DEPARTMENT OF STATISTICS				*CLASS: I M.Sc. Statistics*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
I	Major Core – 3	21P1SMC3	Operations Research	4	5	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	✓
Skill oriented			Entrepreneurship oriented	

Course Objectives:

1. To introduce students the statistical and mathematical formulations for handling a range of business based problems.
2. To develop a broad appreciation of different types of decision-making environments.

Unit	Description	Hours	K-level	CLO(s)
I	(Linear Programming problem – Simplex and Dual Simplex methods. Transportation and assignment problems and their solution. Sensitivity Analysis – Variation in cost vector 'c' – Variation in the requirement vector 'b' – Addition and Deletion of single variable – Addition and Deletion of single constraint.	17	K2	1
II	Parametric Programming – parameterization of the cost vector 'c' – Parameterization of requirement vector 'b' – All integer programming problem – Mixed integer programming problem – Branch and Bound techniques.	16	K3	2
III	Non-linear programming problem (NLPP) – Kuhn-Tucker condition – Wolfe's and Beale's algorithms for solving quadratic programming problem.	11	K3	3
IV	Inventory models – Structure of Inventory system – General deterministic problem for one item, one level – Inventory models with and without shortage – Multi item deterministic problem – one level model with one break.	16	K4	4
V	Queuing theory – Basic characteristics of queuing models – Arrival and service distribution – Steady state solution of M/M/1 and M/M/C models with associated distribution of queue length and waiting time – M/G/I queue and Pollazeck-Khinchin result.	15	K4	5

Books for Reference:

1. Gass, S.I. (1985) Linear Programming, Methods and Applications.Courier Dover, New York.
2. Gupta, P.K. and Man Mohan. (1979) Operations Research: Linear Programming and Theory of Games,3/e, Sultan Chand &Sons, New Delhi.
3. Hadley, G (1963) Linear Programming. Addison Wesley,
4. Hillier, F.S. and Lieberman, G.J. (2005) Introduction to Operations Research,9/e, McGraw Hill, New York.
5. Sharma, J.K. (2013) Operations Research: Problems and Solutions,5/e,Macmillan India, New Delhi.
6. Sharma, S.D. (2010) Operations Research,KedarnathRamnath, Meerut.
7. Swarup, K. Mohan, M. and Gupta, P.K. (2001) Operations Research, Sultan Chand & Sons, New Delhi.
8. Taha, H.A .(2011) Operations Research- An Introduction.9/e,. Prentice Hall, New Delhi.
9. Rao S.S. (1972), Optimization: Theory and Applications, Wiley Eastern (P) Ltd., New Delhi

Web Resources:

1. Linear Programming Simple, Transportation and Assignment Problems:
   http://www.phpsimplex.com/en/simplex_method_example.htm
   https://www.youtube.com/watch?v=-YBlR1UF-UY
2. Sensitivity analysis:
   https://www.youtube.com/watch?v=DNZpiOCdC6w
   http://web.mit.edu/15.053/www/AMP-Chapter-03.pdf
3. Inventory models
   http://ecoursesonline.iasri.res.in/mod/resource/view.php?id=90023
   https://www.youtube.com/watch?v=y2m3-dgtWG0
4. Queuing theory:
   http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2969
   https://www.youtube.com/watch?v=7EB5A3Iv-xk

Rationale for Nature of the course

This course enables the students to gain in-depth knowledge on advance level of optimization technique problems in both theoretical and application orientation.

Activities having direct bearing on Skill development / Employability / Entrepreneurship

Seminars / Assignments on industry based problems related to optimization

Pedagogy

Chalk and Talk, PPT, Seminar, Interaction, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	(Linear Programming problem – Simplex and Dual Simplex methods. Transportation and assignment problems and their solution.	**4**	PPT, Chalk and Talk and Assignments
	Sensitivity Analysis	**3**	
	Variation in cost vector 'c'	**2**	
	Variation in the requirement vector 'b'	**3**	
	Addition and Deletion of single variable	**2**	
	Addition and Deletion of single constraint	**3**	
II	Parametric Programming – parameterization of the cost vector 'c'	**3**	PPT, Chalk and Talk and Assignments
	Parameterization of requirement vector 'b'	**3**	
	All integer programming problem	**3**	
	Mixed integer programming problem	**3**	
	Branch and Bound techniques	**4**	
III	Non-linear programming problem (NLPP) – Kuhn-Tucker condition	**5**	PPT, Chalk and Talk , seminar and Assignments
	Wolfe's and Beale's algorithms for solving quadratic programming problem	**6**	
IV	Inventory models – Structure of Inventory system	**3**	PPT, Chalk and Talk , Assignments and Seminar
	General deterministic problem for one item, one level	**3**	
	Inventory models with and without shortage	**5**	
	Multi item deterministic problem	**3**	
	one level model with one break	**2**	
V	Queuing theory – Basic characteristics of queuing models	**3**	PPT, Chalk and Talk , Assignments and Seminar
	Arrival and service distribution	**2**	
	Steady state solution of M/M/1 and M/M/C models with associated distribution of queue length and waiting time	**5**	
	M/G/I queue and Pollazeck-Khinchin result	**5**	

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Perform sensitivity analysis to identify the direction and magnitude of change of a linear programming model's optimal solution as the input data change.	Up to K2
CLO-2	Describe the theoretical workings of the solution methods for parametric programming and integer linear programming problems and demonstrate them by solving the problems.	Up to K3
CLO-3	Capability to develop non-linear programming problems.	Up to K3
CLO-4	Explains various cost related to inventory models and develop, extent various deterministic inventory problems to analysis real world systems.	Up to K4
CLO-5	Deep understanding of the theoretical background of queuing systems, apply and extend queuing models to analyse real world systems.	Up to K4

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1	2	3	3	2		2	2
CLO-2	2	2	1	2		2	2
CLO-3	1	2	1	2		2	2
CLO-4	1	2	2	2		2	3
CLO-5	2	2	2	2	2	1	2

Advance application – 3; Intermediate level – 2; Basic level – 1

CIA-I–BluePrint

CLO's	K-Level	Section – A Short Answer		Section B Either / Or type		Section C Open Choice	
		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level
CLO 1	Up to K2	2	K1, K1	2	K2, K2	1	K2
CLO 2	Up to K3	3	K2, K2, K3	2	K3 , K3	2	K3, K3
No. of questions to be asked		5		4		3	
No. of question to be answer		5		2		2	
Marks for each question		2		5		10	
Total marks for each section		10		10		20	

CIA-I :: Distribution of section wise marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	46.67%
K2	4	10	10	24	40.00	
K3	2	10	20	32	53.33	53.33%
K4	-	-	-	-	-	-
Total marks	10	20	30	60	100	100

CIA-II–BluePrint

CLO's	K-Level	Section – A Short Answer		Section B Either / Or type		Section C Open Choice	
		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level
CLO 3	Up to K3	2	K1, K1	2	K2, K3	2	K2, K3
CLO 4	Up to K4	3	K2, K2, K3	2	K3, K4	1	K4
No. of questions to be asked		5		4		3	
No. of question to be answer		5		2		2	
Marks for each question		2		5		10	
Total marks for each section		10		10		20	

CIA-II :: Distribution of section wise marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	38.33%
K2	4	5	10	19	31.66	
K3	2	10	10	22	36.67	36.67%
K4	-	5	10	15	25	25.00%
Total marks	10	20	30	60	100	100%

Summative Examination -Blue Print

Units	CLOs	K- Level	SectionA		SectionB		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		ShortAnswers			
			No.of Questions	K- Level	No.of Questions	K-Level		
1	CLO1	Up toK2	2	K1& K1	1	K1	2(K1&K1)	1(K2)
2	CLO2	Up toK3	2	K2& K2	1	K1	2(K2&K2)	1(K3)
3	CLO3	Up toK3	2	K3& K3	1	K2	2(K3&K3)	1(K3)
4	CLO4	Up toK4	2	K3& K4	1	K2	2(K4&K4)	1(K4)
5	CLO5	Up toK4	2	K3& K4	1	K3	2(K4&K4)	1(K4)
No.of Questions to be asked			10		5		10	5
No.of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each section			10		10		25	30

Distribution of Marks with K Level for Summative Examination

K - Level	Section A (MCQ)	Section B (Short Answer Questions)	Section C (Either / Or Choice)	Section D (Open Chioce)	Total Marks	% of (Marks without Choice)	Consolidated
K1	2	4	10	-	16	13.33	35%
K2	2	4	10	10	26	21.67	
K3	4	2	10	20	36	30.00	30%
K4	2	-	20	20	42	35	35%
K5	-	-	-	-	-	-	-
Total	10	10	50	50	120	100	100

Course Designers:

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