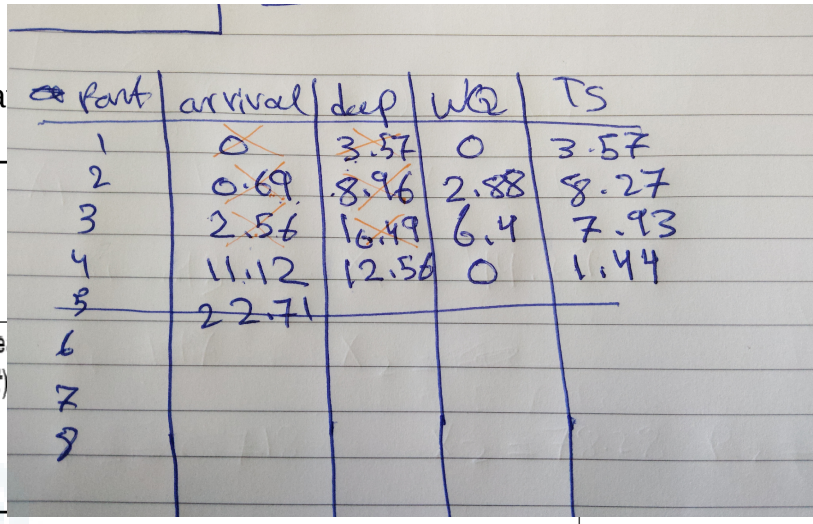
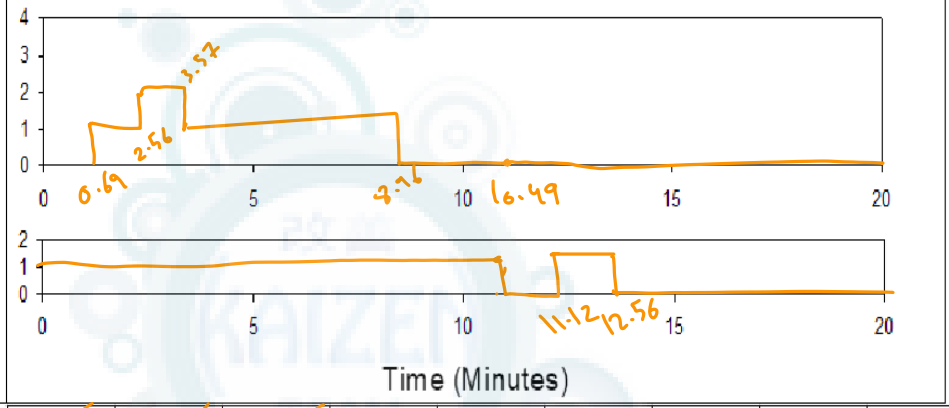



Created by Notein

1.0 a) Solve the following using hand simula

| System | Clock | B(t) | Q(t) |
|---|---|---|---|
| Number of completed waiting times in queue | Total of waiting times in queue | Are Q(t) | |

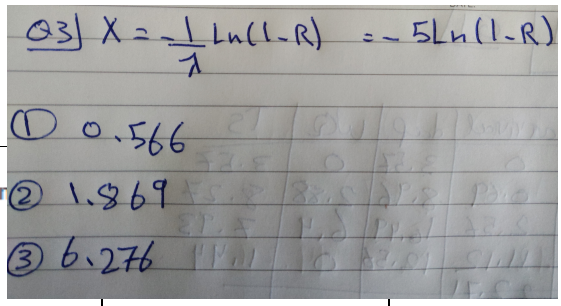


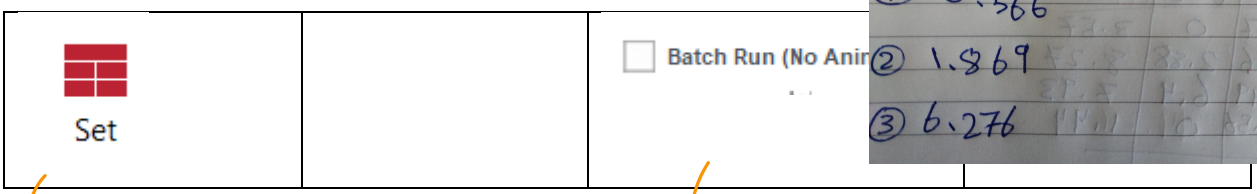

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Interarrival times | 0.69 | 1.87 | 8.56 | 11.59 | 3.93 | 5.90 | 3.14 | 7.38 | 6.99 |
| Service times | 3.57 | 5.39 | 1.53 | 1.44 | 11.08 | 3.76 | 3.06 | 8.91 | 1.90 |

1.0 b)Using linear congruential technique generate next three random numbers ([0-1]) parameters a=11 , c=34 m=101 X0=71 (3 points)

1.0 c) For the rand numbers [0,0.1] {0.107, 0.312 0.715] generate exponential distribution random numbers with mean (1/λ) = 5 (3 points)




2.0 a) What are these arena symbols ( 2 points)



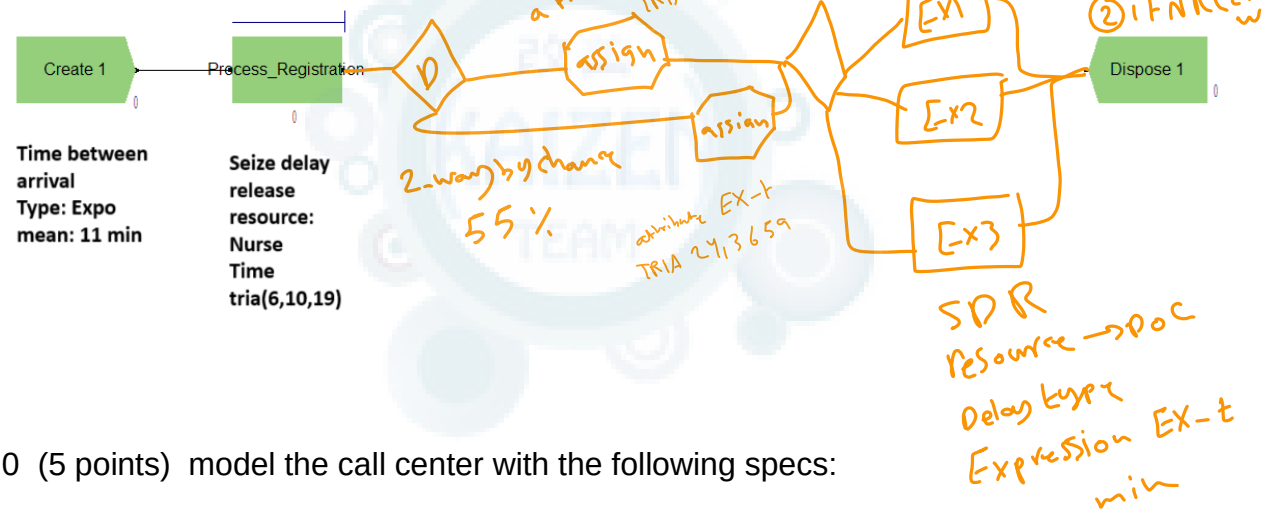

↳ to group the resource insets depending on what type they are or to use Tally or Count to get detailed statics

↳ to run the system w/o animation and see the result in excel after run



Created by Notein

2.0 (5 points) An acute-care facility treats non-emergency patients (cuts, colds, etc.). Patients arrive according to an exponential interarrival-time distribution with a mean of 11 (all times are in minutes). Upon arrival they check in at a registration desk staffed by a single nurse. Registration times follow a triangular distribution with parameters 6, 10, and 19. After completing registration, they wait for an available examination room; there are three identical rooms. Data show that patients can be divided into two groups with regard to different examination times. The first group (55% of patients) has service times that follow a triangular distribution with parameters 14, 22, and 39. The second group (45%) has triangular service times with parameters 24, 36, and 59. Upon completion, patients are sent home. Model using arena simulation




3.0 (5 points) model the call center with the following specs:

One phone number for customers to call in to 26 trunk lines, one needed for each call (incoming or outgoing, talking or on hold) Arriving call finding no free trunk lines gets busy signal, goes away Count number of such rejected calls Calls arrive with interarrivals ~ EXPO (0.857) min. First call arrives at time 0 Three incoming call types Initial recording to decide ~ UNIF (0.1, 0.6) min. Tech support (76%), sales (16%), order status (8%) Tech-support calls For product type 1 (25%), 2 (34%), or 3 (41%) Needs qualified tech-support person Two for type 1, three for type 2, three for type Separate FIFO queues for each type Conversation time ~ TRIA (3, 6, 18) min. for all types Then leaves system

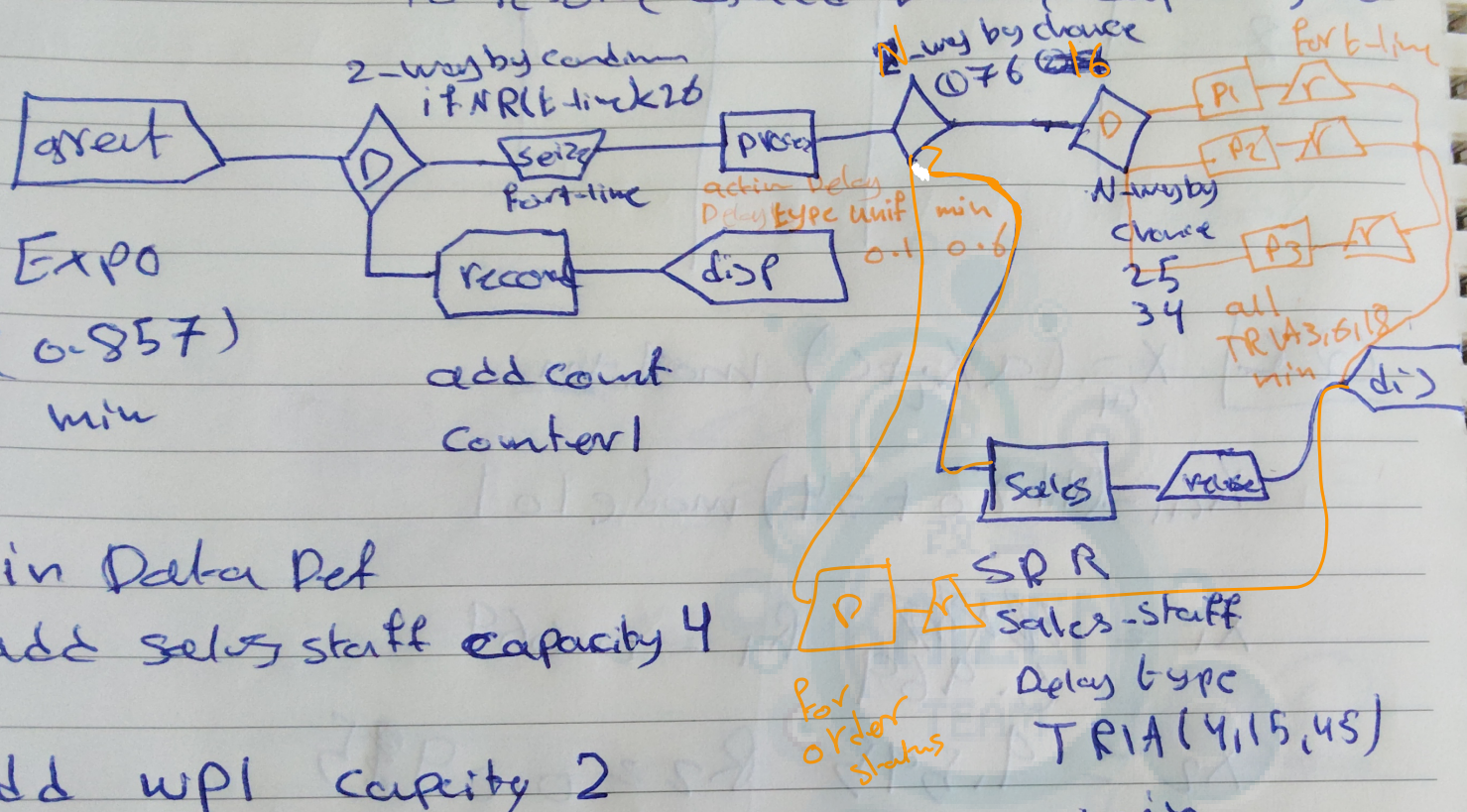


Created by Notein

Call center

inData Def

to resource → add t-line Capacity 26




in Data Def

add sales staff capacity 4

add wp1 capacity 2

wp2 " 3

WP3 " 3

~~in Set add set~~

~~add wp1~~

WP2 → inData_Def → que → For all Select FIFO

$P_1 \rightarrow SRR \rightarrow wp1$

$P_2 \rightarrow SRR \rightarrow wp2$

$P_3 \rightarrow SPR \rightarrow wp3$

Created by Notein

Sales calls All the same Four sales staff, all the same One FIFO queue feeding all sales staff Conversation time ~ TRIA (4, 15, 45) Then leaves system

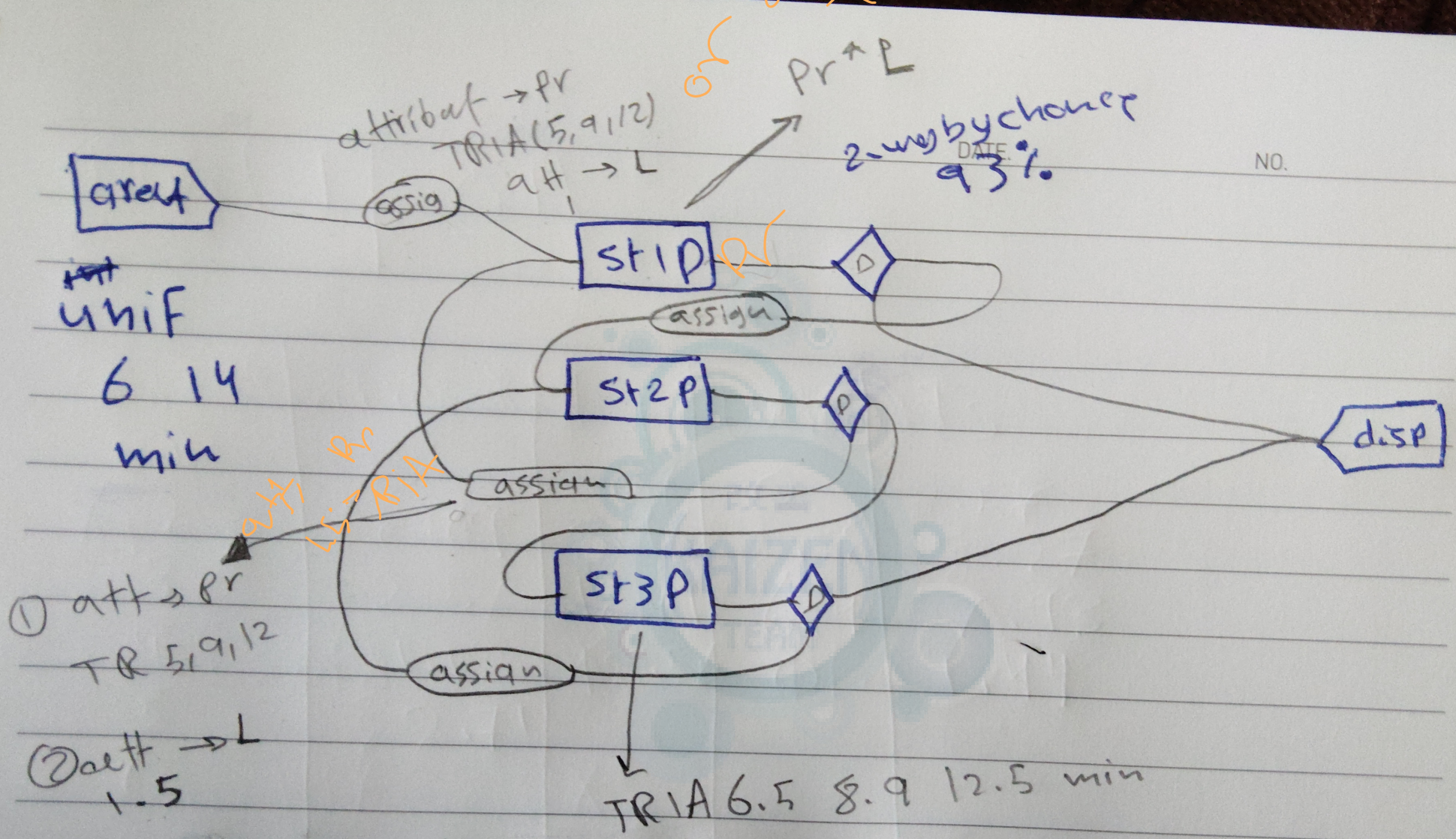
4.0 a) (5 points) Develop a model of a three-workstation serial production line with high reject rates: 7% after each workstation. Parts rejected after the fi rst workstation are sent to scrap. Parts rejected after the second workstation are returned to the fi rst workstation where they are reworked, which requires a fresh “draw” from the processing-time distribution but increased by 50% from the distribution of the original operation. (This penalty factor of 1.5 applies only at workstation 1 and not at workstation 2 when the part returns to it.) Parts rejected at the third workstation are returned to the second workstation where they are reworked, with a 50% penalty there (but not on its revisit to workstation 3). The operation times are TRIA(5,9, 12), TRIA(5, 8.5, 13), and TRIA(6.5, 8.9, 12.5) for workstations 1, 2, and 3 respectively (all times are in minutes). Part interarrival times to the system are UNIF(6, 14). Model using arena

4.0 b) (4 points) illustrate how to use PAN software to compare between the use of two resource capacities in relation to work in process and time in system for entity1

5.0 (5 points) Define the sequences for the following system



Created by Notein


attribut → Pr
TRIA(5,9,12)
att → L
Pr↑L
2-way by chance
93%
creat
assig
st1p
assign
st2p
assign
st3p
assign
disp
unif
6 14
min
① att → Pr
TR 5,9,12
② att → L
1.5
TRIA 6.5 8.9 12.5 min

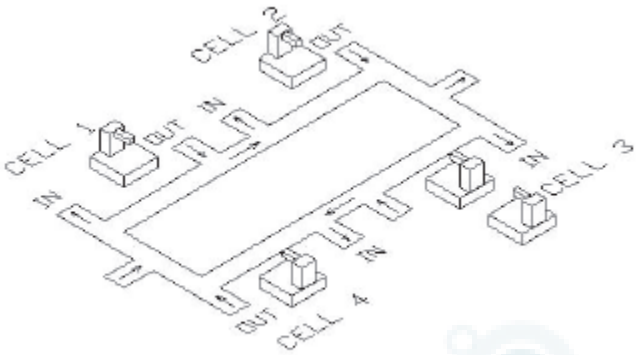



*Figure 7-1. The Small Manufacturing System Layout*

*Table 7-1. Part Routings and Process Times*

| Part Type | Cell/Time | Cell/Time | Cell/Time | Cell/Time | Cell/Time |
|---|---|---|---|---|---|
| 1 | 1<br>6, 8, 10 | 2<br>5, 8, 10 | 3<br>15, 20, 25 | 4<br>8, 12, 16 | |
| 2 | 1<br>11, 13, 15 | 2<br>4, 6, 8 | 4<br>15, 18, 21 | 2<br>6, 9, 12 | 3<br>27, 33, 39 |
| 3 | 2<br>7, 9, 11 | 1<br>7, 10, 13 | 3<br>18, 23, 28 | | |

6.0 (4 points) Describe how to display a message box with a text box to read it and then change the variable value in the arena model, then run it (automatically)



Created by Notein

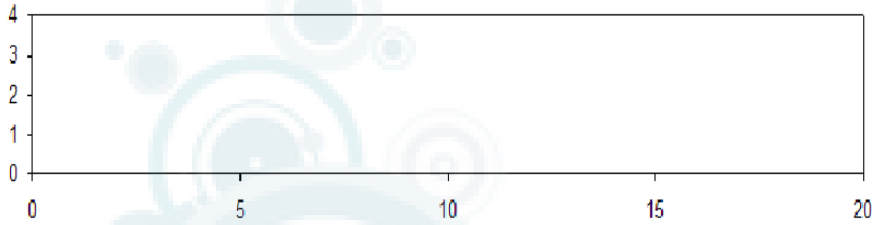



Created by Notein

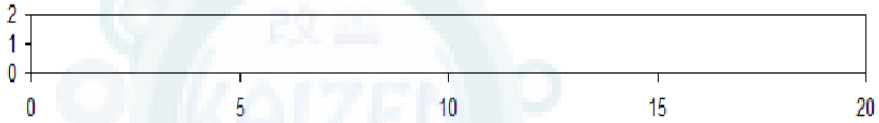
1.0 a) Solve the following using hand simulation (4 points)

| System | Clock | $B(t)$ | $Q(t)$ | Arrival times of custs. in queue | Event calendar |
|---|---|---|---|---|---|
| Number of completed waiting times in queue | Total of waiting times in queue | | Area under $Q(t)$ | | Area under $B(t)$ |

$Q(t)$ graph




$B(t)$ graph




Time (Minutes)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Interarrival times | 3.67 | 4.58 | 1.61 | 2.26 | 1.34 | 3.51 | 8.79 | 1.49 | 2.24 |
| Service times | 5.66 | 5.06 | 0.53 | 2.59 | 0.18 | 2.87 | 7.15 | 0.47 | 0.47 |

1.0 b)Using linear congruential technique generate next three random numbers ([0-1]) parameters a=13 , c=33 m=117 X0=17 (3 points)

1.0 c) For the rand numbers [0,0.1] {0.207, 0.412 0.115] generate exponential distribution random numbers with mean (1/λ) = 5 (3 points)

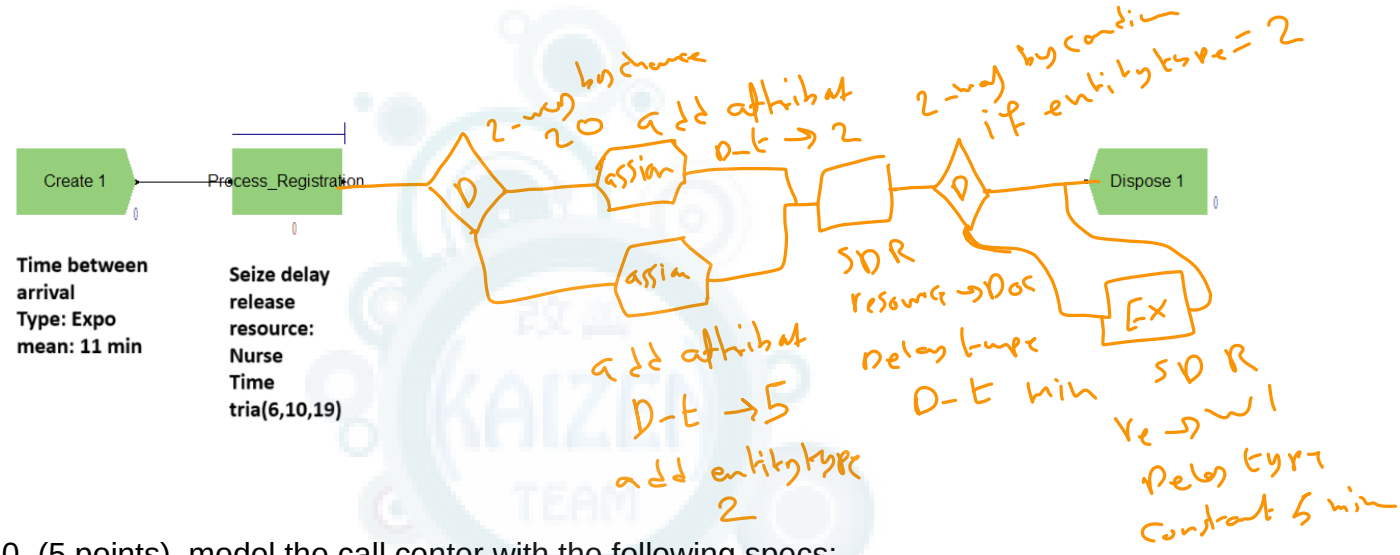
2.0 a) What are these arena symbols ( 2 points)

| | | | |
|---|---|---|---|
|  Hold | Wait condition | Warm-up Period: 0.0 | |



Created by Notein

2.0 b)(5 points) An acute-care facility treats non-emergency patients (cuts, colds, etc.). Patients arrive according to an exponential interarrival-time distribution with a mean of 11 (all times are in minutes). Upon arrival they check in at a registration desk staffed by a single nurse. Registration times follow a triangular distribution with parameters 6, 10, and 19. Patients wait for the doctor, two type of patients type 1 (20%) sees the doctor for 2 mins then go to exam room for 5 mins then leaves. Type 2 (80 %) patients see the doctor for five minutes then leave.




3.0 (5 points) model the call center with the following specs:

One phone number for customers to call in to 26 trunk lines, one needed for each call (incoming or outgoing, talking or on hold) Arriving call finding no free trunk lines gets busy signal, goes away Count number of such rejected calls Calls arrive with interarrivals ~ EXPO (0.857) min. First call arrives at time 0 Three incoming call types Initial recording to decide ~ UNIF (0.1, 0.6) min. Tech support (76%), sales (16%), order status (8%) Tech-support calls For product type 1 (25%), 2 (34%), or 3 (41%) Needs qualified tech-support person Two for type 1, three for type 2, three for type Separate FIFO queues for each type Conversation time ~ TRIA (3, 6, 18) min. for all types Then leaves system Sales calls All the same Four sales staff, all the same One FIFO queue feeding all sales staff Conversation time ~ TRIA (4, 15, 45) Then leaves system



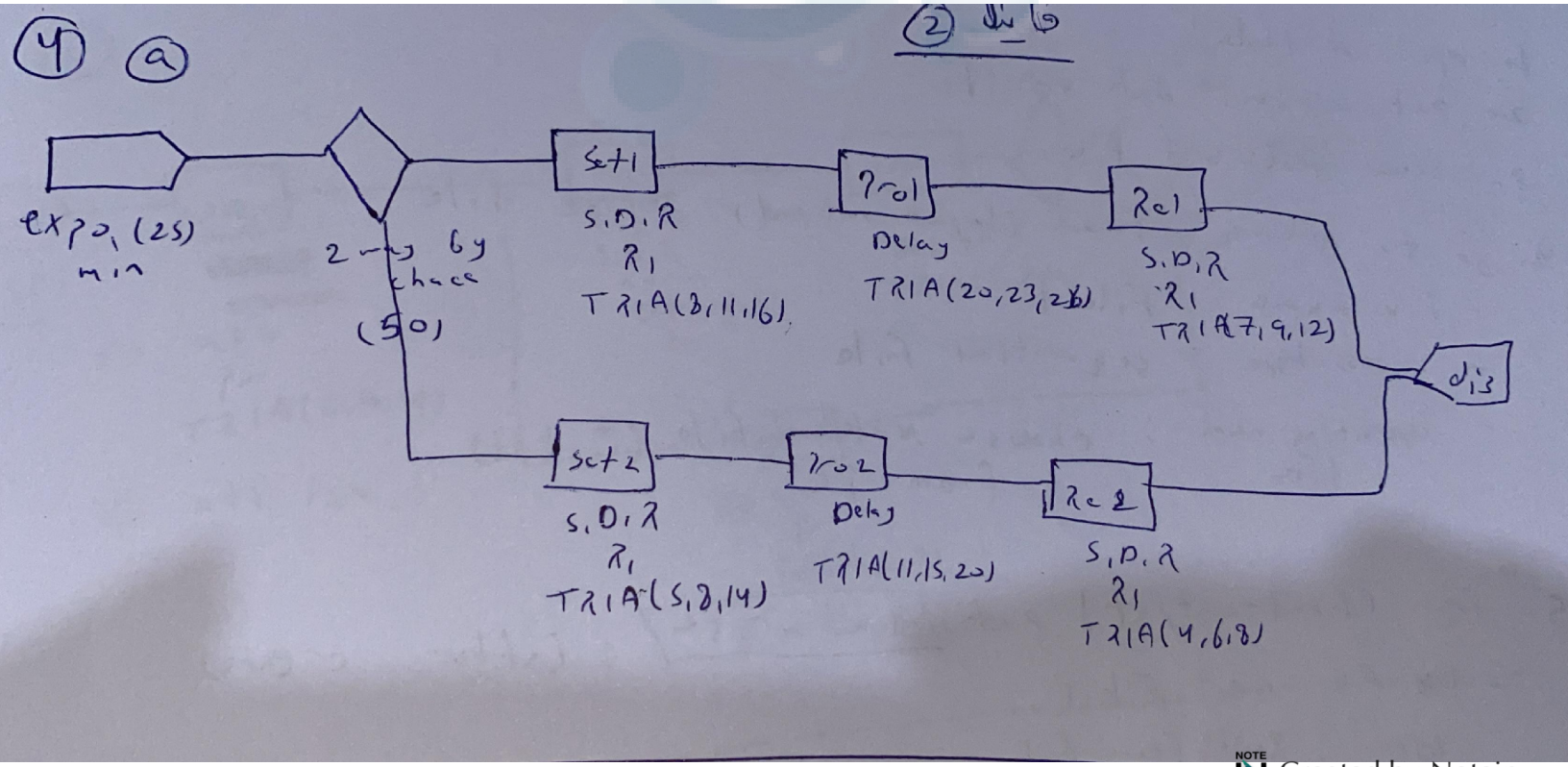
Created by Notein

4.0 a)(5 points)

Parts arrive at a machine shop with EXPO(25) interarrival times (all times are in minutes); the first part arrives at time zero. The shop has two machines, and arriving parts are assigned to one of the machines by flipping a (fair) coin. Except for the processing times, both machines operate in the same fashion. When a part enters a machine area, it requires operator attention to set up the part on the machine (there is only one operator in the shop). After the part is set up, the machine can process it without the operator. Upon completion of the processing, the operator is once again required to remove the part. After completion, the parts exit the system (parts have to go to only one machine). The same operator does all setups and part removals, with priority given to the machine waiting the longest for an operator. The times are (parameters are for triangular distributions):

| Machine Number | Setup Time | Process Time | Removal Time |
|---|---|---|---|
| 1 | 8, 11, 16 | 20, 23, 26 | 7, 9, 12 |
| 2 | 5, 8, 14 | 11, 15, 20 | 4, 6, 8 |

4.0 b) (4 points) describe how to use optoquest to optimize the objective function time in system, when varying resouces 1,2 and resource 3 which has capacities of 1 to 5.




Created by Notein

5.0 (5 points) The sequences are already defined as sequences 1 -4 the travelling distances between the different stations take 1 mins use route to model the system

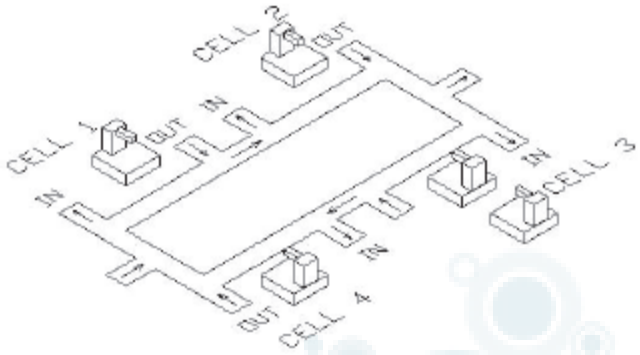



*Figure 7-1. The Small Manufacturing System Layout*

*Table 7-1. Part Routings and Process Times*

| Part Type | Cell/Time | Cell/Time | Cell/Time | Cell/Time | Cell/Time |
|---|---|---|---|---|---|
| 1 | 1<br>6, 8, 10 | 2<br>5, 8, 10 | 3<br>15, 20, 25 | 4<br>8, 12, 16 | |
| 2 | 1<br>11, 13, 15 | 2<br>4, 6, 8 | 4<br>15, 18, 21 | 2<br>6, 9, 12 | 3<br>27, 33, 39 |
| 3 | 2<br>7, 9, 11 | 1<br>7, 10, 13 | 3<br>18, 23, 28 | | |

6.0 (4 points) describe how to read arrival data from a sequential file



Created by Notein



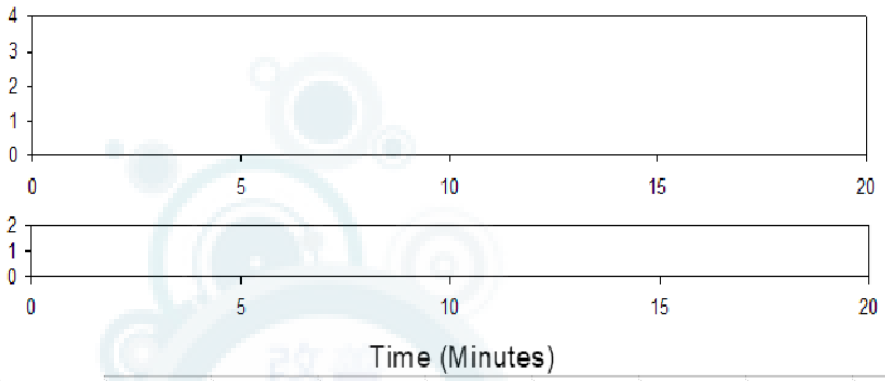

Created by Notein

1.0 a) Solve the following using hand simulation (4 points)

| System | Clock | $B(t)$ | $Q(t)$ | Arrival times of custs. in queue | Event calendar |
|---|---|---|---|---|---|
| Number of completed waiting times in queue | Total of waiting times in queue | | Area under $Q(t)$ | | Area under $B(t)$ |

$Q(t)$ graph

$B(t)$ graph




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Interarrival times | 1.83 | 5.43 | 2.46 | 2.97 | 5.98 | 6.07 | 1.78 | 6.99 | 1.78 |
| Service times | 2.39 | 7.16 | 3.32 | 1.78 | 2.77 | 1.87 | 8.00 | 1.98 | 1.78 |

1.0 b)Using linear congruential technique generate next three random numbers ([0-1]) parameters a=7 , c=113 m=111 X0=81 (3 points)

1.0 c) For the rand numbers [0,0.1] {0.507, 0.112 0.615] generate exponential distribution random numbers with mean (1/λ) = 5 (3 points)

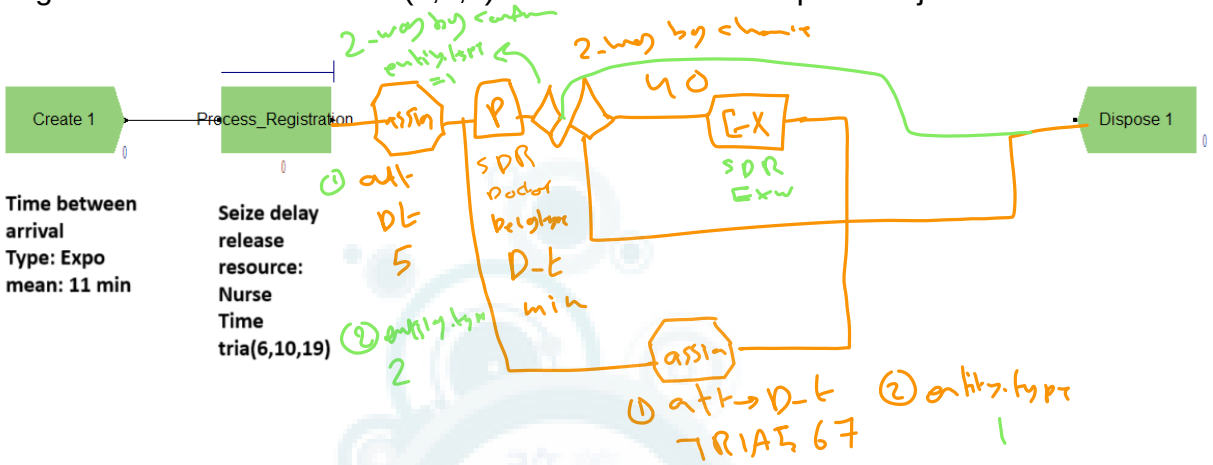
2.0 a) What are these arena symbols ( 2 points)

| | | | |
|---|---|---|---|
| In the model<br>- And + | | square shaped button | |



Created by Notein

2.0 b) (5 points) An acute-care facility treats non-emergency patients (cuts, colds, etc.). Patients arrive according to an exponential interarrival-time distribution with a mean of 11 (all times are in minutes). Upon arrival they check in at a registration desk staffed by a single nurse. Registration times follow a triangularn distribution with parameters 6, 10, and 19. The patient goes to the doctors for 5 mins then 40% of patients go to exam room then go back to doctor take tria(5,6,7) minutes. 60% of the patients just leave.




3.0 (5 points) model the call center with the following specs:

One phone number for customers to call in to 26 trunk lines, one needed for each call (incoming or outgoing, talking or on hold) Arriving call finding no free trunk lines gets busy signal, goes away Count number of such rejected calls Calls arrive with interarrivals ~ EXPO (0.857) min.

First call arrives at time 0 Three incoming call types Initial recording to decide ~ UNIF (0.1, 0.6) min.

Tech support (76%), sales (16%), order status (8%) Tech-support calls For product type 1 (25%), 2 (34%), or 3 (41%) Needs qualified tech-support person Two for type 1, three for type 2, three for type Separate FIFO queues for each type Conversation time ~ TRIA (3, 6, 18) min. for all types Then leaves system

Sales calls All the same Four sales staff, all the same One FIFO queue feeding all sales staff Conversation time ~ TRIA (4, 15, 45) Then leaves system



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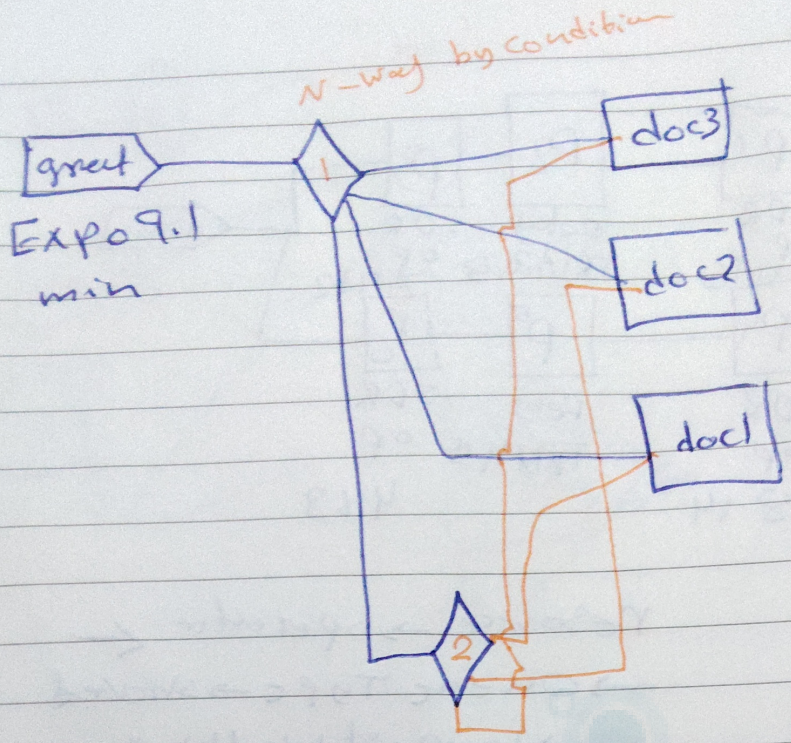
4.0 a)(5 points) Trucks arrive with EXPO(9.1) interarrival times (all times are in minutes) to an unload area that has three docks; the fi rst truck arrives at time 0. The unload times are TRIA(25, 28, 30), TRIA(23, 26, 28), and TRIA(22, 25, 27) for docks 1, 2, and 3, respectively. If there is an empty dock, the truck proceeds immediately to that dock. Assume zero travel times to all docks. If there is more than one empty dock, the truck places preference on the higher-numbered dock (3, 2, 1). If all the docks are busy, it chooses the dock with the minimum number of trucks waiting. If there is a tie, it places preference on the lowest numbered dock (1, 2, 3). Note that in “by Condition” Decide modules, the tests are done from top to bottom, and the fi rst one resulting in a “true” sends the entity out through that corresponding exit point. Model using arena

4.0 b) (4 points) Describe how to use output analyser to obtain the confidence interval for two alternatives to compare them.



Created by Notein

DATE NO.




Expo 9.1
min

1 → ① if NR(doc3W == 0)
② if NR(doc2W == 0)
③ if NR(doc1W == 0)

2 - ① NQ(process1.Que) <= NQ(process2.Que) && NQ( " ) <= NQ(process3.Que)

② NQ(process2.Que) < NQ(process3.Que)

Created by Noteim

5.0 (5 points) The sequences are already defined as sequences 1 -4 There are two units of transportation cart 1 and two the distances is the same between all stations, travelling between station sis via the transporter model the system.

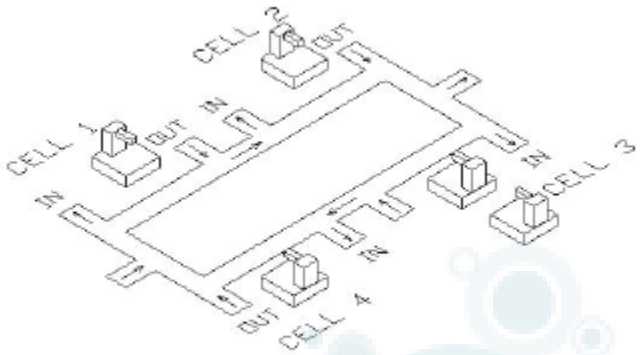



*Figure 7-1. The Small Manufacturing System Layout*

*Table 7-1. Part Routings and Process Times*

| Part Type | Cell/Time | Cell/Time | Cell/Time | Cell/Time | Cell/Time |
|---|---|---|---|---|---|
| 1 | 1<br>6, 8, 10 | 2<br>5, 8, 10 | 3<br>15, 20, 25 | 4<br>8, 12, 16 | |
| 2 | 1<br>11, 13, 15 | 2<br>4, 6, 8 | 4<br>15, 18, 21 | 2<br>6, 9, 12 | 3<br>27, 33, 39 |
| 3 | 2<br>7, 9, 11 | 1<br>7, 10, 13 | 3<br>18, 23, 28 | | |

6.0 (4 points) We have an array named SS1 of size 10 x 1 the data should be initialized from microsoft access suitable range describe how this can be done.



Created by Notein



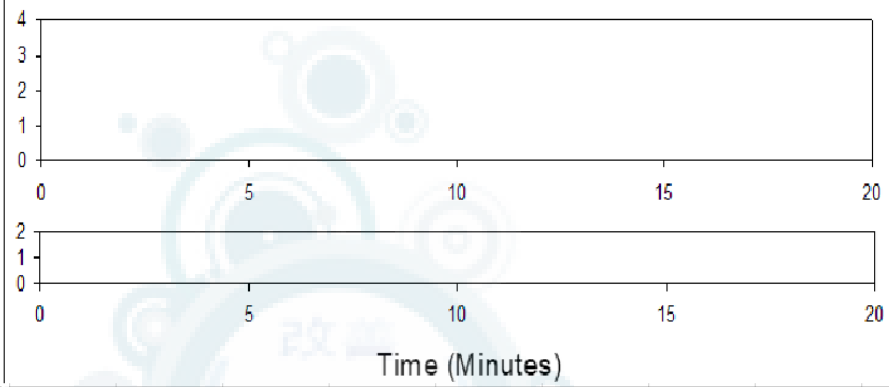

Created by Notein

1.0 a) Solve the following using hand simulation (4 points)

| System | Clock | $B(t)$ | $Q(t)$ | Arrival times of custs. in queue | Event calendar |
|---|---|---|---|---|---|
| Number of completed waiting times in queue | Total of waiting times in queue | | Area under $Q(t)$ | | Area under $B(t)$ |

$Q(t)$ graph

$B(t)$ graph




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Interarrival times | 3.58 | 1.78 | 4.07 | 7.93 | 1.78 | 6.30 | 4.79 | 1.78 | 1.78 |
| Service times | 1.78 | 1.78 | 1.78 | 1.78 | 1.78 | 1.78 | 1.78 | 5.84 | 1.78 |

1.0 b)Using linear congruential technique generate next three random numbers ([0-1]) parameters a=37 , c=13 m=91 X0=76 (3 points)

1.0 c) For the rand numbers [0,0.1] {0.907, 0.012 0.275] generate exponential distribution random numbers with mean (1/λ) = 5 (3 points)

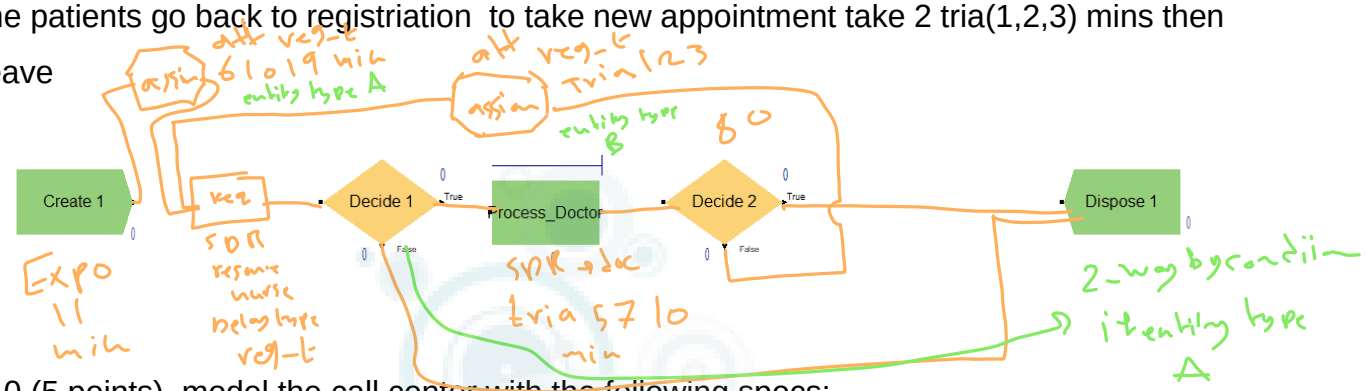
Q2) a) What are these arena symbols ( 2 points)

| | | | |
|---|---|---|---|
|   | |  | |



Created by Notein

2.0 b) (5 points) An acute-care facility treats non-emergency patients (cuts, colds, etc.). Patientsmarrive according to an exponential interarrival-time distribution with a mean of 11 (all times are in minutes). Upon arrival they check in at a registration desk staffed by a single nurse. Registration times follow a triangular distribution with parameters 6, 10, and 19. Patients go to doctor take tria(5,7,10) then 80% of the patients leave, 20% of the patients go back to registriation to take new appointment take 2 tria(1,2,3) mins then leave




3.0 (5 points) model the call center with the following specs:

One phone number for customers to call in to 26 trunk lines, one needed for each call (incoming or outgoing, talking or on hold) Arriving call finding no free trunk lines gets busy signal, goes away Count number of such rejected calls Calls arrive with interarrivals ~ EXPO (0.857) min. First call arrives at time 0 Three incoming call types Initial recording to decide ~ UNIF (0.1, 0.6) min.

Tech support (76%), sales (16%), order status (8%) Tech-support calls For product type 1 (25%), 2 (34%), or 3 (41%) Needs qualified tech-support person Two for type 1, three for type 2, three for type Separate FIFO queues for each type Conversation time ~ TRIA (3, 6, 18) min. for all types Then leaves system Sales calls All the same Four sales staff, all the same One FIFO queue feeding all sales staff Conversation time ~ TRIA (4, 15, 45) Then leaves system

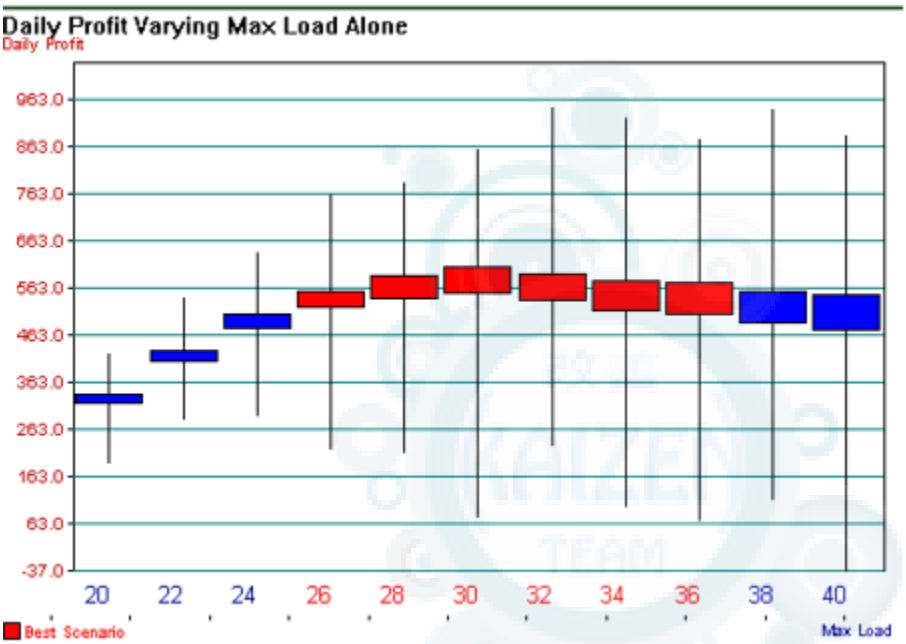
4.0 a) (5 points) Parts arrive at a two-machine system according to an exponential interarrival distribution with mean 20 minutes; the fi rst arrival is at time 0. Upon arrival, the parts are sent to Machine 1 and processed. The processing-time distribution is TRIA(4.5, 9.3, 11) minutes. The parts are then processed at Machine 2 with a processing-time distribution as TRIA(16.4, 19.1, 20.8) minutes. The parts from Machine 2 are directed

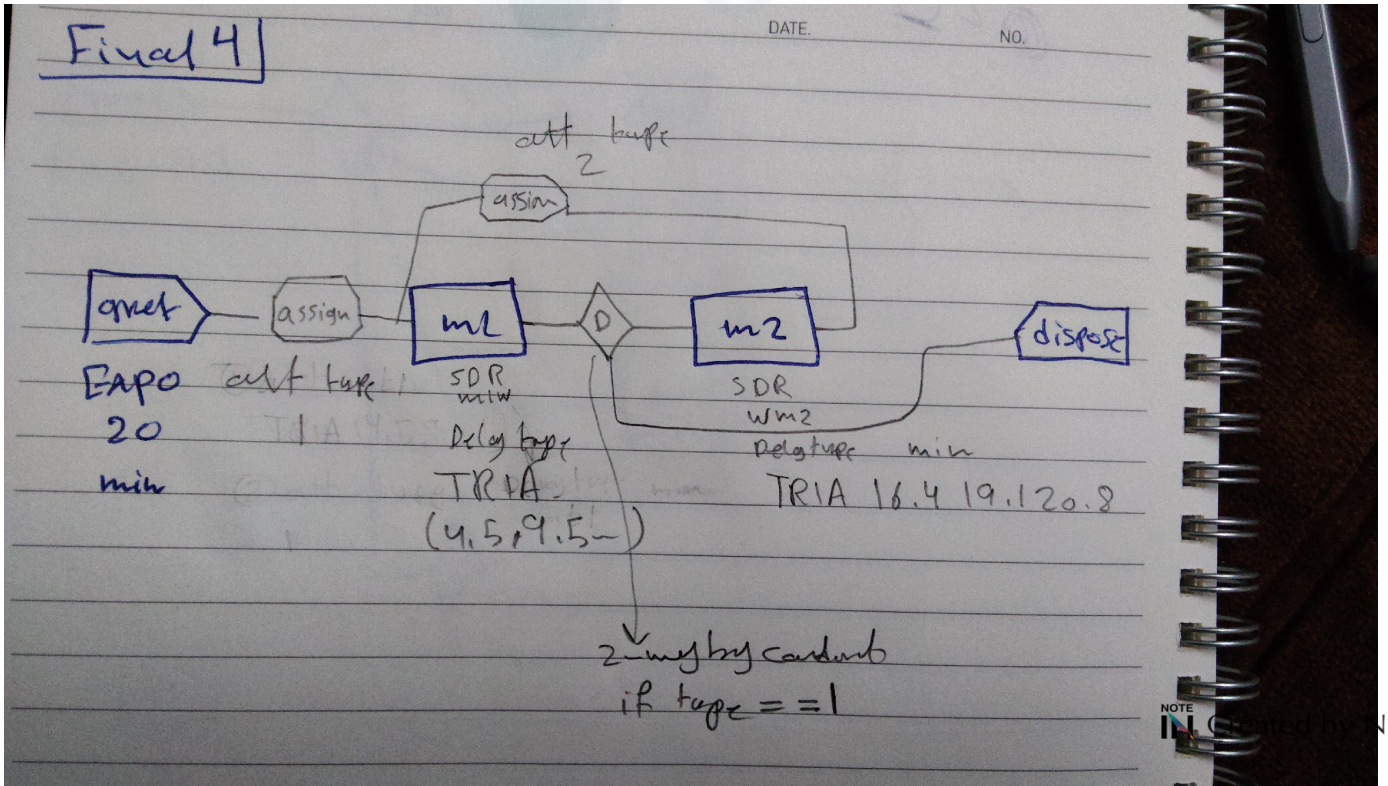


Created by Notein

back to Machine 1 to be processed a second time (same processing-time distribution as the first visit but an independent draw from it). The completed parts then exit the system. Model using arena

4.0 b)(4 points) describe how to use use PAN to generate the following chart from different scenarios start by defining the scenarions with variable resource capacities



5.0 (5 points) The sequences are already defined as sequences 1 -4. Now there is a conveyor loop that goes from the arrival station to cell 1 cell2 depart then cell4 then cell3 then arrival distances is the same assume 5 units, model sing arena

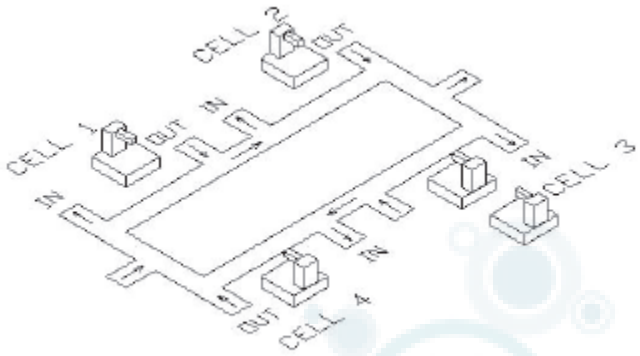



*Figure 7-1. The Small Manufacturing System Layout*

*Table 7-1. Part Routings and Process Times*

| Part Type | Cell/Time | Cell/Time | Cell/Time | Cell/Time | Cell/Time |
|---|---|---|---|---|---|
| 1 | 1<br>6, 8, 10 | 2<br>5, 8, 10 | 3<br>15, 20, 25 | 4<br>8, 12, 16 | |
| 2 | 1<br>11, 13, 15 | 2<br>4, 6, 8 | 4<br>15, 18, 21 | 2<br>6, 9, 12 | 3<br>27, 33, 39 |
| 3 | 2<br>7, 9, 11 | 1<br>7, 10, 13 | 3<br>18, 23, 28 | | |

6.0 (4 points) We have a variable array named DD1 of size 5 x 6 we need to initalise it from excel of suitable range.



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