

MEPL CLASSES  
CMA INTER – OM

TOPIC - STUDY NOTE 1 + ASSIGNMENT + SIMULATION

TOTAL MARKS 50

TIME ALLOWED - 90 MINUTES

**Questions 1 to 7 are allotted 7 marks each**

**Question 1.**

“Recent trends in production and operations management relate to global competition and the impact it has on manufacturing firms.” State the recent trends.

**Answer –**

Recent trends in production and operations management relate to global competition and the impact it has on manufacturing firms. Some of the recent trends are:

- 1. Global Market Place:** Globalisation of business has compelled many manufacturing firms to have operations in many countries where they have certain economic advantage. This has resulted in a steep increase in the level of competition among manufacturing firms throughout the world.
- 2. Production/Operations Strategy:** More and more firms are recognising the importance of production/ operations strategy for the overall success of their business and the necessity for relating it to their overall business strategy.
- 3. Total Quality Management (TQM):** TQM approach has been adopted by many firms to achieve customer satisfaction by a never-ending quest for improving the quality of goods and services.
- 4. Flexibility:** The ability to adapt quickly to changes in volume of demand, in the product mix demanded, and in product design or in delivery schedules, has become a major competitive strategy and a competitive advantage to the firms. This is sometimes called as agile manufacturing.
- 5. Time Reduction:** Reduction of manufacturing cycle time and speed to market for a new product provide competitive edge to a firm over other firms. When companies can provide products at the same price and quality, quicker delivery (short lead times) provide one firm competitive edge over the other.

**6. Technology:** Advances in technology have led to a vast array of new products, new processes and new materials and components. Automation, computerisation, information and communication technologies have revolutionised the way companies operate. Technological changes in products and processes can have great impact on competitiveness and quality, if the advanced technology is carefully integrated into the existing system.

**7. Worker Involvement:** The recent trend is to assign responsibility for decision making and problem solving to the lower levels in the organisation. This is known as employee involvement and empowerment. Examples of worker involvement are quality circles and use of work teams or quality improvement teams.

**8. Re-engineering:** This involves drastic measures or break-through improvements to improve the performance of a firm. It involves the concept of clean-slate approach or starting from scratch in redesigning the business processes.

**9. Environmental Issues:** Today's production managers are concerned more and more with pollution control and waste disposal which are key issues in protection of environment and social responsibility. There is increasing emphasis on reducing waste, recycling waste, using less-toxic chemicals and using biodegradable materials for packaging.

**10. Corporate Downsizing (or Right Sizing):** Downsizing or right sizing has been forced on firms to shed their obesity. This has become necessary due to competition, lowering productivity, need for improved profit and for higher dividend payment to shareholders.

**11. Supply-Chain Management:** Management of supply-chain, from suppliers to final customers reduces the cost of transportation, warehousing and distribution throughout the supply chain.

**12. Lean Production:** Production systems have become lean production systems which use minimal amounts of resources to produce a high volume of high-quality goods with some variety. These systems use flexible manufacturing systems and multi-skilled workforce to have advantages of both mass production and job production (or craft production).

### **Question 2.**

What are the characteristics of Modern Operations Function?

**Answer –**

The production management of today presents certain characteristics which make it look totally different from what it was during the past. Specifically, today's production system is characterised by at least four features.

**1. Manufacturing as Competitive Advantage** In the past production was considered to be like any other function in the organisation. When demand was high and production capacities were inadequate, the concern was to somehow muster all inputs and use them to produce goods which would be grabbed by market. But today's scenario is contrasting. Plants have excess capacities, competition is mounting and firms look and gain competitive advantage to survive and succeed. Interestingly, production system offers vast scope to gain competitive edge and firms intend to exploit the potential. Total Quality Management (TQM), Time-Based Competition, Business Process Re-engineering (BPRE), Just-in-Time (JIT), Focused Factory, Flexible Manufacturing Systems (FMS), Computer Integrated Manufacturing (CIM), and The Virtual Corporation are but only some techniques which the companies are employing to gain competitive advantage.

**2. Services Orientation** was stated earlier, service sector is gaining greater relevance these days. The production system, therefore, needs to be organised keeping in mind the peculiar requirements of the service component. The entire manufacturing needs to be geared to serve.

- (i) intangible and perishable nature of the services,
- (ii) constant interaction with clients or customers,
- (iii) small volumes of production to serve local markets, and
- (iv) need to locate facilities to serve local markets. There is increased presence of professionals on the production, instead of technicians and engineers.

**3. Disappearance of Smokestacks** Protective labour legislation, environmental movement and gradual emergence of knowledge-based organisations have brought total transformation in the production system. Today's factories are aesthetically designed and built, environment friendly - in fact, they are homes away from homes. Going to factory every day is no more excruciating experience; it is like holidaying at a scenic spot. A visit to ABB, L&T or Smith Kline and Beecham should convince the reader about the transformation that has taken place in the wealth creation system.

4. Small has Become Beautiful It was E.F. Schumacher who, in his famous book Small is Beautiful, opposed giant organisations and increased specialisation. He advocated, instead, intermediate technology based on smaller working units, community ownership, and regional workplaces utilising local labour and resources. For him, small was beautiful. Businessmen, all over the world, did not believe in Schumacher’s philosophy. Inspired by economies of scale, industrialists went in for huge organisations and mass production systems.

**Question 3.**

Six men are available for different jobs. From past records the time in hours taken by different persons for different jobs are given below.

		Jobs					
Men		1	2	3	4	5	6
	1	2	9	2	7	9	1
	2	6	8	7	6	14	1
	3	4	6	5	3	8	1
	4	4	2	7	3	10	1
	5	5	3	9	5	12	1
	6	9	8	12	13	9	1

Find out an allocation of men to different jobs which will lead to minimum operation time.

Answer-

Man \ Job	1	2	3	4	5	6
1	2	9	2	7	9	1
2	6	8	7	6	14	1
3	4	6	5	3	8	1
4	4	2	7	3	10	1
5	5	3	9	5	12	1
6	9	8	12	13	9	1

Row Operation\* (Table - 1)

Job \ Man	1	2	3	4	5	6
1	1	h	1	6	h	0
2	5	7	6	5	13	0
3	3	5	4	2	7	0
4	3	1	6	2	9	0
5	4	2	h	4	11	0
6	h	7	11	12	h	0

\* Matrix is obtained by subtracting min. element of each row of the given Matrix from all the elements of the corresponding

Column Operation\* (Table - 2)

Job \ Man	1	2	3	4	5	6
1	0	7	0	4	1	0
2	4	fi	5	3	6	0
3	2	4	3	0	0	0
4	2	0	fi	0	2	0
5	3	1	7	2	4	0
6	7	6	10	10	1	0

Matrix is obtained by subtracting min. element of each column of Table - 1 from all the elements of the corresponding column.

Table - 3

Job \ Man	1	2	3	4	5	6
1	0	7	0	4	1	0
2	4	fi	5	3	6	0
3	2	4	3	0	0	0
4	2	0	fi	0	2	0
5	3	1	7	2	4	0
6	7	6	10	10	1	0

All the zeros obtained in Table - 2 are covered by minimum no. of horizontal and vertical straight lines and shown above. Here order of the given matrix = 6 and minimum no. of horizontal and vertical lines = 4.

As 4 / fi, the saturation is non optimal.

Tshle - 4

Job Man	\$	2	3	4	fi	6
2	3	5	4	2	5	0
3	2	4	3	0	0	1
4	2	0	5	0	2	1
5	2	0	6	1	3	0

Above table is obtained by subtracting minimum uncovered element of Table 3 from all the uncovered elements and by adding the same to all the elements at the junction of the intersecting straight lines.

Minimum no. of horizontal and vertical straight lines to cover all the zeros = 3 (order of the matrix). So the solution is not optimal.

Tshle - 5

Job Man	1	2	3	4	5	6
1	X	9	0	6	3	3
2	1	5	2	2	5	0
3	0	4	1	0	X	1
4	0	0	3	0	2	1
5	0	0	4	1	3	X
6	4	5	7	9	0	X

Above table is obtained by subtracting minimum uncovered element of Table 4 from all the uncovered elements and by adding the same to all the elements at the junction of the intersecting straight lines. Here minimum no. of horizontal or vertical straight lines to cover all the zeros = 6 = Order of the Matrix. So the solution is optimal.

Tshle - 6 Showing Optimal Solution

Job Man	1	2	3	4	5	6
1	9	0	6	3	3	
2	1	5	2	2	5	0
3	0	4	1	X	1	
4	0	0	3	0	2	1
5	0	0	4	1	3	X
6	4	5	7	9	0	X

Table - 7 Showing Optimum Solution - 2

Man \ Job	1	2	3	4	5	6
1	∞	9	0	6	3	3
2	1	5	2	2	5	0
3	∞	4	1	0	∞	1
4	0	∞	3	∞	2	1
5	∞	0	4	1	3	∞
6	4	5	7	9	0	∞

Table - 8 Showing Optimum Solution - 3

Man \ Job	1	2	3	4	5	6
1	∞	9	0	6	3	3
2	1	5	2	2	5	0
3	∞	4	1	0	∞	1
4	∞	0	3	∞	2	1
5	0	∞	4	1	3	∞
6	4	5	7	9	0	∞

So the Optimal Assignments are as follows:—

As per Table - 6			As per Table - 7			As per Table - 8		
Man	Job	Time (hrs.)	Man	Job	Time (hrs.)	Man	Job	Time (hrs.)
1	3	2	1	3	2	1	3	2
2	6	1	2	6	1	2	6	1
3	1	4	3	4	3	3	4	3
4	4	3	4	1	4	4	2	3
5	2	3	5	2	3	5	1	5
6	5	9	6	5	9	6	5	9
<b>Total</b>	—	22	<b>Total</b>	—	22	<b>Total</b>	—	22

Minimum total operation time = 22 hrs.

**Question 4.**

A captain of a cricket team has to allot five middle batting positions to five batsmen. The average runs scored by each batsman at these positions are as follows:

		Batting Position				
		III	IV	V	VI	VII
Batsmen	A	40	40	35	25	50
	B	42	30	16	25	27
	C	50	48	40	60	50
	D	20	19	20	18	25
	E	58	60	59	55	53

Make the assignment so that the expected total average runs scored by these batsmen are maximum.

Answer–

This is a problem of Maximisation. To solve it using Assignment technique it has to be converted to a Minimisation problem by forming a Relative Loss Matrix.

		Batting Position				
Batsman		III	IV	V	VI	VII
A		40	40	35	25	50
B		42	30	16	25	27
C		50	48	40	60	50
D		20	19	20	18	25
E		58	60	59	55	53

Relative Loss Matrix\*

		Batting Position				
Batsman		III	IV	V	VI	VII
A		20	20	25	35	10
B		18	30	44	35	33
C		10	12	20	0	10
D		40	41	40	42	35
E		2	0	1	5	7

\* This matrix is formed by subtracting all the elements of the given matrix from the highest element (50) of it,

Row operation matrix

Batsmen	Batting Position				
	III	IV	V	VI	VII
A	10	10	15	25	0
B	0	12	26	17	15
C	10	12	25	0	10
D	5	6	5	7	0
E	2	0	1	5	7

Column operation matrix

Batsmen \ Batting Position	III	IV	V	VI	VII
A	10	10	14	2	0
B	0	12	25	17	15
C	10	12	19	0	10
D	5	6	4	7	0
E	2	0	0	5	7

Minimum no. of horizontal and vertical straight lines to cover all the zeros = 4 / Order of the matrix {5}. So the solution is non optimal.

Adjusted matrix

Batsman	III	IV	V	VI	VII
A	10	6	10	25	0
B	0	12	21	17	15
C	10	1	15	0	10
D	5	2	0	7	0
E	6	0	0	9	1

Here minimum no. of horizontal and vertical straight lines to cover all the zeros = 5 = Order of the matrix. So the solution is optimal.

Optimal Assignment

Batsman	Batting Position	Average runs scored
A	VII	50
B	III	42
C	VI	60
D	V	20
E	IV	60
Total =		232

Expected maximum total runs = 232

**Question 5.**

A company has four sales representatives who are to be assigned to four different sales territories. The monthly sales increase estimated for each sales representative for different sales territories (in lakhs of rupees) are shown in the following table:

Sales Representatives	Sales Territories			
	I	II	III	IV
A	200	150	170	220
B	160	120	150	140
C	190	195	190	200
D	180	175	160	190

Suggest optimal assignment and the total maximum sales increase per month

**Answer**

The Sales increase monthly is as follows:

	I	II	III	IV
A	200	150	170	220
B	160	120	150	140
C	190	195	190	200
D	180	175	160	190

Since the given problem is a maximization problem it needs to be converted into a minimization problem by subtracting each element in the table above from the highest element in the table i.e. 220 and the resultant table is given below:

	I	II	III	IV
A	20	70	50	0
B	60	100	70	80
C	30	25	30	20
D	40	45	60	30

Then follow the normal assignment rule and iterations are:

	I	II	III	IV
A	20	70	50	0
B	0	40	10	20
C	10	5	10	0
D	10	15	30	0

	I	II	III	IV
A	20	65	40	0
B	0	35	0	20
C	10	0	0	0
D	10	10	20	0

	I	II	III	IV
A	10	55	30	0
B	0	35	0	30
C	10	0	0	10
D	0	0	10	0

The problem has two alternative solution. Alternative I arbitrarily assigned B to I and Alternative II arbitrarily assigned to III

Alternative I

	I	II	III	IV
A	10	55	30	A
B	A	35	0	30
C	10	0	A	10
D	0	A	10	0

Alternative II

	I	II	III	IV
A	10	55	30	A
B	0	35	A	30
C	10	A	0	10
D	A	0	10	0

**Question 6.**

A book store wishes to carry 'Ramayana' in stock. Demand is probabilistic and replenishment of stock takes 2 days (i.e. if an order is placed on March 1, it will be delivered at the end of the day on March 3). The probabilities of demand are given below

Demand (daily)	0	1	2	3	4
Probability	0.05	0.10	0.30	0.45	0.10

Each time an order is placed, the store incurs an ordering cost of ₹ 10 per order. The store also incurs a carrying cost of ₹ 0.50 per book per day. The inventory carrying cost in calculated on the basis of stock at the end of each day. The manager of the bookstore wishes to compare two options for his inventory decision.

A. Order 5 books when the inventory at the beginning of the day plus order outstanding is less than 8 books.

B. Order 8 books when the inventory at the beginning of the day plus order outstanding is less than 8.

Currently (beginning 1st day) the store has a stock of 8 books plus 6 books ordered two days ago and expected to arrive next day.

Using Monte-Carlo Simulation for 10 cycles, recommend, which option the manager, should choose. The two-digit random numbers are given below:

89	34	70	63	61	81	39	16	13	73
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Demand	Probability	Cumulative Probability	Random No. Range
0	0.05	0.05	00-04
1	0.10	0.15	05-14
2	0.30	0.45	15-44
3	0.45	0.90	45-89
4	0.10	1.00	90-99

Option - A

Day	Random No.	Demand	Opening Stock	Ordered Quantity receipt	Closing Stock	Quantity for which Order Placed
1	89	3	8	-	5	-
2	34	2	5	6	9	-
3	70	3	9	-	6	0

Day	Random No.	Demand	Opening Stock	Ordered Quantity receipt	Closing Stock	Quantity for which Order Placed
4	63	3	6	-	3	5
5	61	3	3	0	0	-
6	81	3	0	5	2	5
7	39	2	2	-	0	5
8	16	2	0	5	3	-
9	13	1	3	5	7	-
10	73	3	7	-	4	5
					39	

Ordering cost $4 \times 10$	₹ 40
Carrying cost $0.5 \times 39$	₹ 19.50
<b>Total Cost</b>	<b>₹ 59.50</b>

**Option B**

Day	R No.	Demand	Opening Stock	Ordered Quantity receipt	Closing Stock	Quantity for which Order placed
1	89	3	8	-	5	-
2	34	2	5	6	9	-
3	70	3	9	-	6	-
4	63	3	6	-	3	8
5	61	3	3	-	0	-
6	81	3	0	8	5	-
7	39	2	5	-	3	8
8	16	2	3	-	1	-
9	13	1	1	8	8	-
10	73	3	8	-	5	-
					45	

Ordering cost $2 \times 10$	₹ 20.0
Carrying cost $0.5 \times 45$	₹ 22.50
<b>Total Cost</b>	<b>₹ 42.50</b>

Option 'B' is better because it has low Inventory cost.

**Question 7.**

After observing heavy congestion of customers over a period of time in a petrol station, Mr. Petro has decided to set up a petrol pump facility on his own in a nearby site. He has compiled statistics relating to the potential customer arrival pattern and service pattern as given below. He has also decided to evaluate the operations by using the simulation technique.

Arrivals		Services	
Inter-arrival time (minutes)	Probability	Service time (minutes)	Probability
2	0.22	4	0.28
4	0.30	6	0.40
6	0.24	8	0.22
8	0.14	10	0.10
10	0.10		

Assume:

- (i) The clock starts at 8:00 hours
- (ii) Only one pump is set up.
- (iii) The following 12 Random Numbers are to be used to depict the customer arrival pattern: 78, 26, 94, 08, 46, 63, 18, 35, 59, 12, 97 and 82.
- (iv) The following 12 Random Numbers are to be used to depict the service pattern: 44, 21, 73, 96, 63, 35, 57, 31, 84, 24, 05, 37

You are required to find out the

- (i) probability of the pump being idle, and
- (ii) Average time spent by a customer waiting in queue.

Answer–

Inter-arrival time				Service time			
Minutes	Probability	Cumulative probability	Range of Random No.	Minutes	Probability	Cumulative probability	Range
2	0.22	0.22	00-21	4	0.28	0.28	00-27
4	0.30	0.52	22-51	6	0.40	0.68	28-67
6	0.24	0.76	52-75	8	0.22	0.90	68-89
8	0.14	0.90	76-89	10	0.10	1.00	90-99
10	0.10	1.00	90 - 99	–	–	–	–

Sl. No.	Random No. for inter arrival time	Inter arrival time (Mins.)	Entry time in queue as per clock	Service start time as per clock	Random no for service time	Service time (Mins.)	Service end time as per clock	Waiting time of customer (Mins.)	Idle time (Mins.)
1	78	8	8.08	8.08	44	6	8.14	-	8
2	26	4	8.12	8.14	21	4	8.18	2	-
3	94	10	8.22	8.22	73	8	8.30	-	4
4	08	2	8.24	8.30	96	10	8.40	6	-
5	46	4	8.28	8.40	63	6	8.46	12	-
6	63	6	8.34	8.46	35	6	8.52	12	-
7	18	2	8.36	8.52	57	6	8.58	16	-
8	35	4	8.40	8.58	31	6	9.04	18	-
9	59	6	8.46	9.04	84	8	9.12	18	-
10	12	2	8.48	9.12	24	4	9.16	34	-
11	97	10	8.58	9.16	05	4	9.20	18	-
12	82	8	9.06	9.20	37	6	9.26	14	-
<b>Total Time</b>								<b>150</b>	<b>12</b>

Average time spent by the customer waiting in the queue =  $150/12 = 12.50$  minutes

Probability of idle time of petrol station =  $\frac{\text{Total idle time}}{\text{Total Operating}} = 12/86 = 0.1395$  time of the Service Channel\*

\*Service End Time – 9.26 Hrs. Service Channel opened at 8.00 hrs. i.e. Total Time of the Service Channel = 1 hr. 26 Mins = 86 Mins.

**Question 8.**

Operations management is applicable:

**1 marks**

- a. Mostly to service sector.
- b. Mostly to manufacturing sector.
- c. To manufacture and service sector.**
- d. To services exclusively.