Question 1:

A retailer dealing in electronic gadgets wants to determine the optimal order size for smartphones. The demand and lead time are probabilistic, and their distributions are given below:

Demand/week(thousand)	Probability	Lead time (weeks)	Probability
10	0.3	1	0.3
20	0.4	2	0.4
30	0.2	3	0.3
40	0.1		

The cost of placing an order is Rs 100 per order, and the shortage cost is Rs. 20 per unit. The inventory manager follows a policy of ordering whenever the inventory level falls to or below 50 units, with an order size equal to the difference between the current inventory balance and the maximum replenishment level of 100 units. Random digits for the **- Demand/week: 82, 19, 67, 45, 31, 90, 25, 73, 58, 41, 13, 88, 76, 34, 59, 28, 64, 49, 71, 56. Random digits for the Lead time: 46, 91, 35, 72, 18.**

Make a program to simulate the policy for 20 weeks period assuming that

- Beginning inventory is 80 units.

- No backorders are permitted.

- Orders are placed at the beginning of the week following the drop in inventory level to or below the reorder point.

- Replenishment orders are received at the beginning of the week.

Calculate the average ending inventory and total average weekly cost.

Total average weekly cost= Ordering cost + shortage cost

Question 2:

A small bank branch has a single teller serving customers from 9:00 AM to 10:00 AM. The inter-arrival times and service times are probabilistic, and their distributions are given below:

Inter-arrival time (min)	Probability	Service time (min)	Probability
1	0.2	3	0.2
2	0.3	5	0.5
3	0.3	7	0.3
4	0.1		
5	0.1		

Use the following random numbers to predict customers' inter-arrival and service times.

- Inter-arrival times: 42, 19, 67, 85, 31, 56, 90, 24, 73, 48, 61, 35, 79, 28, 51.

- Service times: 36, 82, 49, 17, 63, 91, 25, 58, 74, 40, 29, 85, 67, 32, 56.

Make a program to simulate the system for 15 customers and determine:

1. Average waiting time.

2. Total time in the system.

3. Maximum queue length.

4. Time spent by the 8th customer in the system.

5. Waiting time in the queue by the 10th customer.

6. Arrival time of the 12th customer.

7. Service start time of the 15th customer.

Question 3:

A retail store has a daily demand for a product with the following probability distribution:

Daily demand	0	10	20	30	40	50
Probability	0.01	0.20	0.15	0.5	0.12	0.02

A linear congruential generator is used to generate random numbers (X1, X2, ………..X10) with the following parameters:

- X0 = 35 (initial seed)

- a = 13 (multiplier)

- c = 7 (increment)

- m = 100 (modulus)

Calculate

1. Average daily demand for the first six days
2. Average daily demand for the first ten days
3. Expected demand on 5th day

Question 4:

Apply the linear Congruential Method to generate a series of random numbers.

Use $X_0 = 7$, $a = 5$, $c = 3$, and $m = 16$.

Make a program to change the value of $X_0 = 1, 2, 3, 4, 5, 6$. Make a table to show the values of i, X_i, R_i . Observe after how many random numbers cycle is repeated.

Question 5:

Make a program to apply the Kolmogorov-Smirnov test to determine whether a set of random numbers generated using a linear congruential generator follows a uniform distribution. Use $X_0 = 5$, $a = 3$, $c = 2$, and $m = 16$ to check that the numbers following the uniformity property and null hypothesis can be accepted or rejected with $\alpha=0.05$. Use the first ten random numbers and $D\alpha = 0.43$. The program should ask the values of the linear congruential generator during run time.

Question 6:

Make a program to apply chi-square test to check the uniformity of 100 generated random numbers between [0,1] with $\alpha=0.05$ and $\chi^2_{0.05,9} = 16.9$

Interval	Upper limit	Observed Frequency	Expected frequency
1	0.1	8	10
2	0.2	11	10
3	0.3	9	10
4	0.4	7	10
5	0.5	6	10
6	0.6	14	10
7	0.7	10	10
8	0.8	10	10
9	0.9	12	10
10	1	13	10

Question 7:

Apply tests for autocorrelation for the following Hypothesis:

H_0: $\rho_{i,m} = 0$ *if numbers are independent*

H_1: $\rho_{i,m}$!= 0 *if numbers are dependent*

Use the following sequence of numbers:

1	2	3	4	5	6	7	8	9	10
0.63	0.28	0.30	0.42	0.97	0.05	0.71	0.63	0.17	0.86
0.61	0.19	0.94	0.64	0.84	0.54	0.56	0.57	0.09	0.99
0.01	0.10	0.69	0.38	0.93	0.85	0.68	0.14	0.18	0.84
0.19	0.71	0.44	0.72	0.95	0.28	0.96	0.51	0.50	0.89
0.66	0.31	0.50	0.33	0.89	0.54	0.73	0.76	0.62	0.92

Every number in the 5th, 10th, 15th, and 20th position is a larger value.

Use $\alpha=0.05$, $i=5$, $m=5$, $N=50$, $M=?$

Question 8: Develop a program to simulate repairman problem. A factory possesses a total of *M* identical machines that are subject to breakdown. A certain minimum number of working machines $N < M$ is required for the factory to function correctly. When less than *N* of the machines are in working order, the factory is forced to stop production. The number of machines that are in working order at time *t* is denoted by *n* while the number that are broken is denoted by *b*. There are two different types of events—a machine breaks down, or a machine is repaired and returns to the spare category. Use this simulation to compute the length of time until the number of working machines first falls below *N* and the factory is forced to halt production.

The model parameters are taken to be $M = 10$ and $N = 6$. Both repair time and breakdown times are taken to be normally distributed: mean repair times are 100-time units with standard deviation $\sigma = 50$ while times between breakdown have mean 300 time units and standard deviation $\sigma = 80$.

Question 9: Develop a program to simulate single server queueing system. The program should include the modules to handle arrival and departure events. The service time and interarrival time are exponentially distributed. Run the simulation until a total of N customers have been served and then compute the mean interarrival time, the mean service time and the mean time spent waiting in the queue. Use integer n to completely characterize a state of the system and t to denote the internal clock time. Use Integer variables n_a and n_d count the number of arrivals and departures, respectively. The variables t_a and t_d to denote the scheduled times of the next arrival and the next departure. Use t_λ and t_μ to denote generated interarrival times and service times, respectively. During the simulation run, tot_λ and tot_μ refer to running totals of arrival times and service times.

The model parameters are taken to be $N = 50$, $\lambda = 1.0$ and $\mu = 2.5$. Generate terminal statistics and print report.

Question 10: Develop a program simulate the following problem statement:

The lifetime, in years, of a satellite placed in orbit is given by the following pdf:

$$f(x) = \begin{cases} 0.4e^{-0.4x}, & x \geq 0 \\ 0, & \text{otherwise} \end{cases}$$

(a) What is the probability that this satellite is still "alive" after 5 years?

(b) What is the probability that the satellite dies between 3 and 6 years from the time it is placed in orbit?

Question 11: A retail store wants to simulate the daily demand for a new product using a triangular distribution. The minimum demand is 50 units, the maximum demand is 200 units, and the most likely demand is 120 units. Simulate the triangular distribution to determine the probability that the daily demand will be greater than 150 units. Develop a program to simulate the triangular distribution.

Question 12: 19SW must pass three theory subjects and two practical in the 8th semester. Find the probability that they will pass more subjects and practical than they fail out of five. The binomial distribution uses an average pass rate of 70%. Evaluate the problem by developing a Java/Python program. Apply the binomial distribution to determine the probability that 19SW will pass more subjects than they fail out of five by developing a program.

Question 13: Develop simulation table using event scheduling technique and define the systems state variable: LQ(t), L(t), WQ(t), W(t).
Entities: The six dump trucks (DT 1, … , DT 6)
LQ(t) = number of trucks in loader queue
L(t) = number of trucks (0, 1, or 2) being loaded
WQ(t) = number of trucks in weigh queue
W(t) = number of trucks (0 or 1) being weighed, all at simulation time t
Event notices:
(ALQ, t, DTi): dump truck i arrives at loader queue (ALQ) at time t
(EL, t, DTi): dump truck i ends loading (EL) at time t
(EW, t, DTi): dump truck i ends weighing (EW) at time t

Distribution of Loading Time		Distribution of Weighing Time		Distribution of Travel Time	
Loading time	Probability	Weighing Time	Probability	Travel Time	Probability
5	0.3	12	0.3	40	0.4
10	0.5	14	0.4	60	0.3
15	0.2	16	0.3	80	0.3

Generate the random digits for loading time, weighing time and travel time. It has been assumed that five of the trucks are at the loaders and one is at the scale at time 0. The purpose of the simulation is to estimate the loader and scale utilizations (percentage of time busy).

Question 14: Develop a program simulate the following problem statement:

The probability that a basketball player, Alex, gets selected for any match is 0.3.

- What is the probability that the first match Alex enters is the fifth match of the season?

- What is the probability that Alex plays in no more than three of the first six matches?

Question 15: Develop a program simulate the following problem statement:

The number of customer complaints per day at a retail store follows a Poisson distribution with a mean of 1.2. Find the probability that:

i) There will be exactly 2 complaints in a particular day.

ii) There will be more than 3 complaints in a particular day.

iii) In a 5-day period, there will be at least 2 complaints.

Question 16: A quality control engineer at a manufacturing plant wants to determine the number of inspections required to find the first defective product, given a defect rate of 5%. Assuming the inspections are independent and identically distributed, what is the probability that the first defective product is found on the 5th inspection? What is the expected value (mean) and variance of the geometric distribution?

Question 17:

A bookstore owner wants to determine the optimal number of books to stock for a new release. The book costs $15 and sells for $25. Unsold books can be returned for $5. The demand for the book is uncertain and can be classified into three types of days:

- High demand: 100 books sold with probability 0.4

- Medium demand: 80 books sold with probability 0.3

- Low demand: 50 books sold with probability 0.3

Distribution of books demanded on each of these days is:

Demand	High	Medium	Low
50	0.05	0.12	0.3
60	0.07	0.16	0.2
70	0.1	0.3	0.06
80	0.2	0.2	0.12
90	0.3	0.08	0.13
100	0.15	0.06	0.09
110	0.13	0.08	0.1

The bookstore owner can stock books in multiples of 10. The lost profit from excess demand is $10 per book. Simulate the total profit for 20 days if the bookstore owner stocks 90 books each day by developing a program.

Question 18: A vendor sells fresh flowers at a market stall. The vendor buys bouquets for $8 and sells them for $15. Unsold bouquets can be sold as arrangements for $3. The demand for bouquets is uncertain and can be classified into three types of days:

- Peak day: 40 bouquets sold with probability 0.25

- Normal day: 30 bouquets sold with probability 0.50

- Slow day: 20 bouquets sold with probability 0.25

The vendor can order bouquets in multiples of 5. The lost profit from excess demand is $7 per bouquet. Simulate the total profit for 25 days if the vendor orders 35 bouquets each day.

Question 19: Estimate, by simulation program, the average number of lost sales per week for an inventory system that functions as follows

(a) Whenever the inventory level falls to or below 10 units, an order is placed. Only one order can be outstanding at a time.

(b) The size of each order is equal to 20-I, where I is the inventory level when the order is placed.

(c) If a demand occurs during a period when the inventory level is zero, the sale is lost.

(d) Daily demand is normally distributed, with a mean of 5 units and a standard deviation of 1.5 units. (Round off demands to the closest integer during the simulation, and, if a negative value results, give it a demand of zero.)

(e) Lead time is distributed uniformly between zero and 5 days-integers only.

(f) The simulation will start with 18 units in inventory.

(g) For simplicity, assume that orders are placed at the close of the business day and received after the lead time has occurred. Thus, if the lead time is one day, the order is available for distribution on the morning of the second day of business following the placement of the order.

(h) Let the simulation run for 5 weeks.

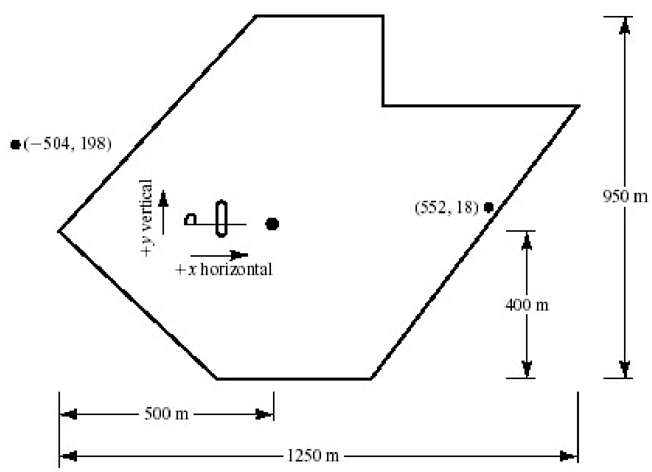
Question 20: A manufacturing plant has 15 identical production lines, and at least 10 working lines are required for the plant to operate efficiently. When a production line breaks down, it takes a certain amount of time to repair. The time between breakdowns and repair times follows normal distributions:

- Time between breakdowns: mean = 250 hours, standard deviation = 60 hours

- Repair time: mean = 120 hours, standard deviation = 40 hours

Develop a simulation program to calculate the time until the number of working production lines first falls below 10, forcing the plant to halt production.

Question 21: A classic simulation problem is that of a squadron of bombers attempting to destroy an ammunition depot shaped as shown in figure below:



If a bomb lands anywhere on the depot, a hit is scored. Otherwise, the bomb is a miss. The aircraft flies in the horizontal direction. Ten bombers are in each squadron. The aiming point is the dot located in the heart of the ammunition dump. The point of impact is assumed to be normally distributed around the aiming point with a standard deviation of 500 meters in the horizontal direction and 350 meters in the vertical direction. The problem is to simulate the operation and make statements about the number of bombs on target by generating RNN for x and y coordinates. The aiming point is considered as (0, 0); that is, the mu value in the horizontal direction is 0, and similarly for the mu value in the vertical direction. $X = Z\sigma_X$ $Y = Z\sigma_Y$

where (X,Y) are the simulated coordinates of the bomb after it has fallen.