K L Deemed to be University
Department of CSE -- KLVZA
Course Handout
2020-2021, Even Sem

Course Title	:Mathematical Programming II
Course Code	:19CS2204
L-T-P-S Structure	: 2-2-0-0
Pre-requisite	:
Credits	: 4
Course Coordinator	:Choudhary Shyam Prakash
Team of Instructors	:
Teaching Associates	:

Syllabus :• Robust optimization, Large scale optimization, network flows, Dynamic Programming, Nonlinear Programming, Decomposition methods for linear optim optimization. Lagrange multipliers, Constraint qualification, KKT optimality conditions, Quadratic programs - Wolfe method, Applications of quadratic programs in s Machine • Combinatorial Optimization: Approximation Algorithms, Submodular functions, Matroids, multilinear extensions, convex and conclave closures, Continuo Programming with Optimization: Monte Carlo Sampling, Heuristics & Metaheuristics: Single solution vs. population-based, Parallel Metaheuristics, Nature-inspired M optimization, Simulated annealing, Evolutionary algorithms, Workforce modelling

Text Books :1. Applied Mathematical Programming by Bradley, Hax, and Magnanti (Addison-Wesley, 1977) 2. Aharon Ben-Tal, Laurent El Ghaoui, and ArkadiNemi

Reference Books :1. Linear Programming by Howard Karloff 2. Understanding and Using Linear Programming by Ji˘ríMatoušek and Bernd Gärtner 3. LINEAR PRO BAZARAA, John J. Jarvis and HANIF D. SHERALI 4. NONLINEAR PROGRAMMING Theory and Algorithms by MOKHTAR S. BAZARAA, HANIF D. SHERA Dorigo and Thomas StutzleA Bradford book, The MIT Press 6. Evolutionary Optimization Algorithm by Dan Simon, Willey Edition 7. Complexity and Approximatio Approximability Properties by Alberto Marchetti-Spaccamela, Giorgio Ausiello, Giorgio Gambosi, Marco Protasi, Pierluigi Crescenzi, and Viggo Kann 8. Introductio Tsitsiklis 9. Convex Optimization by Stephen Boyd and Lieven Vandenberghe

Web Links :1. http://web.mit.edu/15.053/www/AMP.htm 2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-251j-introduction-to-mathema https://www.coursera.org/learn/discrete-optimization 4. https://www.coursera.org/learn/solving-algorithms-discrete-optimization 5. https://www.edx.org/course/conve http://people.brunel.ac.uk/~mastjjb/jeb/or/ip.html 7. https://ocw.mit.edu/courses/mathematics/18-433-combinatorial-optimization-fall-2003/ 8. https://people.seas.harv

MOOCS :1)https://www.coursera.org/programs/coursera-response-program-for-kl-university-dkj6o/browse?productId=qvkru5bqEeigcQ6ACV18LA&productType=c 2)https://www.udemy.com/course/mathematics-for-machine-learning/ 3)https://www.edx.org/course/convex-optimization 4)https://www.coursera.org/programs/course productId=bNfKJYcIEemsaArI-0TJTA&productType=course&query=support+vector+machine&showMiniModal=true&utm_campaign=programId%3A3ifOynKMEeqJyRLym1QOVQ%3Bprogram 5)https://www.udemy.com/course/optimisation/ 6)https://www.edx.org/course/introduction-to-computational-thinking-and-data-4

Course Rationale : The course will cover a range of topics inLinear Programming Problems, Transportation and Assignment Problems with the objective of providing problems. The emphasis is on studying and analyzing fundamental issues in LPP. Apply various computational methods and tools, working in teams to solve the probl methods.

Course Objectives : Understand the basic theory and methods for optimization and non-linear programming problems. Apply robust optimization, quadratic programs and ML related problems. Apply these techniques constructively to make effective business decisions. Use a computer package to solve a mathematical programming

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Solve optimization problems for large scale systems, network models, dynamic programming, and robustness	PSO2,PO2	3
CO2	Model and solve Non-linear programming problems for decision-making problems	PO2,PSO2	3
CO3	Demonstrate the combinatorial optimization problems and their applications	PSO2,PO2	3
CO4	Demonstrate stochastic optimization and nature-inspired algorithms	PSO2,PO2	3

COURSE OUTCOME INDICATORS (COIs)::

Outcome No.	Highest BTL	COI-1	COI-2	COI-3
CO1	3	**Btl-1** Identify large scale systems, network models, and robust optimization.	**Btl-2** Illustrate optimization problems on large-scale systems, network models, dynamic programming, and robustness.	**Btl-3** Determine the solutions of optimization problems for large-scale systems, network models, dynamic programming, and robustness.
CO2	3	**Btl-1** Define nonlinear programing problems (NLPP)and identify Quadratic programing problems(QPP)	**Btl-2** Model and describe the procedure for solving NLPP and QPP	**Btl-3** Solve NLPP and QPP using Lagrange's and Wolfe method
CO3	3	**Btl-1** Define sub modular functions, matriods, convex and concave closures.	**Btl-2** Describe approximation algorithms, multilinear extensions and rounding errors.	**Btl-3** Solve combinatorial optimization problems using sub modular function, matriods and approximation algorithms.
CO4	3	**Btl-1** Identify stochastic optimization problems	**Btl-2** Illustrate Monte Carlo Sampling, Heuristics & Metaheuristics, Workforce modelling.	**Btl-3** Determine the solutions of optimization problems with the stochastic process and using nature-inspired algorithms

PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES (POs/PSOs)

Po No.	Program Outcome

PO1	Engineering Knowledge :An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization for the solution of complex engineering problems in engineering
PO2	Problem Analysis :An ability to identify, formulate, research literature, analyze complex engineering problems in mechanical engineering using first principles of mathematics, natural sciences and engineering sciences
PO3	Design/ development of solutions :An ability to design solutions for complex engineering problems and system component or processes that meet the specified needs considering public health & safety and cultural, societal & environment
PO4	Conduct investigations of complex problems :An ability to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to obtain solutions to engineering problems
PO5	Modern tool usage :Ability to create, select and apply appropriate techniques, resources and modern engineering activities, with an understanding of the limitations
PO6	The engineer and society :Ability to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	Environment and sustainability Ability to demonstrate the knowledge of engineering solutions, contemporary issues understanding their impacts on societal and environmental contexts, leading towards sustainable development
PO8	Ethics : An ability to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice
PO9	Individual and team work :An ability to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings
PO10	Communication :Ability to communicate effectively oral, written reports and graphical forms on complex engineering activities
PO11	Project management and finance :Ability to demonstrate knowledge and understanding of the engineering and management principles and apply those one's own work, as a member and leader in team, to manage projects and in multi-disciplinary environments
PO12	Lifelong learning An ability to recognize the need for and having the preparation and ability to engage independent and life-long learning in broadest context of technological change
PSO1	An ability to design and develop software projects as well as Analyze and test user requirements.
PSO2	An Ability to gain working Knowledge on emerging software tools and technologies.

Lecture Course DELIVERY Plan:

Sess.No.	CO	COI	Topic	Book No[CH No]|Page No]	Teaching-Learning Methods	EvaluationComponents
1	CO1	COI-1	Robust optimization: Uncertain data	B.No.-2 [CH 1] [Page No. 3-6]	LTC,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
2	CO1	COI-1	Robust optimization: Robust linear programs	B. No.-2 [CH 1] [Page No. 7-15]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
3	CO1	COI-1	Large scale systems, Geometrical Interpretation of Decomposition	B. No.-1 [CH 12] [Page No. 363 -373]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
4	CO1	COI-1	Large scale systems: Decomposition Methods	B. No.-1 [CH 12] [Page No. 373-377]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
5	CO1	COI-2	Network Flows: Electrical & Power Networks, Road Networks	B. No.-1 [CH 8] [Page No. 234-237]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
6	CO1	COI-2	Network Flows:Internet Backbone, Social Networks	B. No.-1[CH 8] [Page No.]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
7	CO1	COI-2	Dynamic Programming: The General DP Framework, Bellman Equation	B. No.-1[CH 11] [Page No.]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
8	CO1	COI-2	LP Problems using Dynamic Programming	B. No.-1[CH 11] [Page No.]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,Tutorial

Sess.No.	CO	COI	Topic	Book No[CH No][Page No]	Teaching-Learning Methods	EvaluationComponents
9	CO1	COI-2	Farkas lemma	B. No.-1[Page No. 527]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
10	CO2	COI-2	Introduction to Nonlinear Programming	B. No.-1 [CH.13][Page No. 410]	LTC,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
11	CO2	COI-2	Lagrange multipliers	Ref. B. No.4[CH.6][Page No. 257]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
12	CO2	COI-2	KKT optimality conditions	Ref. B. No.4[CH.4] [Page No. 257]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
13	CO2	COI-2	Constraint qualification	Ref. B. No.4[CH.5] [Page No. 237]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
14	CO2	COI-2	Quadratic programs:Linear Approximations of Nonlinear Programs, Unconstrained Minimization And SUMT, One-Dimensional Optimization	B. No.-1 [CH.13] [Page No. 433-448]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,SEM-EXAM1,SEP,Tutorial
15	CO2	COI-2	Wolfe method: Linear Approximations of Nonlinear Programs	B. No.-1 [CH.13][Page No. 425-433]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
16	CO2	COI-2	Applications of quadratic programs in some domains like portfolio optimization	B. No.-1 [CH.14] [Page No. 465]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
17	CO2	COI-2	Applications of quadratic programs in some domains like SVM	B. No.-1 [CH.14] [Page No. 465]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
18	CO2	COI-2	Applications of quadratic programs in some other domains	B. No.-1 [CH.14] [Page No. 465]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM1,SEP,Tutorial
19	CO3	COI-3	Combinatorial Optimization: Approximation Algorithms, Submodular functions	T Book[3], T Book [4]	LTC,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial
20	CO3	COI-3	Matroids, multilinear extensions	T Book[3], T Book [4]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial
21	CO3	COI-3	convex and conclave closures	T Book[3], T Book [4]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial

Sess.No.	CO	COI	Topic	Book No[CH No][Page No]	Teaching-Learning Methods	EvaluationComponents
22	CO3	COI-3	Continuous approximation algorithms,	B.No.1 [CH No. 9] [Page No. 272-276]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial
23	CO3	COI-3	Rounding techniques	B.No.1 [CH No. 9] [Page No. 276-280]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial
24	CO4	COI-2	Stochastic Programming with Optimization	B.No.1[CH No. 9] [Page No. 287-289]	LTC,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial
25	CO4	COI-3	Heuristics & Metaheuristics: Single solution vs. population-based, Parallel Metaheuristics	B.No.1 [CH No. 9] [Page No. 301-305]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial
26	CO4	COI-3	Nature-inspired Metaheuristics: Ant-colony optimization,	B.No.1 [CH No. 9] [Page No. 292-297]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial
27	CO4	COI-3	Particle swarm optimization, Simulated annealing	B.No.1 [CH No. 9] [Page No. 297-301]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial
28	CO4	COI-3	Evolutionary algorithms, Workforce modelling	B.No.1 [CH No. 9] [Page No. 297-301]	Chalk,PPT,Talk	Continuous Evaluation -Project,End Semester Exam,Hackathon,Home Assignment,MOOCs Certification,MOOCs Review,SEM-EXAM2,SEP,Tutorial

Lecture Session wise Teaching – Learning Plan

SESSION NUMBER : 1

Session Outcome: 1 Explain Introduction to Robust optimization

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	LTC	--- NOT APPLICABLE ---
20	Explain Introduction to Robust optimization:	2	PPT	--- NOT APPLICABLE ---
5	Questions on Robust optimization	2	PPT	--- NOT APPLICABLE ---
10	Uncertain data	3	PPT	--- NOT APPLICABLE ---
10	Problems Discussion	3	PPT	Video synthesis

SESSION NUMBER : 2

Session Outcome: 2 Robust linear programsProblem

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Explain Introduction to Robust optimization:	1	Talk	--- NOT APPLICABLE ---
5	Questions on Robust optimization	1	Talk	Leading question
20	Uncertain data	1	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	1	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 3

Session Outcome: 1 Large scale systems, Geometrical Interpretation of Decomposition

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Large scale systems	2	Talk	--- NOT APPLICABLE ---
10	Geometrical Interpretation of Decomposition	2	Talk	Leading question
20	Problems on Large scale systems and Geometrical Interpretation of Decomposition	2	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	2	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 4

Session Outcome: 1 Large scale systems: Decomposition Methods

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Large scale systems: Decomposition Methods	2	Chalk	--- NOT APPLICABLE ---
10	Questions on Decomposition Methods	2	Chalk	Leading question
20	Problems on Decomposition Methods	2	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	2	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 5

Session Outcome: 1 Network Flows: Electrical & Power Networks, Road Networks

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Network Flows: The Critical-Path Problem	3	Talk	--- NOT APPLICABLE ---
10	Questions on CPM	3	Talk	Leading question
20	Problems on CPM	3	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	3	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 6

Session Outcome: 2 Network Flows:Internet Backbone, Social Networks

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Chalk	--- NOT APPLICABLE ---
10	Network Flows: PERT	3	Talk	--- NOT APPLICABLE ---
10	Questions on PERT	3	Talk	Leading question
20	Problems on PERT	3	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	3	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 7

Session Outcome: 1 Dynamic Programming

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Chalk	--- NOT APPLICABLE ---
10	Dynamic Programming: The General DP Framework, Bellman Equation	3	Talk	--- NOT APPLICABLE ---
10	Questions on Dynamic Programming	3	Talk	Leading question
20	Problems on Dynamic Programming	3	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	3	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 8

Session Outcome: 1 LP Problems using Dynamic Programming

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	LP Problems using Dynamic Programming	3	Chalk	--- NOT APPLICABLE ---
10	Questions on LP Problems	3	Chalk	Leading question
20	Problems on LP Problems	3	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	3	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 9

Session Outcome: 1 Farkas lemma

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Farkas lemma	1	Talk	--- NOT APPLICABLE ---
10	Questions on Farkas lemma	3	Chalk	Leading question
20	Problems on Farkas lemma	3	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	3	Chalk	--- NOT APPLICABLE ---

SESSION NUMBER : 10

Session Outcome: 1 Introduction to Nonlinear Programming

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	LTC	--- NOT APPLICABLE ---
10	Introduction to Nonlinear Programming	2	PPT	--- NOT APPLICABLE ---
25	Questions on Nonlinear Programming	2	PPT	--- NOT APPLICABLE ---
10	Problems on Nonlinear Programming	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 11

Session Outcome: 2 Lagrange multipliers

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Lagrange multipliers	2	Chalk	--- NOT APPLICABLE ---
10	Questions on Lagrange multipliers	2	Chalk	Leading question
20	Problems on Lagrange multipliers	2	Chalk	--- NOT APPLICABLE ---
5	Problems Discussion	2	Chalk	--- NOT APPLICABLE ---

SESSION NUMBER : 12

Session Outcome: 2 KKT optimality conditions

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	KKT optimality conditions	2	Chalk	--- NOT APPLICABLE ---
10	Questions on KKT optimality conditions	2	Chalk	Leading question
20	Problems on KKT optimality conditions	2	Talk	--- NOT APPLICABLE ---
5	Problems Discussion	2	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 13

Session Outcome: 2 Constraint qualification

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Constraint qualification	3	Chalk	--- NOT APPLICABLE ---
10	Questions on Constraint qualification	3	Chalk	Leading question
20	Problems on Constraint qualification	3	Chalk	--- NOT APPLICABLE ---
5	Problems Discussion	3	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 14

Session Outcome: 2 Quadratic programs:Linear Approximations of Nonlinear Programs, Unconstrained Minimization And SUMT, One-Dimensional Optimization

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Quadratic programs:Linear Approximations of Nonlinear Programs,	3	Talk	--- NOT APPLICABLE ---
10	Unconstrained Minimization And SUMT,	3	Talk	Leading question
20	One-Dimensional Optimization and problems	3	Chalk	--- NOT APPLICABLE ---
5	Problems Discussion	3	Chalk	--- NOT APPLICABLE ---

SESSION NUMBER : 15

Session Outcome: 2 Wolfe method: Linear Approximations of Nonlinear Programs

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
10	Wolfe method: Linear Approximations of Nonlinear Programs	3	Chalk	--- NOT APPLICABLE ---
10	Questions on Wolfe method	3	Chalk	Leading question
20	Problems on Wolfe method	3	Chalk	--- NOT APPLICABLE ---
5	Problems Discussion	3	Chalk	--- NOT APPLICABLE ---

SESSION NUMBER : 16

Session Outcome: 2 Applications of quadratic programs in some domains like portfolio optimization

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	PPT	--- NOT APPLICABLE ---
20	Applications of quadratic programs in some domains like portfolio optimization	2	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	2	PPT	--- NOT APPLICABLE ---
5	Problems for practice/ Discussion	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 17

Session Outcome: 2 Applications of quadratic programs in some domains like SVM

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Applications of quadratic programs in some domains like SVM	2	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	2	PPT	--- NOT APPLICABLE ---
5	Problems for practice/ Discussion	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 18

Session Outcome: 2 Applications of quadratic programs in some other domains

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods

5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Applications of quadratic programs in some other domains	3	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	3	PPT	--- NOT APPLICABLE ---
5	Problems for practice/ Discussion	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 19

Session Outcome: 1 Approximation Algorithms

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	PPT	--- NOT APPLICABLE ---
10	Combinatorial Optimization: Approximation Algorithms,	2	PPT	--- NOT APPLICABLE ---
10	Submodular functions, Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	3	PPT	--- NOT APPLICABLE ---
25	Problems for practice	3	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 20

Session Outcome: 3 Matroids, multilinear extensions

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Matroids	2	PPT	--- NOT APPLICABLE ---
20	Multilinear extensions, Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	2	PPT	--- NOT APPLICABLE ---
5	Problems for practice / Discussions	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 21

Session Outcome: 3 convex and conclave closures

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	convex and conclave closures	2	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	2	PPT	--- NOT APPLICABLE ---
5	Problems for practice/ Discussions	1	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 22

Session Outcome: 3 Continuous approximation algorithms,

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Continuous approximation algorithms,	2	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	2	PPT	--- NOT APPLICABLE ---
5	Problems for practice / Discussion	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 23

Session Outcome: 3 Rounding techniques

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Rounding techniques	3	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	3	PPT	--- NOT APPLICABLE ---

5	Problems for practice/ Discussion	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 24

Session Outcome: 1 Stochastic Programming with Optimization

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	PPT	--- NOT APPLICABLE ---
10	Stochastic Programming with Optimization: Monte Carlo Sampling	1	PPT	--- NOT APPLICABLE ---
25	Discussion on Submodular functions, Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	2	PPT	--- NOT APPLICABLE ---
10	Problems for practice	3	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 25

Session Outcome: 4 Heuristics & Metaheuristics: Single solution vs. population-based, Parallel Metaheuristics

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Heuristics & Metaheuristics: Single solution vs. population-based, Parallel Metaheuristics	2	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	2	PPT	--- NOT APPLICABLE ---
5	Problems Discussion	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 26

Session Outcome: 4 Nature-inspired Metaheuristics: Ant-colony optimization,

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Nature-inspired Metaheuristics: Ant-colony optimization,	3	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	3	PPT	Leading question
5	Problems Discussion	3	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 27

Session Outcome: 4 Particle swarm optimization, Simulated annealing

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Particle swarm optimization, Simulated annealing	3	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	3	PPT	Leading question
5	Problems Discussion	3	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 28

Session Outcome: 4 Evolutionary algorithms, Workforce modelling

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Evolutionary algorithms, Workforce modelling	3	PPT	--- NOT APPLICABLE ---
20	Problems as Assignment/Quiz (ALM) Doubts can be asked in Public Chat	3	PPT	Leading question
5	Problems Discussion	3	Chalk	--- NOT APPLICABLE ---

Tutorial Course DELIVERY Plan:

List of Experiments supposed to finish in Open Lab Sessions:

Lab session no	List of Experiments	CO-Mapping
1	Demonstrate the Dynamic programming in Non Linear Programming.	CO1
2	Demonstrate the Minimum Cost flow problem in Non Linear Programming.	CO1
3	Demonstrate KKT Optimality in Non Linear Programming.	CO2
4	Demonstrate Quadratic programming in Non Linear Programming	CO2
5	Demonstrate the Wolfe Method for Quadratic program in Non Linear Programming.	CO3
6	Demonstrate Approximation Algorithms in Non Linear Programming	CO3
7	Demonstrate Rounding Techniques in Non Linear Programming.	CO3
8	Demonstrate Ant Colony Optimization in Non Linear Programming.	CO4
9	Demonstrate Particle Swarm optimization in Non Linear Programming.	CO4
10	Demonstrate the Non linear program using Simulated Annealing.	CO4

Tutorial Session wise Teaching – Learning Plan

SESSION NUMBER : 1

Session Outcome: 1 Demonstrate the Dynamic programming in Non Linear Programming.

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Dynamic programming	2	Talk	--- NOT APPLICABLE ---
5	CREATING A BREAKOUT ROOM	1	Talk	--- NOT APPLICABLE ---
20	Formulating and solving Dynamic programming	3	Talk	--- NOT APPLICABLE ---
40	Solving the Dynamic programming using Python language	3	Talk	--- NOT APPLICABLE ---
10	Problems Discussion	1	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 2

Session Outcome: 1 Demonstrate the Minimum Cost flow problem in Non Linear Programming.

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Minimum Cost flow problem in Non Linear Programming.	2	LTC	--- NOT APPLICABLE ---
5	CREATING A BREAKOUT ROOM	1	Talk	--- NOT APPLICABLE ---
20	Formulating and solving Minimum Cost flow problem in Non Linear Programming.	3	LTC	--- NOT APPLICABLE ---
40	Solving the Minimum Cost flow problem in Non Linear Programming.Python language	3	LTC	--- NOT APPLICABLE ---
10	Problems Discussion	1	Talk	--- NOT APPLICABLE ---

SESSION NUMBER : 3

Session Outcome: 2 Demonstrate KKT Optimality in Non Linear Programming.

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	KKT Optimality in Non Linear Programming	2	LTC	--- NOT APPLICABLE ---
5	CREATING A BREAKOUT ROOM	1	Talk	--- NOT APPLICABLE ---
20	Formulating and solving KKT Optimality in Non Linear Programming.	3	LTC	--- NOT APPLICABLE ---

40	Solving the Minimum KKT Optimality in Non Linear Programming in Python language	3	LTC	--- NOT APPLICABLE ---
10	Problems Discussion	1	LTC	--- NOT APPLICABLE ---

SESSION NUMBER : 4

Session Outcome: 1 Demonstrate Quadratic programming in Non Linear Programming

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	Talk	--- NOT APPLICABLE ---
20	Quadratic programming in Non Linear Programming	2	LTC	--- NOT APPLICABLE ---
5	CREATING A BREAKOUT ROOM	1	Talk	--- NOT APPLICABLE ---
20	Formulating and solving Quadratic programming in Non Linear Programming	3	LTC	--- NOT APPLICABLE ---
40	Solving the Minimum Quadratic programming in Non Linear Programming in Python language	3	LTC	--- NOT APPLICABLE ---
10	Problems Discussion	1	LTC	--- NOT APPLICABLE ---

SESSION NUMBER : 5

Session Outcome: 1 Demonstrate the Wolfe Method for Quadratic program in Non Linear Programming.

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance/Recap ;Poll/Pop Question	1	LTC	--- NOT APPLICABLE ---
20	Wolfe Method for Quadratic program in Non Linear Programming	2	LTC	--- NOT APPLICABLE ---
5	CREATING A BREAKOUT ROOM	1	Talk	--- NOT APPLICABLE ---
20	Formulating and solving Wolfe Method for Quadratic program in Non Linear Programming	3	LTC	--- NOT APPLICABLE ---
40	Solving the Minimum Wolfe Method for Quadratic program in Non Linear Programming in Python language	3	LTC	--- NOT APPLICABLE ---
10	Problems Discussion	1	LTC	--- NOT APPLICABLE ---

SESSION NUMBER : 6

Session Outcome: 1 Approximation Algorithms

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	Talk	--- NOT APPLICABLE ---
25	Formulate Approximation Algorithms	2	Talk	--- NOT APPLICABLE ---
40	Solving Approximation Algorithms	3	Talk	--- NOT APPLICABLE ---
30	Solving the Approximation Algorithms using Python language	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 7

Session Outcome: 1 Rounding Techniques

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	Talk	--- NOT APPLICABLE ---
30	Rounding Techniques	1	Talk	--- NOT APPLICABLE ---
45	Formulating and solving Rounding Techniques	3	PPT	--- NOT APPLICABLE ---
20	Solving the Rounding Technique using Python language	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 8

Session Outcome: 1 Explain Introduction Ant Colony Optimization

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	Talk	--- NOT APPLICABLE ---

30	Ant Colony Optimization	2	PPT	--- NOT APPLICABLE ---
35	Formulating and solving Dynamic programming	2	PPT	--- NOT APPLICABLE ---
30	Solving the Formulating and solving Dynamic programming using Python language	2	LTC	--- NOT APPLICABLE ---

SESSION NUMBER : 9

Session Outcome: 1 Particle Swarm optimization

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	Talk	--- NOT APPLICABLE ---
30	Particle Swarm optimization	2	PPT	--- NOT APPLICABLE ---
35	Formulating and solving Particle Swarm optimization	2	PPT	--- NOT APPLICABLE ---
30	Solving the Particle Swarm optimization using Python language	2	PPT	--- NOT APPLICABLE ---

SESSION NUMBER : 10

Session Outcome: 1 Explain Simulated Annealing

Time(min)	Topic	BTL	Teaching- Learning Methods	Active Learning Methods
5	Attendance	1	Talk	--- NOT APPLICABLE ---
30	Simulated Annealing	2	PPT	--- NOT APPLICABLE ---
35	Problems on Simulated Annealing	2	PPT	--- NOT APPLICABLE ---
30	Solving the Simulated Annealing using Python language	2	PPT	--- NOT APPLICABLE ---

Practical Course DELIVERY Plan: NO Delivery Plan Exists

Practical Session wise Teaching – Learning Plan

No Session Plans Exists

Skilling Course DELIVERY Plan: NO Delivery Plan Exists

Skilling Session wise Teaching – Learning Plan

No Session Plans Exists

WEEKLY HOMEWORK ASSIGNMENTS/ PROBLEM SETS/OPEN ENDEDED PROBLEM-SOLVING EXERCISES etc:

Week	Assignment Type	Assignment No	Topic	Details	co

COURSE TIME TABLE:

	Hour	1	2	3	4	5	6	7	8	9
Day	Component									
Mon	Theory	--	--	--	--	--	--	--	--	--
	Tutorial	--	--	--	--	--	--	--	--	--
	Lab	--	--	--	--	--	--	--	--	--
	Skilling	--	--	--	--	--	--	--	--	--
Tue	Theory	--	--	--	--	--	--	--	--	--
	Tutorial	--	--	--	--	--	--	--	--	--
	Lab	--	--	--	--	--	--	--	--	--
	Skilling	--	--	--	--	--	--	--	--	--
Wed	Theory	--	--	--	--	--	--	--	--	--
	Tutorial	--	--	--	--	--	--	--	--	--
	Lab	--	--	--	--	--	--	--	--	--
	Skilling	--	--	--	--	--	--	--	--	--
Thu	Theory	--	--	--	--	--	--	--	--	--
	Tutorial	--	--	--	--	--	--	--	--	--
	Lab	--	--	--	--	--	--	--	--	--
	Skilling	--	--	--	--	--	--	--	--	--
Fri	Theory	--	--	--	--	--	--	--	--	--

	Tutorial	--	--	--	--	--	--	--	--	--
	Lab	--	--	--	--	--	--	--	--	--
	Skilling	--	--	--	--	--	--	--	--	--
Sat	Theory	--	--	--	--	--	--	--	--	--
	Tutorial	--	--	--	--	--	--	--	--	--
	Lab	--	--	--	--	--	--	--	--	--
	Skilling	--	--	--	--	--	--	--	--	--
Sun	Theory	--	--	--	--	--	--	--	--	--
	Tutorial	--	--	--	--	--	--	--	--	--
	Lab	--	--	--	--	--	--	--	--	--
	Skilling	--	--	--	--	--	--	--	--	--

REMEDIAL CLASSES:

Supplement course handout, which may perhaps include special lectures and discussions that would be planned, and schedule notified according

SELF-LEARNING:

Assignments to promote self-learning, survey of contents from multiple sources.

S.no	Topics	CO	ALM	References/MOOCS

DELIVERY DETAILS OF CONTENT BEYOND SYLLABUS:

Content beyond syllabus covered (if any) should be delivered to all students that would be planned, and schedule notified accordingly.

S.no	Advanced Topics, Additional Reading, Research papers and any	CO	ALM	References/MOOCS

EVALUATION PLAN:

Evaluation Type	Evaluation Component	Weightage/Marks		Assessment Dates	Duration (Hours)	CO1	CO2	CO3	CO4
End Semester Summative Evaluation Total= 40 %	**SEM End Project**	Weightage	5		180	1.25	1.25	1.25	1.25
		Max Marks	100			25	25	25	25
	End Semester Exam	Weightage	35		180	8.75	8.75	8.75	8.75
		Max Marks	100			25	25	25	25
In Semester Formative Evaluation Total= 30 %	**MOOCs Review**	Weightage	5		240	1.25	1.25	1.25	1.25
		Max Marks	100			25	25	25	25
	Hackathon	Weightage	5		240	1.25	1.25	1.25	1.25
		Max Marks	100			25	25	25	25
	Tutorial	Weightage	10		240	2.5	2.5	2.5	2.5
		Max Marks	100			25	25	25	25
	Home Assignment and Textbook	Weightage	5		120	1.25	1.25	1.25	1.25
		Max Marks	100			25	25	25	25
	Continuous Evaluation -Project	Weightage	5		120	1.25	1.25	1.25	1.25
		Max Marks	100			25	25	25	25
In Semester Summative Evaluation Total= 30 %	**Semester in Exam-I**	Weightage	12.5		120	6.25	6.25		
		Max Marks	50			25	25		
	Semester in Exam-II	Weightage	12.5		120			6.25	6.25
		Max Marks	50					25	25
	MOOCs Certification	Weightage	5		120	1.25	1.25	1.25	1.25
		Max Marks	50			12.5	12.5	12.5	12.5

ATTENDANCE POLICY:

Every student is expected to be responsible for regularity of his/her attendance in class rooms and laboratories, to appear in scheduled tests and examinations and fulfill all other tasks assigned to him/her in every course
In every course, student has to maintain a minimum of 85% attendance to be eligible for appearing in Semester end examination of the course, for cases of medical issues and other unavoidable circumstances the students will be condoned if their attendance is between 75% to 85% in every course, subjected to submission of medical certificates, medical case file and other needful documental proof to the concerned departments

DETENTION POLICY :

In any course, a student has to maintain a minimum of 85% attendance and In-Semester Examinations to be eligible for appearing to the Semester End Examination, failing to fulfill these conditions will deem such student to have been detained in that course.

PLAGIARISM POLICY :

Supplement course handout, which may perhaps include special lectures and discussions

COURSE TEAM MEMBERS, CHAMBER CONSULTATION HOURS AND CHAMBER VENUE DETAILS:

Supplement course handout, which may perhaps include special lectures and discussions

Name of	Delivery Component	Sections of	Chamber	Chamber Consultation Timings	Chamber Consultation	Signature of Course

Faculty	of Faculty	Faculty	Consultation Day (s)	for each day	Room No:	faculty:

GENERAL INSTRUCTIONS

Students should come prepared for classes and carry the text book(s) or material(s) as prescribed by the Course Faculty to the class.

NOTICES

Most of the notices are available on the LMS platform.

All notices will be communicated through the institution email.

All notices concerning the course will be displayed on the respective Notice Boards.

Signature of COURSE COORDINATOR

(Choudhary Shyam Prakash)

Signature of Department Prof. Incharge Academics & Vetting Team Member

Department Of CSE

HEAD OF DEPARTMENT:

Approval from: DEAN-ACADEMICS
(Sign with Office Seal) [object HTMLDivElement]