#) which of the following can be an example on the entities of the airport system

a) Travels c) Luggage e) 'a' and 'b' is true but not 'c'

b) Airplanes d) All of the above

1) (Building the model right) the process of determining that a model implementation and its associated data accurately represent the developer's conceptual description and specifications is called ..... (verification or validation).

2) How many times an entity is process is a ..... (Variable or attribute)

.....

.....

1) Explain how the validity of the model is related to assumptions and representation of the real system.

2) what is type III error? Explain it in your own words.

3) In simulation, we do more than replication which are independent and identically distributed (IID), what does the (IID) mean?

4) In simulating a system, why do we do more than one replication?

Student arrive to the main cafeteria to buy a food, where the worker helps them according to the priority role 'first come first serve', we know the mean the distribution of both interatrial time and service time, in order to perform a hand simulation for this case, we generated random numbers for both interatrial and service times using a random number generator (time is in min). Assume that cafeteria starts working in the morning with no student in system, and worker is waiting for the first student. Use the data provided below to perform a hand simulation for the first 11.5 min to estimates the following:

1) Total serve customers.

2) Average waiting time in the queue.

3) Maximum waiting time in the queue.

4) Average total time in the system.

5) Maximum total time in the system.

6) Average number of customer in queue.

7) Maximum number of customer in queue.

8) Server utilization.

(plot the current number waiting in the queue with time and server status with time)

1) True or False: the simulation clock for a discrete event dynamic stochastic model jumps in discreet equal increments of time in the defied time units. for example, 1 second, 2 second, 3 seconds.

2) True or False: the concept of steady state implies that after a long enough time the system will not change with respect to time

3) True or False: the waiting times for entities in queue are time-persistent data.

4) True or False: If a system changes significantly with respect to time, it is said to be stochastic

5) True or False: when solving a problem, it is more powerful to use simulation rather than traditional methods given that both are applicable.

Time Persistent or (?)

1) The number in queue: TP

2) The time that the resource spends serving a customer: Tally

3) Total system time for a customer to finish service in a cafeteria Tally

4) Maximum waiting time in queue TP

5) The number of jobs completed during a week: TP

6) The number of items on sitting on a shelf waiting to be sold TP

Match	Concept		Definition
C	System	A	A "snap shot" of the system at particular point in tome characterized by values of the variables that are necessary for determining the future evolution of the system from the present time .
F	Attribute	B	A limited quantity of items that are used (seized and released) by entities as they proceed through the system .
D	Entity	C	A set of inter-related components that act together over time to achieve common objectives .
A	System state	D	An objects of interest in the system whose movement or operation within the system may cause the occurrence of events .
B	Resource	E	An instantaneous occurrence or action that changes the state of the system at a particular point in time .
		F	A property or variable that is associated with an entity

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Problem 1: (30 points - 3 pt each)

a. **True or False**: the simulation clock for a discrete event dynamic stochastic model jumps in equal increments of time in the defined time units. For example, 1 second, 2 seconds, 3 seconds, etc.

b. **True or False**: the concept of steady state implies that after a long enough time the system will not change with respect to time.

c. **True or False**: the waiting times for entities in a queue are time-persistent data.

d. **True or False**: if a system changes significantly with respect to time, it is said to be stochastic.

e. **True or False**: When solving a problem, it is more powerful to use simulation rather than traditional methods given that both are applicable.

f. **True or False**: when an item leaves the queue and starts service, this is considered as an event.

g. **True or False**: When an entity departed from service, arrival of another entity to the system is scheduled

h. (Building the model right) The process of determining that a model implementation and its associated data accurately represent the developer's conceptual description and specifications is called _____. (Verification or Validation).

i. How many times an entity is process is a _____ (Variable or attribute)

j. Which of the following can be an example on the entities of the airport system
   a. Travels
   b. Airplanes
   c. Luggage
   d. All of the above
   e. 'a' and 'b' is true but not 'c'

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Problem 2: (30 points)

a. Classify each variable as being observational or time-persistent (3pt each)

f. The number in queue: _____

g. The time that the resource spends serving a customer: _____

h. Total system time for a customer to finish service in a cafeteria _____

i. Maximum waiting time in queue _____

j. The number of jobs completed during a week: _____

k. The number of items in sitting on a shelf waiting to be sold: _____

b. Match the definition to the concept. For the missing concept, give the name of the concept and then match it to its definition. (2pt each)

Match	Concept		Definition
	System	A	A "snap shot" of the system at a particular point in time characterized by the values of the variables that are necessary for determining the future evolution of the system from the present time.
	Attribute	B	A limited quantity of items that are used (seized and released) by entities as they proceed through the system.
	Entity	C	A set of inter-related components that act together over time to achieve common objectives
	System State	D	An object of interest in the system whose movement or operation within the system may cause the occurrence of events
	Resource	E	An instantaneous occurrence or action that changes the state of the system at a particular point in time.
		F	A property or variable that is associated with an entity

Problem 4: (32 points)

Students arrive to the main cafeteria to buy a food, where the worker helps them according to the priority role 'first come first serve'. We know the mean the distribution of both interarrival time and service time. In order to perform a hand simulation for this case, we generated random numbers for both interarrival and service times using a random number generator (time is in minutes). Assume that cafeteria starts working in the morning with no students in system, and worker is waiting for the first student who arrives right away when the cafeteria opens, i.e. at time 0). Use the data provided below to perform a hand simulation for the first 11.5 minutes to estimate the following:

a) Total served customers
b) Average waiting time in the queue
c) Maximum waiting time in the queue
d) Average total time in the system
e) Maximum total time in the system
f) Average number of customer in queue
g) Maximum number of customer in queue
h) Server utilization

(Plot the current number waiting in queue with time and server status with time).

Name: _____ ID: _____

Problem 1: (32 points)

a. **True or False**: the Simulation clock for a discrete event dynamic stochastic model jumps in equal increments of time to the defined time units. For example, 1 second, 2 seconds, 3 seconds, etc. (3pt) (F)

b. **True or False**: the concept of steady state implies that after a long enough time the system will not change with respect to time. (3pt) (T)

c. Classify each variable as being observational or time-persistent (3pt each)
   a. The number in queue: time persistent
   b. The time that the resource spends serving a customer: observational
   c. Total system time for a customer to finish service in a cafeteria: time persistent
   d. Maximum waiting time in queue: time persistent
   e. The number of jobs completed during a week: observational
   f. The number of items in sitting on a shelf waiting to be sold: time persistent

d. Match the definition to the concept. For the missing concept, give the name of the concept and then match it to its definition (2pt each)

Match	Concept		Definition
C	System	A	A "snap shot" of the system at a particular point in time characterized by the values of the variables that are necessary for determining the future evolution of the system from the present time.
F	Attribute	B	A limited quantity of items that are used (seized and released) by entities as they proceed through the system.
D	Entity	C	A set of inter-related components that act together over time to achieve common objectives
A	System State	D	An object of interest in the system whose movement operation within the system may cause the occurrence events
B	Resource	E	An instantaneous occurrence or action that changes the of the system at a particular point in time.
X		F	A property or variable that is associated with an entity

e. **True or False**: the waiting times for entities in a queue are time-persistent data. (3pt)

f. **True or False**: if a system changes significantly with respect to time, it is stochastic. (3pt) T

g. Which of the following can be an example on the entities of the airport system
   a. Travels
   b. Airplanes
   c. Luggage
   d. All of the above
   e. 'a' and 'b' is true but not 'c'

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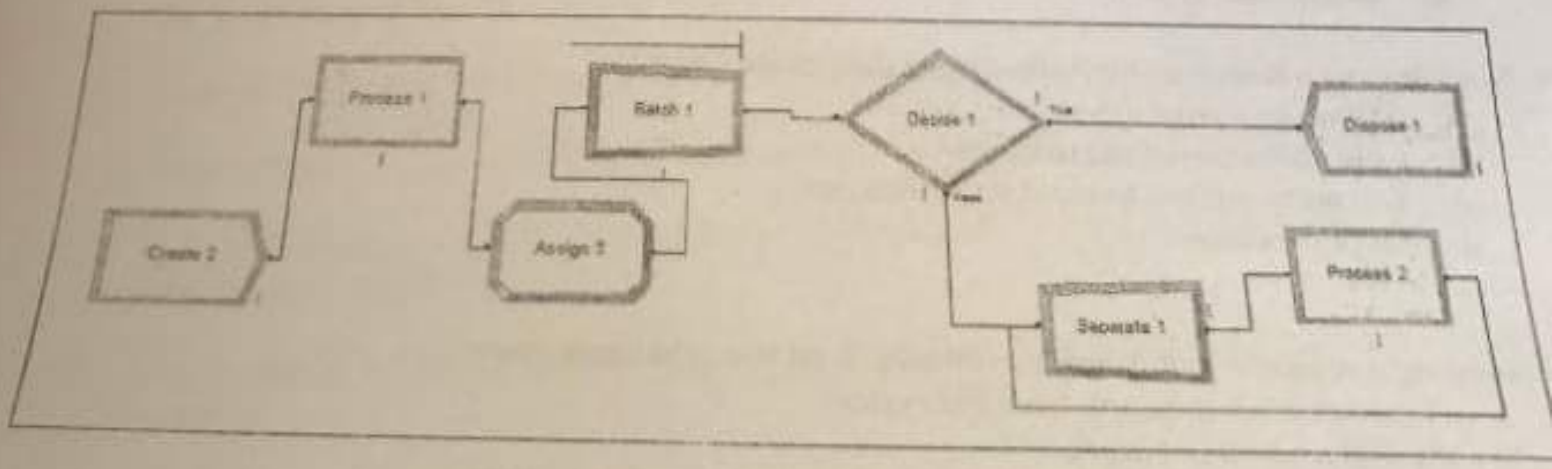
21. A possible cause for the following error message is:
    a. Number of entities in the system are less than 150
    b. You are using two process modules
    c. Using the batch module
    d. You are using the professional version of Arena
    e. None of the above

```
ERROR:

Entity: 150
A runtime error was detected at time 175.46669 at the following block:

*    1 26              CREATE,1,HoursToBaseTime(0.0),Entity 1:
                          HoursToBaseTime(EXPO(1)):
                          NEXT(10):

Maximum of 150 entities exceeded.
```

22. There are two types of modules in Arena and they are _____ and _____

free-path and guided

23. The logic problem with the following model is
    a. It does not specify
    b. The decide module has just 2 branches (it is a 2-way by chance type).
    c. The Separate module has just one branch going out (It is a split existing batch)
    d. The batch module should be before the assign
    e. The loop containing process 2 and separate 1 modules
    f. None of the above



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Problem 5: (10 points)

A small manufacturing system produces parts. The parts arrive from an upstream Poisson process with a rate of arrival of 1 part every 5 minutes. All parts that enter the system must go through a preparation station where there are 2 preparation workers. Each part requires only 1 of the 2 workers during preparation. The preparation time is exponentially distributed with means of 8 minutes.

There is only space for 8 parts in the preparation queue. Any parts that arrive to the system when there are 8 or more pars in the preparation queue cannot enter the system. These parts are shunted to a re-circulating conveyor, which takes 12 minutes to re-circulate the parts before they can try again to enter the preparation queue.

After preparation, the parts are processed on two different production lines. There is a 40% chance that the parts are built on line 1 and a 60% chance that they go to line 2. Line 1 has a build station staffed by 2 workers. Line 2 has a build station that is staffed by 3 workers. The time to build a part on line 1 is triangularly distributed with a (min = 2, mode 6, max = 8) minutes. The time to build a part on line 1 is triangularly distributed with a (min = 3, mode 6, max = 7) minutes. The build time requires only 1 worker for the task to be performed.

After the parts are built they go to a packaging station. The packaging station is staffed by 2 workers. Only 1 of the 2 workers is needed by each part. The time to individually wrap a part is exponential with a mean of 30 seconds. After each individual part is wrapped, the worker fills a box with packing peanuts, and places the part into a box for shipping. The time to fill the box with peanuts is uniformly distributed between 1 and 2 minutes. After the packaging, the box leaves the system.

a. What are the necessary entities and resources for this problem
b. Draw an activity flow diagram for this situation.

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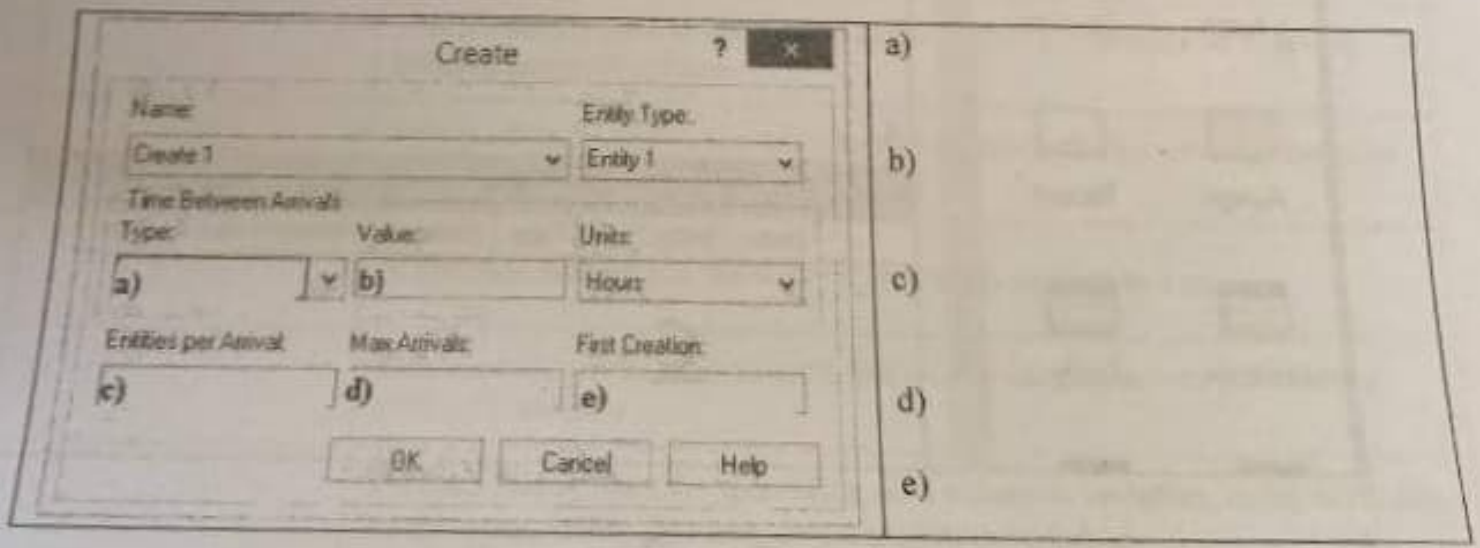
Problem 2: (25 points)

a. Classify the systems as either being discrete or continuous

System	Classification
Electrical Capacitor (you are interested in modeling the amount of current in a capacitor at any time t).	C
On-line shopping system. (you are interested in modeling the number of people shopping from Amazon at any time t.)	C
An airport. (You are interested in modeling the percentage of flights that depart late on any given day).	D
Crude oil supertankers/ships. (you are interested in the level of crude oil left in the ship at any given time t.)	C

b. Specify a Poisson process with a mean rate of 0.5 customers per hour using a CREATE module with a 3 customers arrive every time, where the first 3 arrives according to the same arrival distribution.



c. *What is model conceptualization? Give an example of something that might be produced during model conceptualization.*

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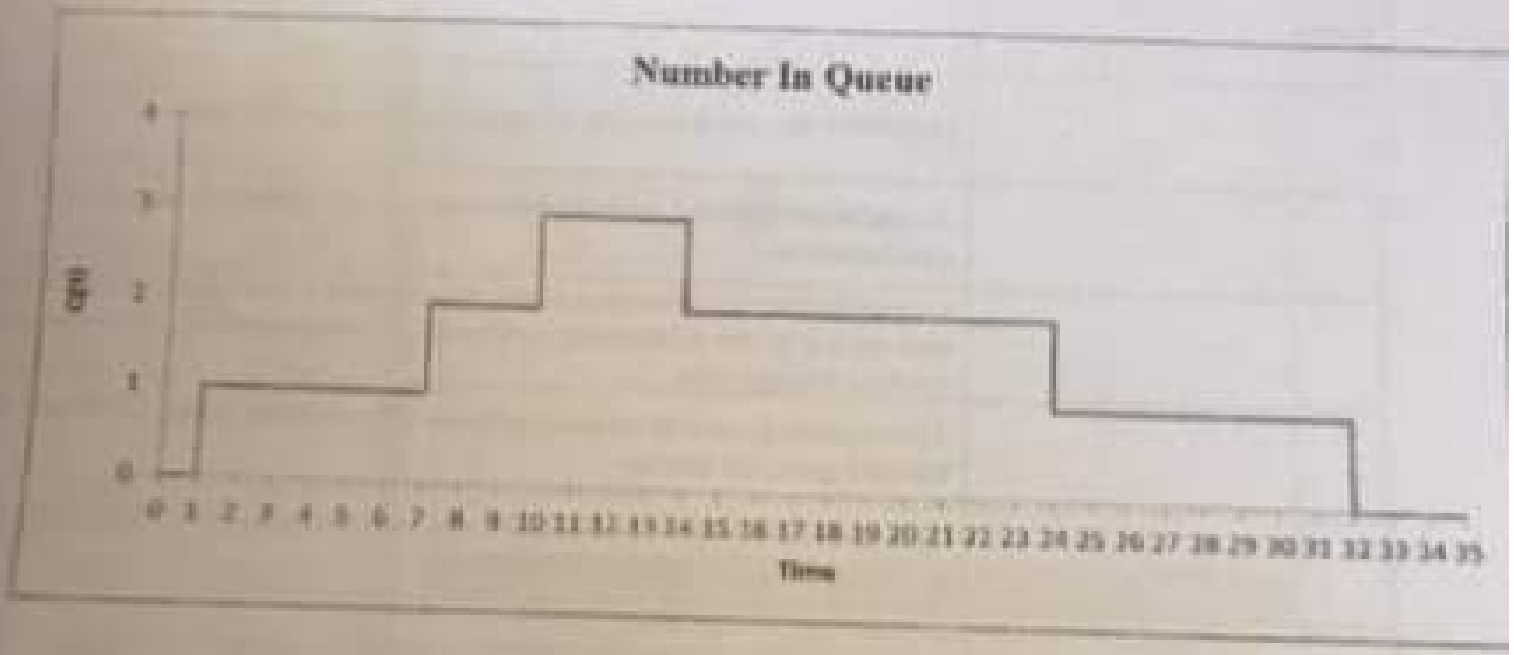
Problem 3: (7 points)

Give a formula for estimating the time average number of customers in the queue, $\bar{Q}(t)$, and then use the sample path to compute the time average number in the queue over the range from 0 to 35. Provide a formula for estimating the proportion of time that there are no customers in the queue. Then use the formula to estimate the proportion of time that there are no customers in the queue.



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Problem 1: (46 points)

1. **True or False**: when defining a resource through the process module, an entry for the resource is automatically defined in the spreadsheet view with the available capacity for it.

2. **True or False**: LCG will generate random numbers between 0 as minimum and $(1-\frac{1}{m})$ as maximum.

3. **True or False**: We need to perform a set of statistical tests of a random number generator to check if it reaches full period.

4. **True or False**: in simulation, when doing more than one replication, the results will be different from one replication to the other.

5. **True or False**: A linear congruential generator (LCG) is a recursive algorithm for producing a sequence of real random numbers.

6. **True or False**: the concept of stochastic simulation is about having random variables in the target system we are simulating.

7. **True or False**: the maximum number of arrivals in CREATE module is one method of ending simulation.

8. **True or False**: the simulation clock for a discrete event dynamic stochastic model will advance once the event has started execution and will keep adding until the same event is done.

9. **True or False**: the waiting times for an entity in a queue is observational data.

10. **True or False**: If a system changes significantly with respect to time, it is said to be continuous.

11. **True or False**: The first generated pseudorandom number from a random number generator (algorithm) is called seed.

12. **True or False**: An important property of an LCG is that it has a long cycle, as close to length m as possible.

13. In modeling arrival of two different parts, a _____ module was used to give the entities their service time, and a _____ module to assemble them.

14. Which of the following are advantages of simulation?
    a. Simulation allows "what-if" type of questions.
    b. Simulation can usually be performed by hand or using a small calculator.
    c. Simulation does not interfere with the real-world system.
    d. all of the above
    e. (a) and (c) only

15. A simulation model uses mathematical expression and logical relationships of the
    a. Real system
    b. Computer model
    c. Performance measures
    d. Estimated

16. If customer 2 has a service time of 1.6, and customer 3 has an inter-arrival time of 1.1 and a service time of 2.3, when will customer 3's service be completed?
    a. 5.0
    b. 3.9
    c. 3.4
    d. It depends on the arrival of the 4th customer
    e. There is not enough information to answer.

17. In order to verify a simulation model
    a. Compare results from several simulation languages.
    b. Be sure that the procedures for calculations are logically correct.
    c. Confirm that the model accurately represents the real system.
    d. Run the model long enough to overcome initial start-up results.

18. Misspecifying the time units in the CREATE module (For example if it is really 1 hour and you specified it as 1 minute) is an issue of
    a. Validation
    b. Verification
    c. Type II error
    d. Steady state system

19. Not releasing a resource at the appropriate time might cause
    a. 150 entities error message
    b. Low utilization of the resource
    c. Too many entities to build up in the system
    d. All of the above
    e. a+c

20. Requesting a resource that is never available, is an issue that may cause
    a. A syntax error message from the system
    b. the system will not work
    c. the system will work until the first entity arrives at this station
    d. a zero output
    e. none of the above

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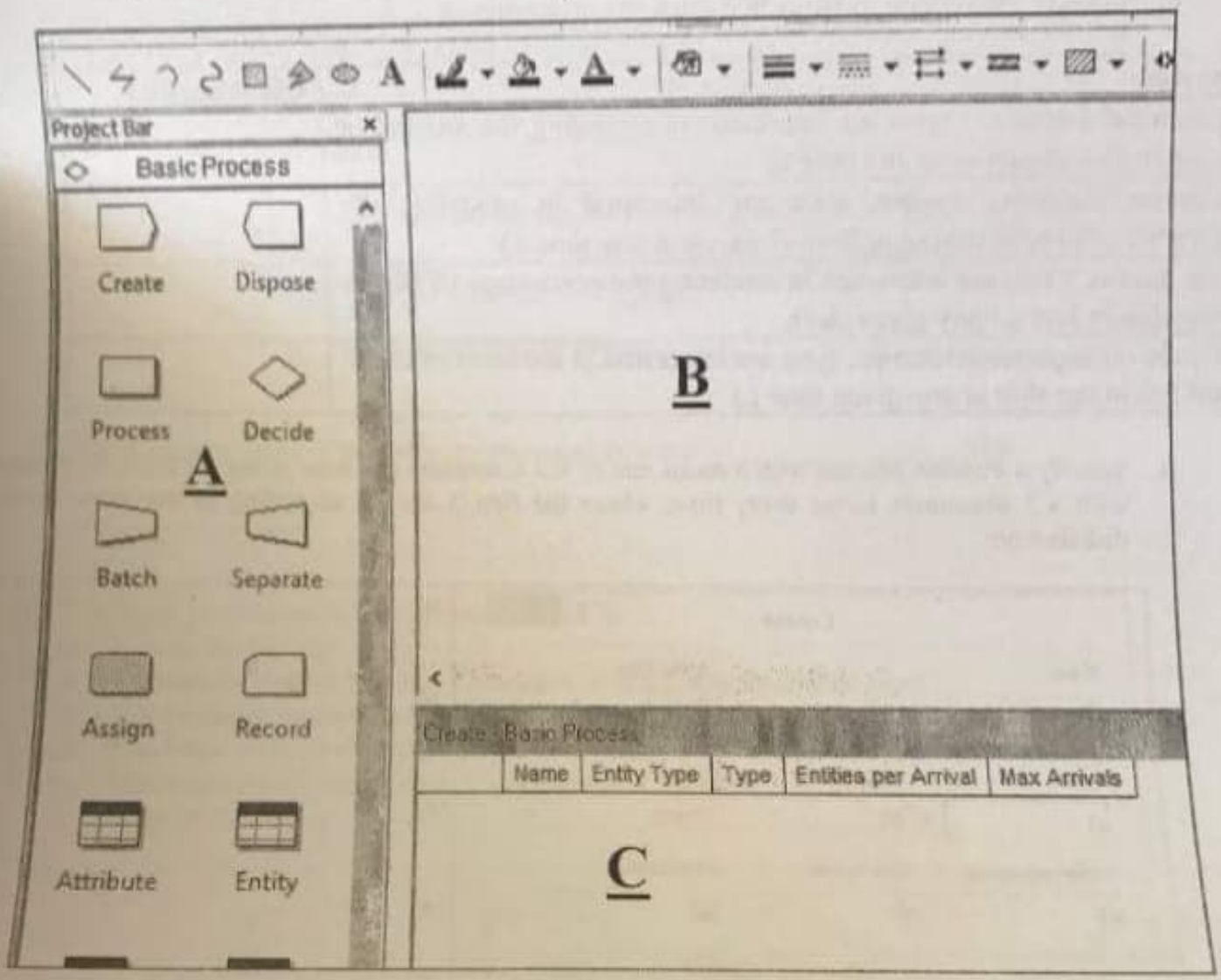
d. For the following screenshots taken from Arena interface, write the appropriate name for each part (indicated with letters)



A: project bar - basic process Pannel

B: model window - flowchart view (logic)

C: model window - spreadsheet view

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e. Fill in the proper Arena construct name for the given functionality

Arena Construct	Description Functionality
	Something that can potentially constrain the flow of an entity within the system
Entity	
	Quantities that are properties of entities with a specific value
	A special pre-defined variable that Arena uses to represent the current simulation time
	Quantities that are properties of the system (as a whole) that change or are determined by the relationships between the components of the system as it evolves through time.
	This module is used to create duplicates of an existing entity or to split a batched group of entities.
	This module is used to provide alternative flow paths for an entity based on probabilistic or criteria based branching
	A function that returns the number of entities waiting in a queue
	This module can be used to represent a time-varying arrival pattern for a CREATE module
	This module is used for specifying new values to variables, entity attributes, entity types, entity pictures, or other system variables.
	Used to capture and tabulate statistics within the flow chart model area