4	5	

CLOCK	SYS STATES		CHECKOUT TIME	FEL	CUMULATIVE STATS		
	LQ(t)	LS(t)			S	ND	F_{25}
0	0	1	$(C_1,0)$	$(D,2,C_1)(A,3,C_2)$	0	0	0
2	0	0	–	$(A,3,C_2)$	2	1	0
3	0	1	$(C_2,3)$	$(D,8,C_2)(A,5,C_3)$	2	1	0
5	1	1	$(C_2,3)(C_3,5)$	$(D,8,C_2)(A,10,C_4)$	2	1	0
8	0	1	$(C_3,5)$	$(D,13,C_3)(A,11,C_4)$	7	2	1
11	1	1	$(C_3,5)(C_4,11)$	$(D,13,C_3)(A,13,C_5)$	7	2	1
13	1	1	$(C_4,11)(C_5,13)$	$(D,21,C_4)(A,17,C_6)$	15	3	2
17	2	1	$(C_4,11)(C_5,13)(C_6,17)$	$(D,21,C_4)(A,22,C_7)$	15	3	2
21	1	1	$(C_5,13)(C_6,17)$	$(D,25,C_5)(A,22,C_7)$	25	4	3
22	2	1	$(C_5,13)(C_6,17)(C_7,22)$	$(D,25,C_5)$	25	4	3

$e_s = 24$ mins

$S_{avg} = \frac{25}{4} = 6.25$

$F_{25} = \frac{3}{4} = 0.75$

$ND = 4$

2019.

Q6a $\lambda = 12/\text{week}$

$T_s = 2\text{hrs}$ $\mu = \frac{1}{2} \times 40 = 20/\text{week}$

a) $\rho = ?$

b) $L_q = ?$

c) $c = 3$ $L_q = ?$

a) $\rho = \frac{\lambda}{\mu} = \frac{12}{20} = 0.6 = 60\%$

b) $L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = \frac{12^2}{20(8)} = 0.9$ 0.081 motors

c). $\rho = \frac{\lambda}{c\mu} = \frac{12}{3(20)} = 0.2 = 20\%$

$c\rho = 0.6 = 60\%$

$$P_0 = \left\{ \left[\sum_{n=0}^{c-1} \frac{(c\rho)^n}{n!} \right] + \left[c\rho^c \cdot \frac{1}{c!} \cdot \frac{1}{1-\rho} \right] \right\}^{-1}$$

$$= \left\{ \left[0.6^0 + 0.6^1 + \frac{0.6^2}{2} \right] + \left[0.6^3 \cdot \frac{1}{6} \cdot \frac{1}{1-0.2} \right] \right\}^{-1}$$

$$= \left\{ (1 + 0.6 + 0.18) + \left(\frac{0.216}{4.8} \right) \right\}^{-1}$$

$$= (1.78 + 0.045)^{-1} = 1.825^{-1}$$

$$= 0.5477.$$

$$L_s = c\rho + \frac{c\rho^{c+1} P_0}{c(c!)(1-\rho)^2}$$

$$= 0.6 + \frac{0.6^4 (0.5479)}{3(6)(1-0.2)^2}$$

$$= 0.6061$$

$$W_s = \frac{L_s}{\lambda} = \frac{0.6061}{12} = 0.0505$$

$$W_q = W_s - \frac{1}{\mu} = 0.0505 - \frac{1}{20}$$

$$= 5.0833 \times 10^{-4}$$

$$L_q = \lambda W_q = 6.09996 \times 10^{-3}$$

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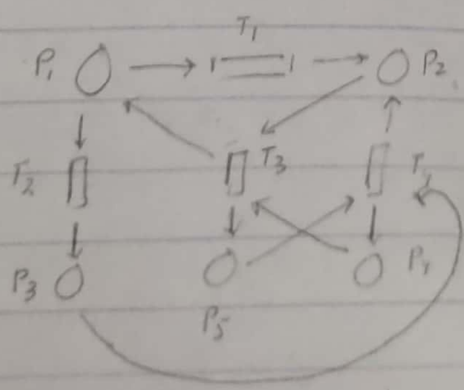
2019

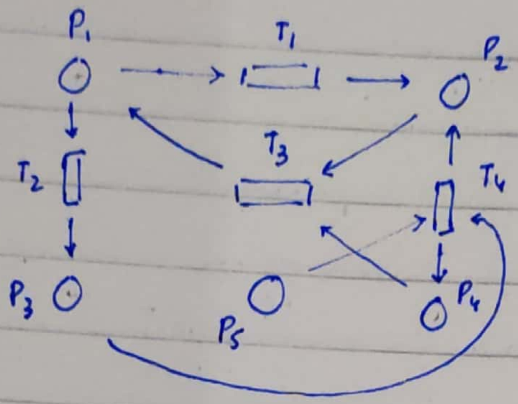
Q4.

$$E^{+} = \begin{array}{c|cccc} & T_1 & T_2 & T_3 & T_4 \\ \hline P_1 & 1 & 1 & 0 & 0 \\ P_2 & 0 & 0 & 1 & 0 \\ P_3 & 0 & 0 & 0 & 1 \\ P_4 & 0 & 0 & 1 & 0 \\ P_5 & 0 & 0 & 0 & 1 \end{array}$$

$$E^{-} = \begin{array}{c|cccc} & T_1 & T_2 & T_3 & T_4 \\ \hline P_1 & 0 & 0 & 1 & 0 \\ P_2 & 1 & 0 & 0 & 1 \\ P_3 & 0 & 1 & 0 & 0 \\ P_4 & 0 & 0 & 0 & 1 \\ P_5 & 0 & 0 & 1 & 0 \end{array}$$

$$M_0 = \begin{pmatrix} 1 \\ 0 \\ 0 \\ 1 \\ 1 \end{pmatrix}$$





P_1	P_2	P_3	P_4	P_5
(1	0	0	1	1)

$\xrightarrow{T_1}$ (0 1 0 1 1)

- $\xrightarrow{T_3}$ (1 0 0 0 1)
  - $\xrightarrow{T_1}$ (0 1 0 0 1) → DEADLOCK.
  - $\xrightarrow{T_2}$ (0 0 1 0 1) $\xrightarrow{T_4}$ (0 1 0 1 0)

$\xrightarrow{T_2}$ (0 0 1 1 1)

- $\xrightarrow{T_4}$ (0 1 0 2 0)
- $\xrightarrow{T_3}$ (1 0 0 1 0)
  - $\xrightarrow{T_2}$ (0 0 1 1 0) → DEADLOCK.
  - $\xrightarrow{T_1}$ (0 1 0 1 0)
    - $\xrightarrow{T_3}$ (1 0 0 0 0)
    - $\xrightarrow{T_1}$ (0 1 0 0 0) → DEADLOCK.

P_1: safe.
P_2: safe.
P_3: safe.
P_4: 2B.
P_5: safe

LIVE

DEADLOCK.

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY

FINAL YEAR FALL SEMESTER (SOFTWARE ENGINEERING)
EXAMINATIONS 2017-2018
BATCH 2014-2015

Time: 3 Hours | **Dated:09-03-2018**
Max.Marks:60

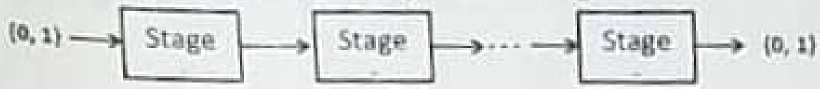
Modeling & Simulation - SE-401

Instructions:

i. Attempt any five questions.
ii. All questions carry equal marks.
iii. Attempt questions and their parts in the given order.

QUESTION NO. 1

(a) What is a Stochastic process ? Describe Marchov process and Marchov chain.
(b) A binary communication channel transmits 0 and 1 through multiple stages. The probability, that the output of a given stage is the same as its input, is 0.75. Model the process as a Markov chain and hence calculate the probability that a 0 entering the first stage is received as 0 by the fifth stage.



QUESTION NO. 2

(a) Explain Monte Carlo simulation with the help of an example.
(b) Generate a manual event list for customers arriving at a single-queue, single-server system. Calculate system time, average number in queue, and resource utilization based on the system for 18 min.

Inter-arrival times in minutes for 10 arrivals: 2, 1, 3, 1, 3, 2, 4, 2, 1, 1

Service times in minutes for 10 arrivals: 2, 3, 1, 3, 2, 2, 1, 3, 2, 2

QUESTION NO. 3

(a) What are Petri nets ? How these are used in system modeling.
(b) Model the following constructs by Petri nets;

i- Sequential actions ii- Concurrency iii- Dependency
iv- Cycles v- Conflict vi- Synchronization

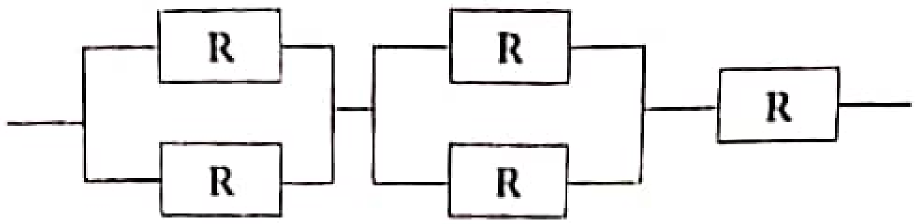
QUESTION NO. 4

(a) Discuss Availability Analysis. What is Instantaneous Availability ?
(b) Draw and discuss the following curves:

i- Load vs Throughput
ii- Load vs Response Time

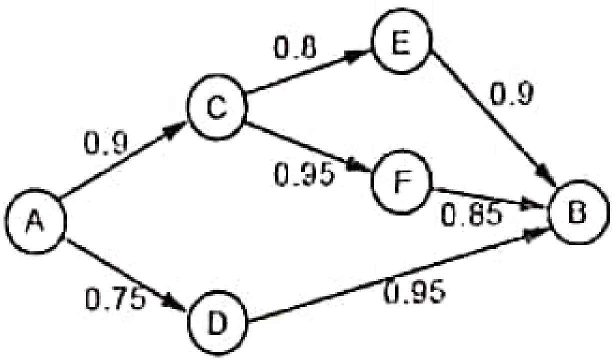
QUESTION NO. 5

(a) What is Reliability ?
Express the reliability of a series system in the form of a mathematical model.
By taking an appropriate example show that the reliability of a series system degrades
As the complexity of the system is increased.



Write the expression for the overall Reliability of the system given in the above Reliability Block Diagram.

(b) A computer network connects two nodes A and B through intermediate nodes C, D, E, F, as shown. For every pair of directly connected nodes, say i and k, there is a given probability p_{ik} that the link from i to k is up. We assume that link failures are independent of each other.
What is the probability that there is a path connecting A and B in which all links are up?



QUESTION NO. 6

(a) Consider a single server, infinite queue length and infinite population queueing model where arrival and service of entities both follow the Markovian property.
Model the system at steady state and derive expression for expected number of entities is the system.

(b) Consider an M/M/1: ∞/∞ queuing system which has a Poisson arrival rate of 8/hr. and an exponential service rate of 9/hr. Find the following:

i- Probability that there is no entity in the system
ii- Probability that there is no queue
iii- Probability that there are at least two entities in the system
iv- Expected number of entities in the queue and in the system

—— X ——

2017-2018.

Q2b $L_q = ?$

$\rho = ?$

$W_s = ?$

$\lambda = (2+1+3+1+3+2+4+2+1+1)/10 = 2/min$

$\mu = (2+3+1+3+2+2+1+3+2+2)/10 = 2.1/min$

$\rho = \frac{\lambda}{\mu} = \frac{2}{2.1} = 0.9523 = 95.23\%$

$W_s = \frac{1}{\mu-\lambda} = \frac{1}{2.1-2} = \frac{1}{0.1} = 10\ min$

$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = \frac{2^2}{2.1}(10) = 19.047 = 17$ or 20 customers.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
IAT	0	2	1	3	1	3	2	4	2	1	1
ST	2	3	1	3	2	2	1	3	2	2	

CLOCK	SYS STATE		CHECKOUT ~~LINE~~	FEL	CUMULATIVE STATS		
	LQ(t)	LS(t)			S	ND	$F_{\geq 5}$
0	0	1	$(C_1, 0)$	$(D, 2, C_1)$ $(A, 2, C_2)$	0	0	0
2	0	1	$(C_2, 2)$	$(D, 5, C_2)$ $(A, 3, C_3)$	2	1	0
3	1	1	$(C_2, 2)(C_3, 3)$	$(D, 5, C_2)$ $(A, 6, C_4)$	2	1	0
5	0	1	$(C_3, 3)$	$(D, 6, C_3)$ $(A, 6, C_4)$	5	2	0
6	0	1	$(C_4, 6)$	$(D, 9, C_4)$ $(A, 7, C_5)$	8	3	0
7	1	1	$(C_5, 7)(C_4, 6)$	$(D, 9, C_4)$ $(A, 10, C_6)$	8	3	0
9	0	1	$(C_5, 7)$	$(A, 10, C_6)$ $(D, 11, C_5)$	11	4	0

10	1	1	(C_6, 10) (C_5, 7)	(D, 11, C_5) (A, 12, C_7)	11	4	0
11	0	1	(C_6, 10)	(D, 13, C_6) (A, 12, C_7)	15	5	0
12	1	1	(C_6, 10) (C_7, 12)	(D, 13, C_6) (A, 16, C_8)	15	5	0
13	0	1	(C_7, 12)	(D, 14, C_7) (A, 16, C_8)	18	5	0
14	0	0	–	(A, 16, C_8)	20	5	0
16	0	1	(C_8, 16)	(D, 17, C_8) (A, 18, C_9)	20	5	0
18	1	1	(C_8, 16) (C_9, 18)	(D, 19, C_8) (A, 19, C_9)	20	5	0

2017-2018.

Q5b) $\lambda = 8/hr$.

$\mu = 9/hr$.

i) P_0

ii) P

iii) P_2

iv) L_s, $L_q = ?$

iv). $\rho = \frac{\lambda}{\mu} = \frac{8}{9} = 0.887$.

$P_0 = 1-\rho = 0.1111$

$L_s = \frac{1}{\mu-\lambda}$ $\qquad$ $L_q = \frac{\lambda}{\mu(\mu-\lambda)}$

$= 1$ hr entity. $\qquad$ $= 0.887$ hr entity

i). $P_0 = \sum_{n=0}^{0} P_0 \rho^n = (1-0.887)(0.887)^0$

$= 0.1111$

iii) $\sum_{n=0}^{2} P_0 \rho^n = (0.1111)(0.887)^0 + (0.1111)(0.887)^1 + (0.1111)(0.887)^2$

$= 0.2774 = 27.74\%$