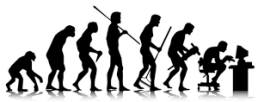
ACADEMIC YEAR: 2019-2020; 1st SEMESTER



PHY670A: EVOLUTIONARY GAME DYNAMICS

Instructor: Sagar Chakraborty, Department of Physics, IIT Kanpur.

(No serious prerequisite required but a taker of the course should not have a dislike for abstract mathematics.)

Details of Course-Content:

S. No.	Broad Topics	Detailed Contents	No. of Lectures
1.	**Basics of nonlinear dynamics**	Autonomous flows and maps, fixed points, linear stability analysis, Lyapunov function, limit cycles, chaos, Lyapunov exponents.	**5**
2.	**Basics of evolution**	Examples of evolution in biology, ecology, society, and language; Darwin's theory; Mendel's Laws, Hardy–Weinberg principle; Wright's equation for adaptive landscape; Fisher's fundamental theorem; Price equation; Hamilton's inclusive fitness theory.	**8**
3.	**Basics of game theoretic concepts***	Normal and extensive forms; minimax solution, dominant strategy equilibrium, Nash equilibrium, Pareto efficiency, payoff dominance, risk dominance, and evolutionary stable strategy; repeated games and evolution of cooperation.	**7**
4.	**Games in infinite population: deterministic models**	Quasispecies equation; replicator-mutator equation; evolutionary stable state and its relation to the fixed points; evolutionary stable set; Folk theorem of evolutionary game theory; Bishop–Cannings theorem; connection between replicator-mutator equation and expanded Price equation; doubly symmetric matrix game and Fisher's fundamental theorem; examples like generalized rock-paper-scissors game, language evolution, etc.; mention of other game dynamics (imitation dynamics, monotone selection dynamics, best-response dynamics, adjustment dynamics, logit dynamics, adaptive dynamics, etc.).	**9-10**
5.	**Games in finite population: stochastic models**	Fixation probability of alleles in Wright–Fisher model and Moran model, Kimura's neutral theory of evolution, Diffusion approximation (Kolmogorov forward and backward equations), games in finite population, one-third law and its relation with risk dominance, evolutionary stability, evolutionary graph theory, spatial games, deriving replicator equation from modified Moran model.	**11-12**
		Total number of lectures:	**40-42**

*Mostly concepts will be discussed; formal rigorous proofs will be avoided wherever possible.

Recommended Reference Books:

A) **M. A. Nowak**, *Evolutionary Dynamics*, The Belknap Press of Harvard University Press (2006).

B) **S. H. Rice,** *Evolutionary Theory,* Oxford University Press (2004).

C) **J. Hofbauer and K. Sigmund**, *Evolutionary Games and Population Dynamics*, Cambridge University Press (1998).

D) **J. W. Weibull,** *Evolutionary Game Theory,* The MIT Press (1997).

E) **J. Maynard Smith,** *Evolution and the Theory of Games,* Cambridge University Press (1982).