

ACADEMIC YEAR: 2018-2019; 1st SEMESTER



PHY670: EVOLUTIONARY GAME DYNAMICS

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

(3 lecture hours per week. No prerequisite required but a taker of the course must be comfortable with mathematical way of thinking.)

Details of Course-Content:

S. No.	Broad Title	Topics	No. of Lectures
1.	Basics of evolution	Examples of evolution in biology, ecology, society, and language; Darwin's theory; Fisher's fundamental theorem; Price equation; Hamilton's inclusive fitness theory.	6
2.	Basics of game theoretic concepts	Concepts* of Nash equilibrium, Pareto efficiency, risk dominance, and evolutionary stable strategy; normal and extensive forms; repeated games and evolution of cooperation; spatial games.	8
3.	Basics of nonlinear dynamics	Autonomous flows and maps, fixed points, linear stability analysis, limit cycles, chaos.	4
4.	Games in infinite population: deterministic models	Quasispecies equation, replicator-mutator equation, imitation dynamics, monotone selection dynamics, best-response dynamics, adjustment dynamics, adaptive dynamics, evolutionary stable state, connection between replicator-mutator equation and expanded Price equation, Folk theorem, application to language evolution.	10
5.	Games in finite population: stochastic models	Moran process, birth-death process, fixation probability, Kimura's neutral theory of evolution, one-third law and its relation with risk dominance, evolutionary stability, evolutionary graph theory.	12
Total number of lectures:			40

*= Only concepts will be discussed; no formal rigorous proof will be done.

Recommended Books:

- A) **M. A. Nowak**, *Evolutionary Dynamics*, The Belknap Press of Harvard University Press (2006).
- B) **J. Hofbauer and K. Sigmund**, *Evolutionary Games and Population Dynamics*, Cambridge University Press (1998).
- C) **J. Maynard Smith**, *Evolution and the Theory of Games*, Cambridge University Press (1982).
- D) **S. H. Rice**, *Evolutionary Theory*, Oxford University Press (2004).
- E) **J. A. R. Marshall**, *Social Evolution and Inclusive Fitness Theory*, Princeton University Press (2015).
- F) **A. F. G. Bourke**, *Principles of Social Evolution*, Oxford University Press (2011).
- G) **R. Cressman**, *Evolutionary Dynamics and Extensive Form Games*, The MIT Press (2003).
- H) **D. Easley and J. Kleinberg**; *Networks, Crowds, and Markets*; Cambridge University Press (2010).