CBCS SCHEME

USN | | | | | | | | | | |

17ME81

Eighth Semester B.E. Degree Examination, July/August 2022
Operations Research

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Discuss the origin and development of Operation Research (OR). **(06 Marks)**

b. Explain the various phases in Operation Research development process. **(08 Marks)**

c. Discuss the applications of Operation Research. **(06 Marks)**

OR

2 a. Explain the assumptions made in Linear Programming Problems (LPP). **(08 Marks)**

b. The company ABC manufactures two types of wooden toys of soldiers and trains. Each soldier toy contribute the profit of Rs.3 and each train toy contribute the profit of Rs.2. Each soldier toy needs 2 hr finishing and 1 hr carpentary time. Each train toy needs 1 hr finishing and 1 hr carpentary time. Only 100 hrs of finishing and 80 hrs of carpentary timings are available in each week. The demand for soldiers toy is atmost limited to 40 in each week. Formulate the above problem as LPP. Solve the above problem using graphical method to find how many each toy should be made in each week to maximize the profit. **(12 Marks)**

Module-2

3 a. Explain the following:

(i) Slack variable

(ii) Surplus variable and

(iii) Artificial variable. **(06 Marks)**

b. Use Penalty (or Big-M) method to solve following LPP :

Minimize $z = 4x_1 + 3x_2$

Subjected to $2x_1 + x_2 \geq 10$

$-3x_1 + 2x_2 \leq 6.$

$x_1 + x_2 \geq 6.$

$x_1, x_2 \geq 0$

(14 Marks)

OR

4 a. Write the relationship between primal and dual LPPs. **(06 Marks)**

b. Solve the following LPP by Dual-Simplex method:

Minimize $z = 6x_1 + 7x_2 + 3x_3 + 5x_4$

Subjected to, $5x_1 + 6x_2 - 3x_3 + 4x_4 \geq 12$

$x_2 + 5x_3 - 6x_4 \geq 10.$

$2x_1 + 5x_2 + x_3 + x_4 \geq 8$

$x_1, x_2, x_3, x_4 \geq 0$

(14 Marks)

Module-3

5 a. What is degeneracy in transportation problems and how it is resolved? **(06 Marks)**

b. A steel company has three open hearth furnaces and five rolling mills. The transportation costs for shipping steel from furnaces to rolling mills are given in the following table with supply and demand requirements:

	M_1	M_2	M_3	M_4	M_5	Supply
F_1	4	2	3	2	6	8
F_2	5	4	5	2	1	12
F_3	6	5	4	7	7	14
Demand	4	4	6	8	8	

What is the optimum shipping schedule? Use VAM's method for IBFs and MODI method for finding optimal solution. **(14 Marks)**

OR

6 a. What is assignment problem? How does it differ from a transportation problem? **(06 Marks)**

b. A computer centre has four expert programmers and needs to develop four application programmes. The head of the computer centre estimates computer time (in minutes) required by the respective experts to develop the application programmes is as follows:

		Programmes			
		A	B	C	D
Programmers	1	120	100	80	90
	2	80	90	110	70
	3	110	140	120	100
	4	90	90	80	90

Find the assignment pattern that minimizes the time required to develop the programmes. **(14 Marks)**

Module-4

7 a. Compare the PERT and CPM in network analysis. **(06 Marks)**

b. A small project consist of following activities and the time estimates:

Activity	Most optimistic time (weeks)	Most likely Time (weeks)	Most Pessimistic time (weeks)
1 – 2	4	8	12
1 – 3	4	10	12
1 – 4	8	14	24
2 – 5	5	8	10
3 – 4	2	5	8
3 – 5	2	4	8
4 – 5	6	10	14
5 – 6	1	3	6

Determine the following :

(i) Construct the operational networks.
(ii) Find the critical path.
(iii) Calculate the expected time of completing the project.
(iv) What is the probability of completing the project is more than 26 weeks. **(14 Marks)**

OR

8 a. Explain various queuing disciplines and customer behaviours. **(08 Marks)**

b. Telephone users arrive at a booth following a Poisson's distribution with mean arrival time of 5 mins. The time taken for a telephone call is with mean of 3 mins and it follows exponential distribution. Find the following :

(i) What is the probability that the booth is busy?

(ii) Average waiting time in the queue?

(iii) Average waiting time in the system?

(12 Marks)

Module-5

9 a. Explain the following : (i) Pure strategy (ii) Mixed strategy (iii) Payoff matrix (iv) Saddle point (v) Value of the game. **(10 Marks)**

b. Solve the following game whose pay-off matrix is given below:

		Player B		
		I	II	III
Player A	I	-2	15	-2
	II	-5	-6	-4
	III	-5	20	-8

Use maximum (minmax) principle to find

(i) Best strategy for Player A.

(ii) Best Strategies for Player B.

(iii) The value of the game.

(10 Marks)

OR

10 a. Write any six assumptions made in sequencing problems. **(06 Marks)**

b. Determine the sequence in which books should be processed on the machines so that total time required is minimized. Also find (i) Total elapsed time (ii) Idle time of printing machine (iii) Idle time of binding machine.

Book	Printing Machine (Hrs)	Binding Machine (Hrs)
A	5	2
B	1	6
C	9	7
D	3	8
E	10	4

(Note : Machine timings are in Hrs)

(14 Marks)

* * * * *

Visvesvaraya Technological University

Belagavi, Karnataka - 590 018

Signature of Scrutinizer

Scheme & Solutions

Subject Title : Operations Research Subject Code : 17ME81

Question Number	Solution	Marks Allocated

MODULE-1

Q.NO 1 (a) Explaining the origin and History of O.R. — (06)

(b) Writing the 6 phases/steps of OR development — (04)
Explaining them — (04)
4+4=08

(c) Discussing any ~~four~~ Three applications of O.R. 02x03 = (06)

Q.NO 2: (a) Listing 4 assumptions of LPP.
(i) Additive (2) proportionality (3) Divisibility
(iv) certainity — (04)
Explaining each one — (04)
4+4 = (08)

(b) The company ABC manufactures wooden toys of Soldiers and Trains. Each Soldier toy contribute the profit of Rs 3/- and Each Train toy contributes a profit of Rs 2/-
x_1 → Soldier toy
x_2 → Train toy
Objective fn. Maximize $Z = 3x_1 + 2x_2$
writing. — (02)

Subject Title : operations Research Subject Code : 17ME81

Question Number	Solution	Marks Allocated
	Writting constraints. $2x_1 + x_2 \leq 100$ (Finishing constraint) $x_1 + x_2 \leq 80$ (Caspentary ") $x_1 \leq 40$ (Restriction on Saddles demand) $x_1, x_2 \geq 0$. — (04) Drawing constraints lines in Graph — (02) Identifying the feasible region — (01) Finding the corner points solution values from feasible region — (02) Finding the optimal solution $x_1 = 20$ & $x_2 = 60$ & Max $Z = 180$ — (01) $2+4+2+1+2+1 = 12$.	
	MODULE-2.	
Q.No 3	(a) Explaining each one — (02). $\therefore 02 \times 3 = (06)$	$2+2+2 = 06$
	(b) writting the Standard form of L.P.P. i.e Maximize $(-Z) = -4x_1 - 3x_2 + 0.S_1 + 0S_2 + 0S_3 + MA_1 - MA_2$ $2x_1 + x_2 - S_1 + 0S_2 + 0S_3 + A_1 + 0A_2 = 10$ $-3x_1 + 2x_2 + 0S_1 + S_2 + 0S_3 + 0A_1 + 0A_2 = 6$ $x_1 + x_2 + 0S_1 + 0S_2 - S_3 + 0A_1 + A_2 = 6$ $x_1, x_2, S_1, S_2, S_3, A_1, A_2 \geq 0$. — (03) Writting initial Feasible solution in Simplex Tabular column — (03)	

Subject Title : Operations Research Subject Code : 17ME81

Question Number	Solution	Marks Allocated

Doing iterations in Simplex table and reaching to optimal solution — (05)

writing the optimal solution

$x_1 = 4$, $x_2 = 2$ & Max $Z = 22$ — (03)

05+03+05+01 = (14).

3+3+5+3=14

MODULE-2

Q.NO.4 (a) comparing the relationships between primal L.P.P & Dual L.P.P — (06)

(b) writing the given L.P.P. in standard form for Dual-Simplex method.

$$\text{Max } (-Z) = -6x_1 - 7x_2 - 3x_3 - 5x_4 + 0S_1 + 0S_2 + 0S_3$$

S.t $-5x_1 - 6x_2 + 3x_3 - 4x_4 + 1S_1 + 0S_2 + 0S_3 = -12$

$0x_1 - x_2 - 5x_3 + 6x_4 + 0S_1 + S_2 + 0S_3 = -10$

$-2x_1 - 5x_2 - x_3 - x_4 + 0S_1 + 0S_2 + S_3 = -8$

$x_1, x_2, x_3, x_4, S_1, S_2, S_3 \geq 0$. — (03)

	C_j	-6	-7	-3	-5	0	0	0	
C_B	X_B	x_1	x_2	x_3	x_4	S_1	S_2	S_3	RHS
0	S_1	-5	-6	3	-4	1	0	0	-12 → most -ve.
0	S_2	0	-1	-5	6	0	1	0	-10
0	S_3	-2	-5	-1	-1	0	0	1	-8
	Z_j	6	7	3	5	0	0	0	
	$Z_j - C_j$	-6	-7	-	-5	-	-	-	
	$\frac{Z_j - C_j}{x_{ij}}$	-6/5	-7/6	-	-5/4	-	-	-	
-7	x_2	5/6	1	-1/2	2/3	-1/6	0	0	2
0	S_2	5/6	0	-11/2	20/3	-1/6	1	0	-8 →
0	S_3	13/6	0	-7/2	7/3	-5/6	0	1	2
	Z_j	7/6	0	13/2	1/3	7/6	-	-	
	$Z_j - C_j$	-	-	-13/11	-	-7	-	-	-
	$\frac{Z_j - C_j}{x_{ij}}$			↑					

(01) (01)

Subject Title : Operations Research Subject Code : 17ME81

Question Number	Solution	Marks Allocated

C_B	X_B	x_1	x_2	x_3	x_4	S_1	S_2	S_3	RHS	
-7	x_2	25/33	1	0	2/33	5/33	-7/11	0	30/11	All are +ve (03)
-3	x_3	-5/33	0	1	-40/33	11/33	-2/11	0	16/11	
0	S_3	18/11	0	0	-21/11	-8/11	-7/11	1	78/11	
$z_j - c_j$		38/33	0	0	274/33	30/33	13/11	0		All are +ve

Reached the optimal

Solution. Solution is

$x_1 = 0, \quad x_2 = 30/11, \quad x_3 = 16/11, \quad x_4 = 0$

Max (-z) = $-258/11$ & Min(z) = $\frac{258}{11}$.

03+03+03+03+02 = 14 — (02)

3+3+3+3+2 = 14

MODULE -3

QNO5 (a). Explaining degeneracy in transportation problem — (03)
explaining how to resolve it — (03)
3+3=06.

3+3=6

(b). Writting the balanced transportation problem — (01)
Getting IBFS by VAM's method.
$x_{12} = 4, x_{14} = 4, x_{24} = 4, x_{25} = 8, x_{31} = 4, x_{33} = 6, x_{36} = 4$
IBFS = 80 — (07)
checking optimality by MODI method & finding optimal solution) — (06)
$x_{11} = 0, x_{12} = 4, x_{14} = 4, x_{24} = 4, x_{25} = 8$
$x_{31} = 4 \quad x_{33} = 6, \quad x_{36} = 0,$
optimal cost = 80.

1+7+6 = 14

QNO6 (a) Explaining about assignment problem — (02)
comparing assignment & Transportation problem — (04)
2+4=06.

2+4=6

(b) Applying Hungarian method and finding optimal assignment cost.
1 → C, 2 → A, 3 → D, 4 → B
80+80+100+90 = 350 mins. — (14)

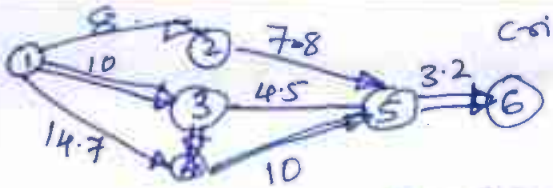
MODULE -4

QNO7 (a) Writing 3-Difference with PERT & CPM 2X3=06 — (06)
(b) (i) Networking drawing — (04) (ii) finding critical path — (04)
(iii) Finding expected time of completion 1-3-4-5-6 t_e = 28.2 weeks — (04)
(iv) probability of completing project in more than 26-weeks — (04) 36.4%

2+2+2=06

Subject Title : Operations Research Subject Code : 17ME81

Question Number	Solution	Marks Allocated



Critical path 1-3-4-5-6.

t_e = 28.2 weeks, σ_{te} = 1.954

prob of completing in more than 26 weeks 86.4%.

$Z = \frac{26 - 28.2}{1.954} = -1.12$

$\therefore P(Z \leq -1.12) = 13.6\%$

$100 - 13.6 = 86.4\%$

4+4+2+4 = 14

QNO8 (a) Explaining various queuing Disciplines — 04

Explaining various behaviours of customers — 04

4+4 = 08

(b) (i) prob that booth is busy = 0.6 or 60% — 04

(ii) Average waiting time in the queue = W_q = 3/40 hr — 04

(iii) Average waiting time in the system = W_s = 1/8 hr — 04

λ = 12/hr

μ = 20/hr.

4+4+4 = 12

MODULE-5

QNO9 (a) Explaining each of one — 02×5 = (10)

2+2+2+2+2 = 10

(b) using Min max (Max min) principle finding the saddle point — 05

(i) Best strategy for player A is — I — 01

(ii) Best strategies for player B is either I or III

(iii) Value of the Game is — 01

−2 for player A & +2 for player B — 02

6+1+1+2 = 10

6+1+1+2 = 10

QNO10 (a) Write 6 assumptions of Sequencing problems 1×6 = 06

1×6 = 6

(b) Finding optimal sequence of jobs.

B	D	C	E	A.

— 06

6+4+2+2 = 14

Books	Printing M/c		Binding M/c	
	In	out	In	out
B	0	1	1	7
D	1	4	7	15
C	4	13	15	22
E	13	23	23	27
A	23	28	28	30

(i) Total Elapsed time = 30 hrs — 02

(ii) Idle time of printing m/c = 30 − 28 = 2 hrs

(iii) Idle time of Binding m/c = 1 + (23 − 22) + (28 − 27) = 3 hrs. — 02