CSE11119	**Optimization and Game Theory**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours 45**	**3**	**0**	**0**	**3**
Pre-requisite/Exposure	**---**				
Co-requisite	**NIL**				

Course Objectives:

- Formulate an equilibrium-finding problem of certain games as a CP/VI or an MPEC
- Rigorously analyze the existence and uniqueness of solutions to CPs, VIs and MPECs, and hence able toprove the existence and uniqueness of Nash equilibrium to certain games
- Understand and utilize various algorithms to solve CPs, VIs and MPECs
- Understand the basic formulation and theories of optimization under uncertainty
- Understand the basic concepts of games with uncertainty

Course Outcomes:

On the completion of this course the student will be able to

Course Description:

This course will serve as an advanced graduate-level course to provide students both solid theoretical foundations ofoptimization in general, and knowledge of the state-of-the-art development the area of complementarity problems (CPs), (finite-dimensional) variational inequalities (VIs), mathematical problems with equilibrium constraints (MPECs) and their applications in game theory. Building upon such knowledge, the course will also provide an introduction, not a comprehensive treatment, of decision- making under uncertainties and competition. While the course will focus on the theoretical aspects of the subjects, it will as well introduce students to modeling languages, such as AMPL and GAMS, and the complementarity-problem solver PATH, through NEOS Online Optimization Server.

Course Content:

Units	**Lecture Hours**
Unit-I: Background linear algebra, real analysis and nonlinear programming Linear algebra Vectors, matrices, norms, Eigenvalues, eigenvectors and singular-value decomposition, Semidefinite and definite matrices Real analysis Limits, continuity, Functions of several variables, differentiability, Contraction mappings, fixed point theoremsConvex analysis Convex sets, convex hulls, Separation and support of sets, Convex functions, differentiability and sub gradients, Generalizations of convex functions, Nonlinear programming Unconstrained optimization: optimality conditions, algorithms Constrained optimization: Tangent cones, Constrained qualifications, Optimality Lagrange	**10**

Units	Lecture Hours
multipliers and duality NLP algorithms: penalty approach, SQP, interior point methods	
Unit-II: Game theory and linear complementarity problems - Game Theory Non-cooperative games: normal-form representation, the concept of Nash equilibrium, Proof of Nash equilibrium through fixed-point theorem -	**10**
Unit-III: Nonlinear complementarity problems and variational inequalities - Problem definitions and application areasSolution analysis Algorithms for CPsAlgorithms for VIs	**15**
Unit-IV: Mathematical problems with equilibrium constraints xtensive-form games and Stackelberg games PECs : Formulation, Solution existence, constraint qualifications, and optimality conditions, Algorithms for MPECs	**10**
Unit-V: Decision-making under uncertainty and competition ecision theory under uncertainty ptimization under uncertainty - Formulation, solution concepts and analysis , Sample average approximation ame theory under uncertainty - Information and equilibrium concepts, Algorithms	**5**

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between Course Outcomes (COs) and Program Outcomes (POs):

1 = Weakly Mapped

2 = Moderately Mapped3 = Strongly Mapped

Course Code	Course Name	COs	P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CSE11	Optimiza	CO111	3	2	2	2	1	3	1	-	1	-	-	3	2	1	3
119	tion and	19.1															
	Game Theory	CO111 19.2	2	3	3	3	2	2	2	-	3	-	-	1	3	3	2
		CO111	2	2	2	2	1	2	1	-	3	-	-	2	2	1	2
		19.3															
		CO111	2	3	3	2	2	3	1	-	1	-	-	3	2	2	3
		19.4															
		CO111	3	3	3	3	1	3	3	-	2	-	-	2	2	2	1
		19.5															

Course Code	Course Name	COs	P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
		CO111	2.	2.	2.	2.	1.	2.	1.	-	2.	-	-	2.2	2.2	1.8	2.2
		19	4	6	6	4	4	6	6		0						