

To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

TEST PAPER – 02

(Chapters Covered – Designing of Operational System & Control & Production Planning & Control)

OPERATIONS MANAGEMENT AND STRATEGIC MANAGEMENT

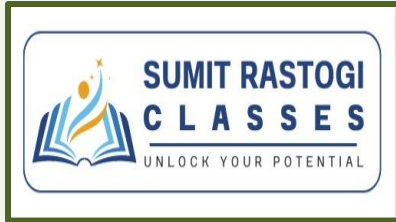
Time Allowed: 3 Hours

Full Marks: 100

**Section A contains Question Number 1. All parts of this question are compulsory.
Working notes should form part of the relevant answer.**

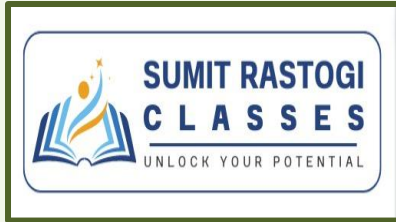
SECTION-A

- 1. Choose the correct answer from the given alternatives (you may write only the Roman number and the alphabet chosen for your answer) (2×15 = 30 Marks)**
- (i) The ability to adapt quickly to changes in volume of demand, in the product mix demanded, and in product design or in delivery schedules, is sometimes referred to as
- (a) Re-Engineering
 - (b) Business Process Restructuring
 - (c) Agile Manufacturing
 - (d) Right Sizing
- (ii) In which one of the following phases of the product life cycle, organisations get engaged in aggressive promotional and pricing program?
- (a) Introduction
 - (b) Growth
 - (c) Maturity
 - (d) Decline
- (iii) The non-linear iterative process that seeks to understand users needs challenge assumptions, redefine problems and create innovative solutions to prototype and test, is called:
- (a) Product Design
 - (b) Product Mix
 - (c) Design Thinking
 - (d) Product Life Cycle



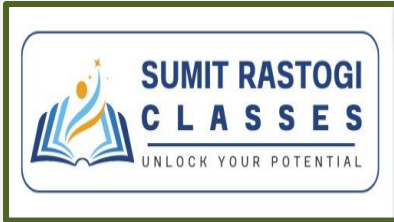
To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

- (iv) In which one of the following stages of Design Thinking, the aim is “to Identify the best possible solution for each problem found”?
- (a) Prototype
 - (b) Define
 - (c) Test
 - (d) Ideate
- (v) In which phase of the product life cycle the objectives is to hold the existing customers and create new customers?
- (a) Scheduling
 - (b) Loading
 - (c) Planning
 - (d) Routing
- (vi) Which one of the following characteristics of good product design refers to ease of manufacture with minimum cost (economic production)?
- (a) Function or Performance
 - (b) Maintainability
 - (c) Productibility
 - (d) Specification
- (vii) Which one of the following basic process types is used when a very highly standardized product is desired in high volumes?
- (a) Batch Process
 - (b) Continuous Process
 - (c) Job Shop Process
 - (d) Project Process
- (viii) Which type of Production Control is most prominently applied in the industries like textiles, and book & magazine printing industries?
- (a) Batch Control
 - (b) Load Control
 - (c) Order Control
 - (d) Block Control
- (ix) In the scheduling function, if the Critical Ratio for a job is greater than 1, it implies that
- (a) The job is behind the Schedule
 - (b) The job is ahead of Schedule
 - (c) The job is not started yet
 - (d) The job is exactly on Schedule



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

- (x) **Gantt Chart is a principal tool used in:**
- (a) Scheduling
 - (b) Loading
 - (c) Planning
 - (d) Routing
- (xi) **Which of the following aims at finding the best and most efficient way of using the available resources – men, materials, money and machinery?**
- (a) Method Study
 - (b) Work Study
 - (c) Time Study
 - (d) Motion Study
- (xii) **Which one of the following production controls is found whenever a particular bottleneck machine exists in the process of Manufacturing?**
- (a) Load Control
 - (b) Batch Control
 - (c) Block Control
 - (d) Flow Control
- (xiii) _____ **is the science of using mathematical calculations and logic to generate time effective sequence of task considering any resource and cost constraints.**
- (a) Scheduling
 - (b) Plan
 - (c) Milestone
 - (d) Work-in-Progress
- (xiv) **Any solution that also satisfies the non-negative restrictions of the general linear programming problem is called a:**
- (a) Basic Solution
 - (b) Feasible Solution
 - (c) Basic Feasible Solution
 - (d) Optimal Feasible Solution
- (xv) **The technique which involves developing a model of real phenomenon and then performing experiments on the model evolved, is referred to as:**
- (a) Transportation
 - (b) Assignment
 - (c) Simulation
 - (d) Queuing



To buy classes visit our website
sumitrastogiclass.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

SECTION-B

2. (a) “Virtually all goods or services are made by using some variation of one of three process Strategies”. Discuss about each of the three process strategies. Also state the situation during the decline stage of a product life cycle. (7 Marks)

2. (b) Briefly describe four stages of Product Life Cycle. (7 Marks)

3. (a) Describe the different types of Production Control. (7 marks)

3. (b) AUTO BUILD Ltd. specializes in high-precision car components. The production manager wants to assign four skilled workers - R, A, N and Z - to four complex assembly jobs: GA, BS, EM and EF. Each worker has different time efficiencies for each job (in hours). The goal is to assign one job to each worker to minimize the total time required.

Workers \ Jobs	GA	BS	EM	EF
R	10	12	16	17
A	9	12	14	14
N	12	14	15	16
Z	10	11	12	13

Required:

(i) Analyze and Assign the appropriate job to each worker to minimize the total work hours.

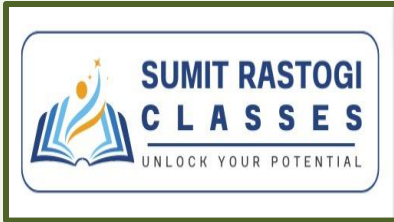
(ii) Assess what is the minimum total time required to finish the jobs. (7 marks)

4. (a) You are working as a Production Manager in a Manufacturing unit. You are required to determine whether resources are to be organized around products or process in order to implement the flow strategy. In this context, describe in brief the basic process types to be chosen. (7 marks)

4. (b) “Customers pay for the products that best fulfill their requirements and provide them the desired value”. In this Context append the Characteristic of a good Product Design. (7 marks)

5. (a) QUICKKAR COURIERS Ltd., a growing logistics firm, wants to simulate their parcel delivery times during monsoon to assess variability and potential delays. They have collected historical data and created a probability distribution of delivery time (in minutes).

Delivery Time (minutes)	15	20	25	30	35
Probability	0.10	0.20	0.35	0.25	0.10



To buy classes visit our website
sumitrastogiclass.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

The following two digits random numbers are to be used to simulate delivery for 10 parcels.

Random Nos: 04 19 33 46 60 74 85 91 23 38

Required:

- (i) Using the given two digit random numbers in sequence. Simulate the 10 parcel delivery times.
(ii) Assess the total and average parcel delivery times. **(7 marks)**

5. (b) ROTIS Ltd., a manufacturing company produces two types of products: Super and Regular. Resource requirements for production are given below in the table. There are 16000 hours of assembly worker hours, 7000 hours of paint time and 3000 hours of inspection time available per week. Regular customers will demand at least 500 units of the Regular type and 200 units of Super type.

Product Type	Profit per unit (₹)	Assembly Time (Hrs.)	Paint time (Hrs.)	Inspection Time (Hrs.)
Regular	50	12	8	2
Super	75	16	9	2

Required:

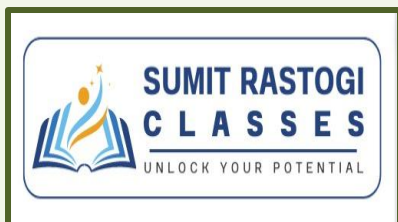
Develop a mathematical formulation of L.P.P to determine how many products should be produced to maximize the profit. (You are not required to solve the LPP) **(7 marks)**

6. (a) A Project consists of four major jobs, for which four contractors have submitted tenders. The tender amounts, in thousands of Rupees, are given below:

Contractor	Jobs			
	A	B	C	D
1	110	98	75	95
2	85	95	115	65
3	105	135	125	98
4	95	95	75	95

Find the assignment, which minimizes the total cost of the project. Each contractor has to be assigned one job. **(7 Marks)**

6. (b) Table shows the time remaining (number of days until due date) and the work remaining (number of days still required to finish to finish the work) for 5 jobs which were assigned the letters A to E as they arrived to the shop. Sequence these jobs by priority rules viz., (i) FCFS, (ii) EDD, (iii) LS, (iv) SPT and (v) LPT.



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

Job	Number of days until due date	Number of days of work remaining
A	10	8
B	4	5
C	8	7
D	11	4
E	5	9

(7 marks)

7. (a) TOXIN Ltd., a manufacturing company has five jobs (D, E, F, G and H) and four machines M_1 , M_2 , M_3 and M_4).

These jobs can be processed on any four machines. Resulting times (hours) vary with assignment. The required time (in hours) for each job on machine are given in following table:

Machine \ Job	M_1	M_2	M_3	M_4
D	8	4	7	4
E	4	7	10	9
F	9	10	8	11
G	8	4	5	6
H	11	5	10	11

The manager (Production) of the company would like to assign the jobs so that total time is minimized.

Required:

Develop the optimal assignment of jobs to machines and assess the corresponding total time (in hours).

(7 marks)

7. (b) MR. RATUN, a bakery shopkeeper sells confectionary items. Past data of demand per week in hundred kilograms with frequency is given as below:

Demand/Week	0	5	10	15	20	25
Frequency	8	16	4	15	5	2

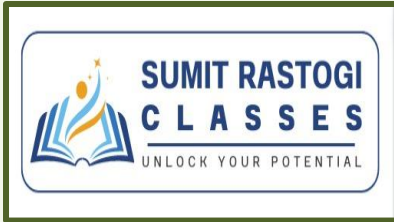
The following two digits random numbers are to be used to generate the demand for 10 weeks.

Random Numbers	27	63	79	35	86	58
	38	67	95	52		-

Required:

- Using the given two digits random numbers, simulate the 10 weeks demand of confectionary items.
- Analyze the average demand per week.

(7 marks)



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

8. (a) Home Town Interior Decoration Ltd., uses a costly drier while painting the fire protection doors. The drier is highly volatile. It cannot be stored. In order to meet the requirement of drier, the exact quantity is purchased every day and consumed. The Management of the Company wants to simulate the demand of the drier. For this the Management of the Company collected data for past 100 days for the application of the drier on the number of doors and the same data are shown in the table below:

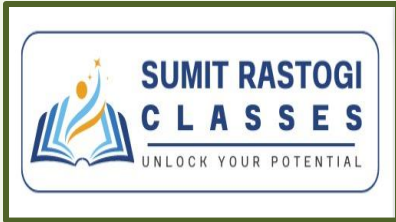
Daily Demand (No. of Driers)	Number of Days
0	20
1	30
2	20
3	10
4	6
5	4
6	10

Consider the following table of two Digit Random Numbers:

Random Numbers	03	23	36	93	69	43	87	51	11	08
----------------	----	----	----	----	----	----	----	----	----	----

Required:

- (i) Using the following generated random numbers in sequence, generate the demand of driers for next ten days.
- (ii) Assess the average demand of drier per day. (7 marks)
8. (b) RAGON (P.) & Co. has a single machinist in a repair shop. He works eight hours a day and on average four machines break each day. It takes on the average one hour to repair a machine. Simple queue conditions exist.
- Required:**
- (i) Identify the expected number of machines on the repair shop.
- (ii) Determine the expected number of machines in the shop on which the machinist has not started to work.
- (iii) Assess the average down-time (waiting for repairs or undergoing repairs) per machine?
- (iv) The average time a machine waits for service would be how much? (7 marks)



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

ANSWERS OF TEST PAPER – 02

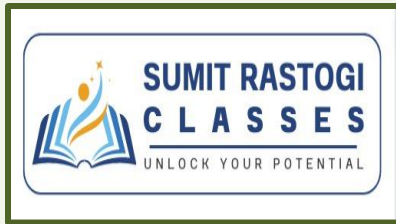
(Chapters Covered – Designing of Operational System & Control & Production Planning & Control)

OPERATIONS MANAGEMENT AND STRATEGIC MANAGEMENT

SECTION-A

ANS.1

- (i) (c) Agile Manufacturing
- (ii) (b) Growth
- (iii) (c) Design Thinking
- (iv) (a) Prototype
- (v) (a) Scheduling
- (vi) (c) Productibility
- (vii) (b) Continuous Process
- (viii) (d) Block Control
- (ix) (b) The job is ahead of Schedule
- (x) (a) Scheduling
- (xi) (b) Work Study
- (xii) (a) Load Control
- (xiii) (a) Scheduling
- (xiv) (d) Optimal Feasible Solution
- (xv) (c) Simulation



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

SECTION-B

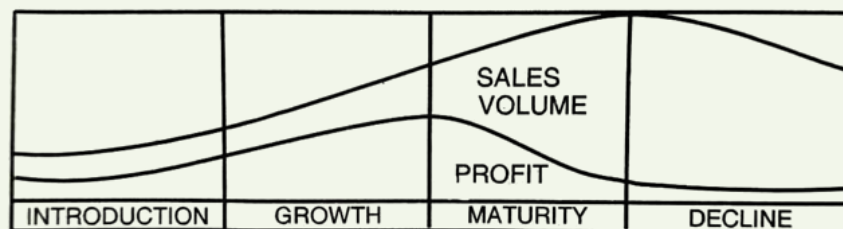
ANS. 2 (a)

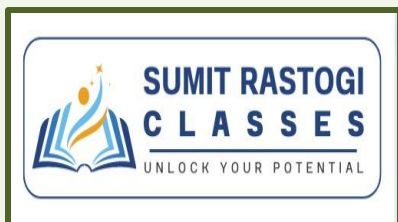
The process strategies are: (i) process focus (ii) repetitive focus and (ii) product focus. Each of these three strategies is discussed below:

- (i) Process Focus:** Majority (about 75 per cent) of global production is devoted to low volume, high variety products in manufacturing facilities called job shops. Such facilities are organized around performing processes. For example, the processes might be welding, grinding or painting carried out in departments devoted to these processes. Such facilities are process focused in terms of equipment, machines, layout and supervision. They provide a high degree of product flexibility as products move intermittently between processes. Each process is designed to perform a wide variety of activities and handle frequent changes. Such processes are called intermittent processes. These facilities have high variable costs and low utilization of facilities.
- (ii) Repetitive Focus:** A repetitive process is a product-oriented production process that uses modules. It falls between product focus and process focus. It uses modules which are parts or components prepared often in a continuous or production process. A good example of repetitive process is the assembly line which is used for assembling automobiles and household appliances and is less flexible than process-focused facility. Personal computer is an example of a repetitive process using modules in which the modules are assembled to get a custom product with the desired configuration.
- (iii) Product Focus:** It is a facility organized around products, a product oriented, high-volume low-variety process. It is also referred to as continuous process because it has very long continuous production run. Examples of product focused processes are steel, glass, paper, electric bulbs, chemicals and pharmaceutical products, bolts and nuts etc. Product-focused facilities need standardization and effective quality control.

The specialized nature of the facility requires high fixed cost, but low variable costs requiring high facility utilization. Situation during the decline stage of a product life cycle: At the final stage of decline, profit margins touch a low level, competition becomes severe and customers start using newer and better products. It is here that the story of a product ends - a natural but hard end.

ANS. 2 (b)





To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

The **introduction stage** is preceded by "production planning and development". This period requires greater investment. This investment should be gradually recouped as the sales pick up. The concept of life cycle would give the management an idea to the time within which the original investment could be recouped. After testing, a product enters the introduction stage and the product will then become available in the national market. Sales would begin gradually as potential buyers learn of the product through advertising and other selling techniques. But the profits will be low as part of the investment is to be recouped besides heavy expenditure on selling.

In the **growth stage**, both sales and profits will begin to increase. It is here that similar other new products begin to appear in the market as substitutes and offer competition. The management, therefore, should try to change its approach by changing its strategy from "buy my product" to "try my product". At the end of this stage, the distribution arrangement is likely to get completed and the prices, if necessary, are reduced a little.

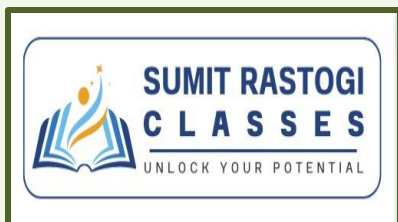
The **third stage** is the maturity stage. During this stage the manufacturers introduce new models or adopt methods such as trading-in, etc., to promote the sale of their brands with a view to retaining their position in the market. The number of buyers will continue to grow, but more slowly. In economic terms this is the stage where supply exceeds demand. Some of the promotional efforts may lengthen the span of this stage but they will not offer a permanent solution.

At the **final stage** of decline, profit margins touch a low level, competition becomes severe and customers start using newer and better products. It is here that the story of a product ends-a natural but hard end.

ANS. 3 (a)

Production control can be of six types

(i)	Block control	This type of control is most prominent in textiles and book and magazine printing. In these industries it is necessary to keep things separated and this is the fundamental reason why industries resort to block control
(ii)	Flow control	This type of control is commonly applied in industries like chemicals, petroleum, glass, and some areas of food manufacturing and processing. Once the production system is thoroughly designed, the production planning and control department controls the rate of flow of work into the system and checks it as it comes out of the system. But, under this method, routing and scheduling are done when the plant is laid out. That is to say, the production line which is established is well balanced and sequenced before production operations begin; this type of control is more prevalent in continuous production systems.



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

(iii)	Load control	Load control is typically found wherever a particular bottleneck machine exists in the process of manufacturing
(iv)	Order control	The most, common type of production control is called order control. This type of control is commonly employed in companies with intermittent production systems, the so-called job-lot shops. Under this method, orders come into the shop for different quantities for different products. Therefore, production planning and control must be based, on the individual orders.
(v)	Special project control	Special production control is necessary in certain projects like the construction of bridges, office buildings, schools, colleges, universities, hospitals and any other construction industries. Under this type of control, instead of having sets of elaborate forms for tooling and scheduling, a man or a group of men keeps in close contact with the work.
(vi)	Batch control	Batch control is another important, type of production control which is frequently found in the food processing industries

ANS. 3 (b)

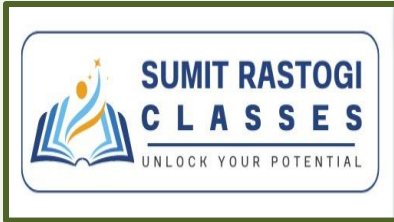
TABLE – 1
Row Reduction

	GA	BS	EM	EF
R	0	2	6	7
A	0	3	5	5
N	0	2	3	4
Z	0	1	2	3

TABLE – 2
Column Reduction

	GA	BS	EM	EF
R	0	1	4	4
A	0	2	3	2
N	0	1	1	1
Z	0	0	0	0

No. of straight line = 2 $\neq$ No. of rows or column.
 It is not optimum.



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

TABLE – 3
Improved Table

	GA	BS	EM	EF
R	✗	0	3	3
A	0	1	2	1
N	✗	✗	0	0
Z	1	✗	0	0

No. of straight line = 4 = No. of rows or column.

It is optimum solution.

Assignment of Jobs to skill workers and total time.

Workers	Jobs	Time (Hrs.)
R	BS	12
A	GA	9
N	EM or EF	15 or 16
Z	EF or EM	13 or 12
		49

It has alternate solution:

R → BS	OR	R → BS
A → GA		A → GA
N → EM		N → EF
Z → EF		Z → EM

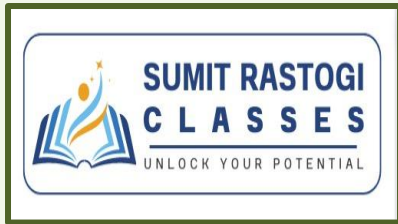
ANS. 4 (a)

A process is a sequence of activities that is intended to achieve some result, typically to create added value for the customers.

A process converts inputs outputs in a production system. It involves the use of organisation's resources to provide something of value. No product can be made no service can be provided without a process and no process can exist without a product or service.

Types of Process: basically process can be categorised as:

1. **Conversion processes**, ie., converting the raw materials into furnished product (for example, converting iron ore into iron and then to steel). The conversion process could be metallurgical or chemical or manufacturing or construction process.
2. **Manufacturing processes** can be categorised into (a) Forming process, (b) Machine process and (c) Assembly process.
3. **Testing processes** which involve inspection and testing of products (some-times considered as part of the manufacturing process).



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

Forming processes include foundry process (to produce casting) and other process such as forging, stamping, embossing and spinning. These processes change the shape of the raw material (a metal) into the shape of the work-place without removing or adding material.

Machine processes comprise metal removal operations such as turning, milling, drilling, grinding, shaping, planning, boring etc.

Assembly processes comprise involve joining of parts or components to produce assemblies having specific functions. Examples of assembly processes are welding, brazing, soldering, riveting, fastening with bolts and nuts joining using adhesives.

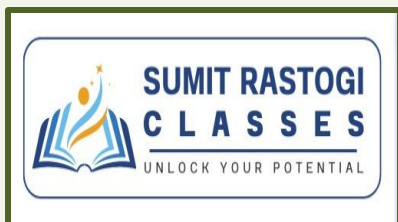
The production manager has to choose from basic process types-

- (a) **Job shop process:** It is used in job shops when a low volume of high-variety goods are needed. Processing is intermittent; each job requires somewhat different processing requirements. A job shop is characterised by high customisation (made to order), high flexibility of equipment and skilled labour and low volume.
- (b) **Batch process:** Batch processing is used when a moderate volume of goods or service is required and also a moderate variety in product or services. A batch process differs from the job process with respect to volume and variety. In batch processing volumes are higher because in batches include paint, ice cream, soft drinks, books and magazines.
- (c) **Repetitive process:** This is used when higher volumes of more standardized goods or services are needed. This type of process is characterised by slight flexibility of equipment (as products are standardised) and generally low labour skills. Products produced include automobiles, home appliances, toys etc. Repetitive process is also referred to as line process as it includes production lines and assembly lines in mass production.
- (d) **Continuous process:** This is used when a very high standardised product is desired in high volumes. These systems have almost no variety in output and hence there is no need for equipment flexibility. A continuous process is the extreme end high volume, standardised production with rigid line flows.
- (e) **Project process:** It is characterised by high degree of job customisation, the large scope for each project and need for substantial resources to complete the project. Examples of projects are building a shopping centre, a dam, a bridge, construction of factory, hospital, developing a new product, publishing a new book etc.

ANS. 4 (b)

Product is an important part of the fundamental marketing mix. Customers pay for the products that best fulfill their requirement and provide them the desired value. The attributes and quality of the product triggers the demand which in turn is a reason for the existence of the value chains and hence organizations. Therefore, designing a product is an important strategic decision.

Product design is a collection of interdependent directional activities that are planned and executed in a structured and planned way to develop the value propositions to be offered to the end customers for fulfilling their needs.



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

Characteristics of Good Product Design

A good product design must ensure the following:

- Product quality: The product must satisfy the needs of the end customers while providing optimum value. The performance should be at par with the expectations.
- The product must be reliable and worthy for paying for the same.
- The product must be designed at an optimum cost to be offered at an afford-able price to the target customers.
- The product must be having a shorter design to market lead time.
- The aesthetics/looks of the product must create an immediate impression in the minds of the customers.
- The product must be compatible, user-friendly and upgradable with availability of after sales support (e.g., spare parts)
- The product must be easily maintainable and reproducible.
- The product should balance between standardized basic features and customized augmented features.
- A detailed specification.
- The product must be safe to use, error proof and should not harm the environment and users.

ANS. 5 (a)

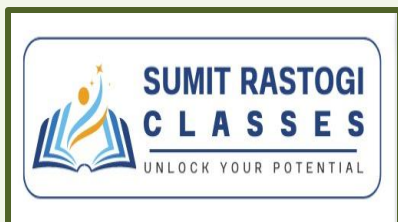
Cumulative Probability and Random Number interval of Delivery time

Delivery Time (min)	Probability	Cumulative Probability	Random Number Interval
15	0.10	0.10	00 – 09
20	0.20	0.30	10 – 29
25	0.35	0.65	30 – 64
30	0.25	0.90	65 – 89
35	0.10	1.00	90 - 99

Simulation Table

No. of Parcels	Random Number	Delivery Time (min)
1	04	15
2	19	20
3	33	25
4	46	25
5	60	25
6	74	30
7	85	30
8	91	35
9	23	20
10	38	25
Total Time		= 250 min

Average parcel delivery time = $250/10 = 25$ min.



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

ANS. 5 (b)

Let x_1 = No. of Regular Product

x_2 = No. of Super Product

Objective Function

Maximization of profit:

$$Z = 50x_1 + 75x_2$$

Subject to Constraints

Assembly time: $12x_1 + 16x_2 \leq 16000$

Paint time: $8x_1 + 9x_2 \leq 7000$

Inspection time: $2x_1 + 2x_2 \leq 3000$

Demand: $x_1 \geq 500$

$x_2 \geq 200$

$x_1, x_2 \geq 0$

ANS. 6 (a)

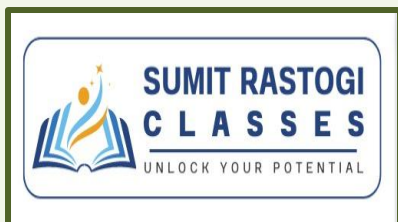
The given problem is a standard minimization problem. Subtracting the minimum element of each row from all its elements in turn, the given problem reduces to:

Contractor	Jobs			
	A	B	C	D
1	35	23	0	20
2	20	30	50	0
3	7	37	27	0
4	20	20	0	20

Now subtract the minimum element of each column from all of its elements in turn. Draw the minimum number of lines, horizontal or vertical, so as to cover all zeros:

Contractor	Jobs			
	A	B	C	D
1	28	3	0	20
2	13	10	50	0
3	0	17	27	0
4	13	0	0	20

Since the minimum number of lines to cover all zeroes is equal to 4 (= order of the matrix), this matrix will give optimal solution. The optimal assignment is made in the matrix below:



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

Contractor	Jobs			
	A	B	C	D
1	28	3	0	20
2	13	10	50	0
3	0	17	27	X
4	13	0	X	20

The optimal assignment is:

Contractors	Job	Cost (in thousands of Rupees)
1	C	75
2	D	65
3	A	105
4	B	95

Hence, total minimum cost of Project will be ₹3,40,000.

ANS. 6 (b)

Job	Number of days until due date	Number of days of work remaining
A	10	8
B	4	5
C	8	7
D	11	4
E	5	9

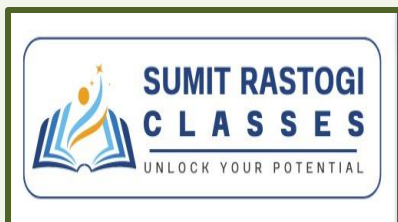
(i) FCFS (First Come First Served): Since the jobs are assigned letters A to E as they arrived/to the shop, the sequence according to FCFS priority rule is A B C D E.

(ii) EDD (Early Due Date Job First) RULE: Taking into account the number of days until due date, the sequence of jobs as per EDD rules is:

Job	B	E	C	A	D
No. of days until due date	4	5	8	10	11

(iii) L.S. (Least Slack) rule also called as Minimum slack rule. Calculation of slack: Slack = (Number of days until due date) – (Number of days of work remaining)

Job	No. of days until/due date	No. of days of work remaining	Slack (Days)
A	10	8	10 – 8 = 2
B	4	5	4 – 5 = -1
C	8	7	8 – 7 = 1
D	11	4	11 – 4 = 7
E	5	9	5 – 9 = -4



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

Job	E	B	C	A	D
Slack	-4	-1	1	2	7

- (iv) SPT (Shortest Processing Time job first) also referred as SOT (Shortest Operation Time job First) rule or MINPRT (Minimum Processing Time job first) rule. As per this rule, jobs are sequenced in ascending order of magnitude of their respective processing time. Sequence:

Job	D	B	C	A	E
Processing Time (Days)	4	5	7	8	9

- (v) LPT (Longest Processing Time Job First) also referred to as LOT (Longest Operation Time Job First) rule. As per this rule jobs are sequenced in descending order of magnitude of their respective processing times. Sequence:

Job	E	A	C	B	D
Processing Time (Days)	9	8	7	5	4

ANS. 7 (a)

Here, No. of rows $\neq$ No. of column.

So, Apply Dummy Column.

TABLE – 1

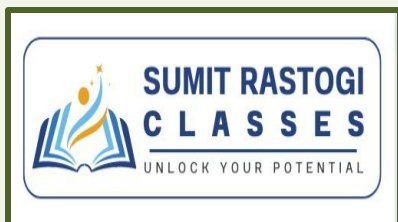
Job/Machine	M ₁	M ₂	M ₃	M ₄	Dummy
D	8	4	7	4	0
E	4	7	10	9	0
F	9	10	8	11	0
G	8	4	5	6	0
H	11	5	10	11	0

TABLE – 2 (Column Reduction)

	M ₁	M ₂	M ₃	M ₄	Dummy
D	4	0	2	0	0
E	0	3	5	5	0
F	5	6	3	7	0
G	4	0	0	2	0
H	7	1	5	7	0

Here, No. of straight line = 4 $\neq$ No. of rows or columns

So it is not optimum solution.



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

TABLE – 3 (Improved Table)

	M ₁	M ₂	M ₃	M ₄	Dummy
D	4	∞	2	0	1
E	0	3	5	5	1
F	4	5	2	6	0
G	4	∞	0	2	1
H	6	0	4	6	1

Here, No. of straight line = 5 = No. of rows or columns

So it is optimum solution.

Statement showing assignment of Jobs to Machine and Total Time

Jobs	Machine	Time
D	M ₄	4
E	M ₁	4
F	Dummy	-
G	M ₃	5
H	M ₂	5
		18 Hrs.

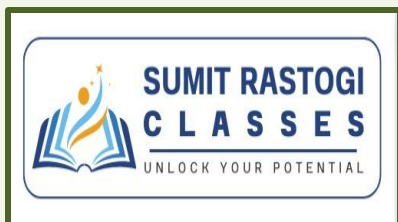
ANS. 7 (b)

Cumulative Probability & Random Number Interval

Demand	Probability	Cumulative Probability	Random no. Interval
0	0.16	0.16	00 - 15
5	0.32	0.48	16 - 47
10	0.08	0.56	48 - 55
15	0.30	0.86	56 - 85
20	0.10	0.96	86 - 95
25	0.04	1.00	96 - 99

Simulation Table

Weeks	Random Nos.	Demand
1	27	5
2	63	15
3	79	15
4	35	5
5	86	20
6	58	15
7	38	5



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

Weeks	Random Nos.	Demand
8	67	15
9	95	20
10	52	10
Total Demand		125

Average Demand per week = $125/10 = 12.5$

ANS. 8 (a)

Cumulative Probability and Random Number Interval

Daily Demand	No. of days	Probability	Cumulative Probability	Random number interval
0	20	$20/100 = 0.20$	0.20	00 – 19
1	30	$30/100 = 0.30$	0.50	20 – 49
2	20	$20/100 = 0.20$	0.70	50 – 69
3	10	$10/100 = 0.10$	0.80	70 – 79
4	6	$6/100 = 0.06$	0.86	80 – 85
5	4	$4/100 = 0.04$	0.90	86 – 89
6	10	$10/100 = 0.10$	1.00	90 – 99

Total Days = 100

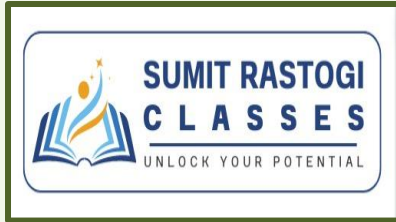
(i)

Simulation Table

Days	Random Number	Demand
1	03	0
2	23	1
3	36	1
4	93	6
5	69	2
6	43	1
7	87	5
8	51	2
9	11	0
10	08	0

Total Demand = 18

(ii) Average Demand of Driver per day = $18/10 = 1.8$



To buy classes visit our website
sumitrastogiclasses.com
and for further queries contact us on
8826965733, 9811229279, 9560978857

ANS. 8 (b)

Average No. of Breakdown per day = 4 Arrival rate = $\lambda = 4$ machine per day. Average No. of repair per day = $1 \times 8 = 8$ i.e. service rate = $\mu = 8$ machine per day

(i) Expected Number of Machine on Shop

$$= L_s = \frac{\lambda}{\mu - \lambda} = \frac{4}{8 - 4} = 1 \text{ machine}$$

(ii) Expected Number of Machine waiting for repair

$$L_q = \frac{\lambda}{\mu - \lambda} \times \frac{\lambda}{\mu} = \frac{4}{8 - 4} \times \frac{4}{8}$$
$$= \frac{4}{4} \times \frac{1}{2} = \frac{1}{2} \text{ machine}$$

(iii) Average waiting time on system

$$W_s = \frac{1}{\mu - \lambda} = \frac{1}{8 - 4} = \frac{1}{4} \text{ day}$$
$$= \frac{1}{4} \times 8 = 2 \text{ Hrs.}$$

(iv) Average waiting time in queue

$$W_q = \frac{1}{\mu - \lambda} \times \frac{\lambda}{\mu}$$
$$= \frac{1}{8 - 4} \times \frac{4}{8} = \frac{1}{4} \times \frac{4}{8} = \frac{1}{8} \text{ day}$$
$$= \frac{1}{8} \times 8 \text{ Hrs.} = 1 \text{ Hrs.}$$