Vishveshwarya Group of Institutions

Model Questions with Answers for Sessional Exam 1

Set No: 1 | Course: MCA

Sub Name & code: CBOT, CA402 | Sem: IV

Time: 1½ HRS | MM: 50

Section A

(Note: Section A Shall have five compulsory parts, each of two marks)

Q 1: Attempt all Questions of this section in brief. [5X2=10]

(a) Define the relation between assignment and transportation problems?

Ans: The transportation problem deals with a transportation of a product manufactured at different plants or factories (supply origins) to a number of different warehouses (demand destination). The objective is to satisfy the destination requirement within the plant capacity at minimum transportation cost.

The objective of assignment problem is to assign a number of origins (jobs) to the equal number of destinations (persons) at a minimum cost.

(b) What are the three phases in the scientific method of "OR".

Ans: Judgement Phase, Research Phase and Action Phase

(c) Define objective function and constraints in LPP.

Ans: Objective Function: It is a function of decision variables whose value must be optimized (maximized or minimized)

Constraints: It is a set of simultaneous linear equations (or inequalities)

(d) What is an Iconic or physical model in OR?

Ans: This is a physical or a pictorial representation of various aspect of a system. Properties of the real system are represented by the properties themselves with a change of scale. eg: Model of a solar system, scaled up model of a cell in biology.

(c) Convert the LPP into Standard form:

$$\text{Max } Z = 3x_1 + 2x_2$$

s.t

$$x_1 + x_2 \leq 4$$

$$x_1 - x_2 \leq 2$$

and $x_1, x_2 \geq 0$

Soln Convert the inequality constraints to equation by introducting the non negative slack or surplus variables. The cofficient of slack or surplus variables are always taken zero in the objective function

$$\text{Max } Z = 3x_1 + 2x_2 + 0S_1 + 0S_2$$

s.t

$$x_1 + x_2 + S_1 = 4$$

$$x_1 - x_2 + S_2 = 2$$

$$x_1, x_2, S_1, S_2 \geq 0$$

Matrix form is

$$\begin{bmatrix} 1 & 1 & 1 & 0 \\ 1 & -1 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ S_1 \\ S_2 \end{bmatrix} = \begin{bmatrix} 4 \\ 2 \end{bmatrix}$$

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Section B

(Note : ~~Attempt all Questions~~ Sec B Shall have five parts, Only three parts are to be attempted by the Students)

Q2. Attempt any ~~two~~ three parts of the following : [3 × 5 = 15]

(a) What is Operation Research / CBOT ? WHY is OR Needed ? also gives some application of OR.

Ans : 1. "OR" is a scientific approach to problem solving for executive management.

2. "OR" is the art of winning war without actually fighting it.

Evolution of OR : The initial beginning of OR has became during the Second word war for military management in england. The Name "Operation research" invented in it because the team was dealing with Research on military operation. This team work was named as "OR" in England.

WHY is OR Needed ? Since "OR" makes Sense to make the best use of available resources. Today's global markets and instant communications mean that customers expect high Quality products and services when they need them, where they need them. Organizations, whether public or private, need to provide these products and services as efficiently as

Possible. This requires careful planning and analysis - The hallmark of good OR.

Applications of OR :

1. Scheduling : of aircrews and the fleet for airlines, of ~~Vechi~~ vehicles in supply chains, of order in a factory etc.

2. Yield Management : Setting the prices of airline seals and hotel room to reflect changing demand and the risk of no shows.

3. Credit Scoring : Deciding which customers offers the best prospects for credit companies

4. Defence & peace keeping : Finding ways to deploy troops rapidly

5. Marketing : evaluating the value of sale promotions, developing customer profiles and computing the life time value of a customer.

(b) Discuss the working principle of OR ?.

Ans: "OR" comprise the following seven sequential steps

1. Orientation 2. Problem Definition 3. Data Collection
4. Model formulation 5. Model Solution 6. Validation and output Analysis 7. Implementation and Monitoring

fig shows this schematically.

The objective of O.R project is to allocate the resources to the optimal fashion.

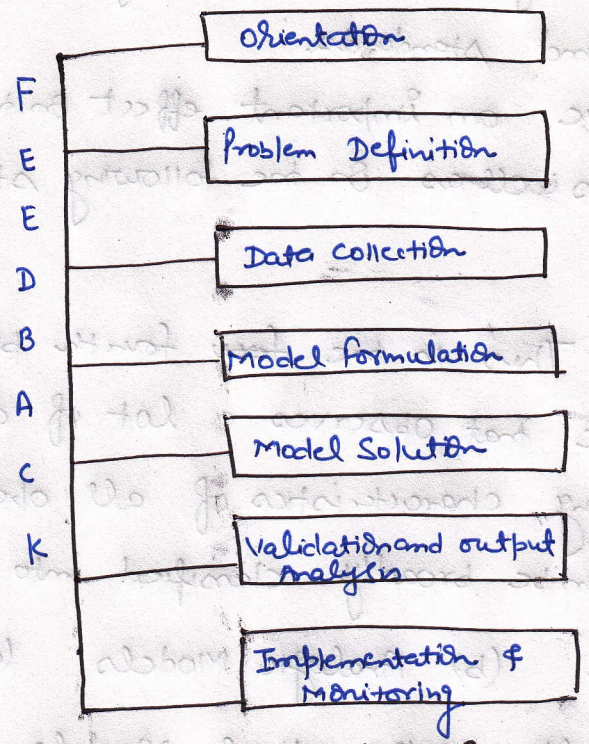

Fig: The Operation Research Approach

1. **Orientation:** The first step in the O.R approach is reffered to as problem Orientation. The primary objective of this step is to constitute the team that will address the problem at hand and ensure that all its members have clear picture of the relevant issues. The aim of Orientation phase is to obtain a clear understanding of the problem and its relation to different operational aspect of the system.

2 **Problem Definition:** This is the second, the most important steps of O.R Process. The objective here is is to further refine the deliberations from the orientation phase to the point where there is a clear definition of the problem in terms of its scope and the desired result.

3 **Data collection:** In the third phase of OR process data is collected with the objective of translating the problem defined in second phase into a model that

can be objectively analyzed. Data typically comes from two sources - Observation and standards.
Data collection can have an important effect on the previous step of problem definition as well as on the following step of model formulation.

4. Model Formulation: This is the ~~four~~ fourth phase of O·R Process. It is also a phase that observes a lot of attension since modeling is a defining characteristics of all operations research projects. Models can be broadly classified into four categories (a) Physical Models. (b) Analogic Models (c) computer Simulation Models (d) Mathematical Models.

5. Model Solution: The fifth phase of the O·R Process is the solution of the problem represented by the model. This is the area on which a huge amount of research and development in OR has been focussed, and there is a plethora of methods for analyzing a wide range of models.

6. Validation and output analysis: Once a solution has been obtained two things need to be done before one even considers developing a final policy or course of action for implementation.
The first is to verify that the solution itself makes sense.
The second part of this step in the O·R process is ~~ref~~ referred to as postoptimality analysis or in layperson's terms "what - if" analysis

7. Implementation and Monitoring: The last step of in the O·R Process is to implement the final recommendation and establish control over it. Once implemenation is complete, responsibility

for monitoring the system is usually turned over to an operating team. As a final word on implementation, it should be emphasized that a major responsibility of the O.R analyst is to convey the result of the project to management in an effective fashion.

(C) Discuss the tool available in "OR".

Sol^{n} "OR" uses many suitable tool or techniques for optimization some common tools of "OR" are non-linear programming, Integer programming, Sequencing theory, markov Proces, network Scheduling - PERT and CPM, Symbolic logic, information theory etc.

The brief explanation of these tools given belaw:

1. Linear Programming: Linear programming is basically a constrained optimazation technique which tries to optimize some criterion with in some constraints. It consists of an objective function which is some measure of effectiveness like profit, loss or return on investment and several boundary conditions putting restriction on the use of resources.

2. Waiting line Theory or Queuing theory: Waiting line theory or queuing theory deals with the situation in which queue is formed. customers waiting for service, machines waiting for repairman and aircraft's waiting for landing strips are some of the situation in which queue is formed.

3. Game Theory: Game theory is used for decision making under conflicting situations where there are one or more opponents. Opponents in game theory are called players. Game theory models a conflict situation and helps us to

improve the decision process by formulating appropriate strategy.

4. Inventory Control Models: When to buy, how much to buy and how much to keep in stores are some of the questions which production Managers, purchase Managers and material Managers address themselves to Inventory control models provide Rational answer to these question in different situation of supply and demand for different kind of materials. Inventory control models help managers to decide reordering time, reorder-ing level and optimal ordering quantity.

5. Simulation: Simulation is basically data generation technique So simulation is a data generation technique and is used when actual experimentation is not feasible, analytical model building or solution of model is not possible.

6 Dynamic programming: Dynamic programming is a method of analysing multistage decision processes, in which each elementary decision is dependent upon those preceding it as well as upon external factors. It drastically reduces the computational efforts.

7. Information theory: Information theory is an analytical process transferred from the electrical communications field to "OR". It seeks to evaluate the effectiveness of information flow with in a given system.

(d) Identify some major limitations of O.R technique in your organization.

Soln "OR" has certain limitations. However these limitations are mostly related to the problems of model building and the time and money factors involved in its application rather than its practical utility. Some of them are as follows:

1. Magnitude of computations: "OR" tries to find out optimal solution taking into account all the factors. In the modern society these factors are enormous and expressing them in quantity and establishing relationships among these require voluminous calculations which can only be handled by machines.

2. Non-Quantifiable Factors: "OR" provides solution only when all elements related to a problem can be quantified. All relevant variables do not lend themselves to quantification. OR do not take into account qualitative factors or emotional factors which may be quite important.

3. Money and Time costs: When the basic data are subjected to frequent changes, incorporating them into the O.R models is a costly affair. Moreover a fairly good solution at present may be more ~~desic~~ desirable than a perfect OR solution available after some time.

4. Implementation: Implementation of decisions is a delicate task. It must take into account the complexities of human relations and behavior. Sometimes resistence is offered only due to psychological factors.

(e) List the name of costs involved in inventory models.

Ans: Different types of costs involved in inventory models are given below:

1. Holding cost or carrying cost (C_1 or C_h): The cost associated with carrying or holding the goods in stock is known as holding or carrying cost denoted by C_1 or C_h per unit of item per unit time.

2. Shortage cost or stock-out cost (C_2 or C_s): The penalty costs that are incurred as a result of running out of stock (i.e shortage). These cost arise due to shortage of goods, good-will may be lost either by a delay in meeting the demand.

3. Set-up cost (C_3 or C_0): These cost associated with setting up of machinery before starting production.

4. Purchase or production cost: It is the purchase price for items that are bought from outside sources and production cost if item are produced with in organization

5. Salvage costs or Selling price: Generally salvage costs are combined with the storage cost and not considered independently. Selling price also include taxes (i.e excise duty, Sales tax etc)

Section C

(Note: Section C shall have five Questions with Internal choice, each of five marks)

Q.3. Attempt any one part. [1X5=5]

(a) A certain equipment needs five repair jobs which have to be assigned to five machines. The estimated time (in hrs) that each machine requires to complete the repair job in the following table.

Job → / Machine ↓	J_1	J_2	J_3	J_4	J_5
M_1	7	5	9	8	11
M_2	9	12	7	11	10
M_3	8	5	4	6	9
M_4	7	3	6	9	5
M_5	4	6	7	5	11

Soln: Step-1 Subtract the smallest element of each row, then smallest element of each col from all element of that row and column.

	J_1	J_2	J_3	J_4	J_5
M_1	2	0	4	2	4
M_2	2	5	0	3	1
M_3	4	1	0	1	3
M_4	4	0	3	5	0
M_5	0	2	3	0	5

Step-2 Assignment of zero

	J_1	J_2	J_3	J_4	J_5
M_1	2	[0]	4	2	4
M_2	2	5	[0]	3	1
M_3	4	1	~~0~~	1	3
M_4	4	~~0~~	3	5	[0]
M_5	[0]	2	3	~~0~~	5

Step-3 Draw the minimum number of Horizontal & vertical lines necessary to cover all zero at once.

	J_1	J_2	J_3	J_4	J_5
M_1	2	[0]	4	2	4
M_2	2	5	[0]	3	1
M_3	4	1	~~0~~	1	3
M_4	4	~~0~~	3	5	[0]
M_5	[0]	2	3	0	5

Here smallest element is 1 from all uncovered element so we adel this element at intersected lines element and substract from uncoved element. we get

	J_1	J_2	J_3	J_4	J_5
M_1	2	0	5	2	4
M_2	1	~~0~~	0	2	0
M_3	3	0	0	0	2
M_4	4	0	4	5	0
M_5	0	2	4	0	5

Step-4 : Repeat Step-2

	J_1	J_2	J_3	J_4	J_5
M_1	2	[0]	5	2	4
M_2	1	4	[0]	2	~~0~~
M_3	3	~~0~~	0	[0]	2
M_4	4	~~0~~	4	5	[0]
M_5	[0]	2	4	0	5

So total cost is

$M_1 \to J_2$	5
$M_2 \to J_3$	7
$M_3 \to J_4$	6
$M_4 \to J_5$	5
$M_5 \to J_1$	4
	27

3b) Compare the relationship between OR Specialist and Manager.

Soln: The role of OR Specialist is to help the manager make better decisions. Decision making is a key responsibility of Managers. Creative and workable solutions to problems require the co-operative involvement of OR Specialist and Managers. Decision Makers move towards OR approach when:

1. They see the problem as complex involving many variables and relationships.
2. They initially feel that the data in the problem are numeric.
3. They have personal experience of applying O.R methods to solve problems.
4. The decision environment lends itself to a specification of goals.
5. They don't think they can develop a solution without O.R methods.

Skills in qualitative analysis are inherent in the manager and generally increase with experience. Skills in quantitative analysis can be acquired by study of mathematical tools. using these tools, managers can improve their decision making effectiveness. They can compare and combine the qualitative and quantitative information at their disposal and thus make the best possible decisions.

Q4: Attempt any One part: [1X5 = 5]

(a) Discuss the ~~role~~ role of computers in Operation Research.

Ans: Infact computers have played a vital role in the

development of OR. Many large scale applications of OR techniques which require only few minutes on the computer may take weeks, months and sometimes years even to yield the same results manually. So the computer has become as essential and integral part of OR.

The computer software packages are useful for rapid and effective calculations which is necessary part of O.R. approach to solve the problems These are:

(i) QSB+ (Quantitative System for Business plus): This software package contains problem solving algorithm for "OR" as well as models on basic statistics, non-linear programming and financial analysis.

(ii) QSOM (Quantitative Systems for operation Management): QSOM is an interactive user friendly system. It contains problem solving algorithms for operation management problems and associated information System.

(iii) Value STORM: It is a special version of personal STORM version 3.0 developed for use in OR.

(iv) Excel 97: Developed by Gene Weiss Kopf and distributed by BPB publications, New Delhi is an easy to use task oriented Guide to Excel spread sheet applications.

4 (b) A company has three operational deptt. (weaving, processing and packing) with capacity to produce three different types of cloths namely suitings, Shirtings and woolens yielding the profit of Rs 2, Rs 4 and Rs 3 per meter respectively. One meter suiting requires 3 minutes in weaving, 2 minutes in processing and 1 min in packing, 1 meter of Shirting requires 4 min in

weaving, 1 min in procesing and 3 min in packing while 1 mtr woolean requires 3 minutes in each department In a week total run time of each deptt. is 60, 40 and 80 hours of weaving, processing and packing deptt. respectively. Formulate the LPP to find the product mix to maximize the profit.

Sol^n: Let x_1 meter, x_2 meter and x_3 meter will be product mix

So we can summarise the above problem:

Resources / Constraints	Product: Suiting	Shirting	Woolen	Total Availability (minutes)
weaving deptt	3	4	3	60×60
Processing deptt	2	1	3	40×60
Packing deptt	1	3	3	80×60

The linear programming formulation can be easily obtained as follows:

Max (Total Profit) $P = 2x_1 + 4x_2 + 3x_3$

s.t

$3x_1 + 4x_2 + 3x_3 \leq 3600$

$2x_1 + x_2 + 3x_3 \leq 2400$

$x_1 + 3x_2 + 3x_3 \leq 4800$

and $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$

Q 5: Attempt any One Part: [1×5=5]

(a) Define the following in context of LPP

(i) Feasible Solution

(ii) Basic Solution

(iii) Unbounded Solution

Sol^n (i) Feasible Solution: If all the constraints of the given

LPP are satisfied by the solution, that solution is known as feasible solution.

(ii) **Basic Solution:** A basic solution to the set of constraints is a solution obtained by setting any n variables equal to zero and solving for remaining m variables, provided the determinant of the coefficients of these m variables is non zero. Such m variables are called basic variables and remaining n zero valued variables are called non basic variables.

for ex
$$a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n + x_{n+1} = b_1$$
$$a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n + x_{n+2} = b_2$$
$$\vdots$$
$$a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n + x_{n+m} = b_m$$

(iii) **Unbounded Solution:** If the objective function value can be increased / decreased infinitely without any limitation then such solution is called unbounded solution.

(b) **what are the limitations of linear programming?**

Soln Some major limitations are associated with LPP are as given below:

1. There is no guarantee of getting integer valued solutions.
2. Linear programming deals with only single objective, whereas in real life problems come across with multiobjectives.
3. LPP do model does not take into consideration the effect of time and uncertainity.
4. Sometimes large-scale problems can't be solved with linear programming techniques even when the computer facility is available.

5. Parameters appearing in the model are assumed to be constant.

Q 6: Attempt any one part: [1 X 5 = 5]

(a) What are the advantages of linear programming Techniques?

Soln: The advantages of linear programming techniques may be out-lined as follows:

1. Linear programming technique helps us in making the optimum utilization of productive resources.
2. The quality of decisions may also be improved by LP techniques.
3. LP Technique provide practically applicable solutions.
4. In production processes, high lighting the bottlenecks is the most significant advantage of this technique. For example, when bottlenecks occur, some machines can't meet the demand while others remain idle for some time.

(b) What are artifical variable? Why do we need them?

Soln: In LPP, the constraints also have "≥" and "=" signs after ensuring that all b_i are ≥ 0 In such problems basis matrix is not obtained as an identity matrix in the starting simplex table, therefore we introduce a new type of variable called the artificial variable. These variables are fictitious and can't have any physical meaning.

for ex

$$\min Z = \frac{15}{2}x_1 - 3x_2$$

s.t

$$3x_1 - x_2 - x_3 \geq 3$$

$$x_1 - x_2 + x_3 \geq 2$$

and $x_1, x_2, x_3 \geq 0$

If we apply simplex method then

$$\text{Max } Z' = -Z = -\frac{15}{2}x_1 + 3x_2 + 0x_3 + 0x_4 + 0x_5$$

$$3x_1 - x_2 - x_3 - x_4 = 3$$

$$x_1 - x_2 + x_3 - x_5 = 2$$

Basic variables	C_B	X_B	x_1	x_2	x_3	x_4	x_5	X_B/X_K
x_4	0	3	3	-1	-1	-1	0	
x_5	0	2	1	-1	1	0	-1	

Not an identity Matrix

Now we required artifical variable to form an identity matrix.

Q:7 Attempt any one part: [1X5=5]

(a) What is degeneracy problem in LPP. Give example.

Soln: During Simplex procedure, min ratio X_B/X_K ($X_K > 0$) is not unique, this cause the problem of degeneracy or at the very first iteration, the value of one or more basic variables in the X_B column become equal to zero. It also causes the problem of degeneracy.

Ex

$$\text{Max } Z = 3x_1 + 9x_2$$

s.t

$$x_1 + 4x_2 \le 8$$
$$x_1 + 2x_2 \le 4$$
$$\text{and } x_1, x_2 \ge 0$$

Introducting slack variables $S_1 \ge 0$ and $S_2 \ge 0$ we get

$$\text{Max } Z = 3x_1 + 9x_2 + 0S_1 + 0S_2$$

s.t

$$x_1 + 4x_2 + S_1 = 8$$
$$x_1 + 2x_2 + S_2 = 4$$
$$x_1, x_2, S_1, S_2 \ge 0$$

Now Simplex table is

Basic variables	C_B	X_B	x_1	x_2	S_1	S_2	Min Ratio X_B/X_K
S_1	0	8	1	4	1	0	$8/4 = 2$ } Tie
S_2	0	4	1	2	0	1	$4/2 = 2$ } Tie
	$Z = 0$		-3	-9	0	0	

Since min Ratio become tie. So above problem have degeneracy.

(b) Discuss the method to resolve the degeneracy ?

Soln Step 1: First pick up the rows for which the min non-negative ratio is same. Let first & third row

Step-2 Now re-arrange the columns of the usual Simplex table so that the columns forming the original unit matrix come first in proper order

Step 3: Then find the minimum of the ratio :

$$\left[\frac{\text{Elements of first column of unit matrix}}{\text{corresponding elements of key column}}\right]$$

Only for the rows for which min ratio was not unique. That is for the rows first, third etc as picked up in Step 1

(i) If we do not get min Ratio unique, then go to next step.

Step: 4 Now compute the min Ratio

$$\left[\frac{\text{Elements of second column of unit matrix}}{\text{corresponding elements of key column}}\right]$$

Only for the rows for which min Ratio was not unique in step-3

(i) If this min Ratio is still not unique then go to next step.

Step: 5 Next compute the min of the ratio

$$\left[\frac{\text{Elements of third col}^{\text{n}} \text{ of unit matrix}}{\text{corresponding elements of key column}}\right]$$

Only for the rows for which min Ratio was not unique in Step - 4

(i) If this min Ratio is still not unique then go on repeating of the above outlined procedure till the unique min Ratio is obtained to resolve the degeneracy. After the resolution of tie, Simplex method is applied to obtain the optimal solution.

Set : 1 COMPLETE

Total Pages : 20