THE PHYSICS OF ECONOMICS
Course Outline (40 Lectures)
Dhirubhai Ambani Institute of Information and Communication Technology
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• Introductory overview:
  1. Econophysics and its motivation. Physics-based approaches and economics anticipating physics. Min-
     imisation methods (Jan Tinbergen’s dissertation) – Fermat’s principle as an optical example.

• Stochastic processes:
  2. Coin-tossing as a simple example of a random system, microstates, macrostates, their probabilities and thermodynamic perspectives. Random walks, multiplicity and the binomial distribution.
  3. Mean value, deviation and dispersion. Mean values for the random walk. Root-mean-square values, width and averaging.
  5. The Gaussian probability density distribution. The Poisson distribution.
  7. The point-source solution of the diffusion equation, the Dirac Delta function as an initial condition and the Gaussian limit. Spatio-temporal features of the point-source solution.
  8. The theory of Brownian motion, general observations, thermalisation, the equipartition theorem, random forces, Stokes’s law and the viscous drag.
 11. Mathematical formulation of Bachelier’s theory of speculation.
 12. Arbitrage and the efficient market. General remarks on arbitrage and the efficient market. Qualifica-
      tions to the efficient market.
 14. The log-normal distribution, its slow convergence and moments.
 15. Stochastic processes in stock pricing, the generalised Wiener process and the Itô process. Itô’s lemma, the log-normal property of stock prices and the geometric random walk in the stock market.
 16. Basic definitions about stocks. Speculation, hedging and a riskless portfolio. Option pricing in idealised markets and the derivation of the Black-Scholes-Merton equation.
 17. The diffusion equation from the Black-Scholes-Merton equation.
• Dynamical Systems:
  1. Properties of autonomous dynamical systems and autonomous differential equations.
  2. The logistic equation, its dynamic features and its integral solution. The laws of social dynamics.
  3. Population dynamics, the Malthus law and the logistic model of Verhulst with examples.
  4. Policy implications of the vital coefficients of the logistic equation. Criticisms and improvement.
  8. Higher-order dynamical systems, the second order and the Jacobean matrix. Price vectors in an N-order system. Demand and supply dynamics.

• Large-aggregate behaviour:
  1. The ideal gas, the equipartition theorem, temperature and pressure as average measures.
  2. The kinetic theory of matter and its physical implications.
  4. Averaging from the Maxwell-Boltzmann function. The energy distribution and the average energy.
  5. The statistical mechanics of money, the Boltzmann-Gibbs distribution and average money.
  7. Asset exchange. Asset exchange models with uniform savings and distributed savings.
  8. Basic concepts of thermodynamics, equilibrium, intensive and extensive variables, equations of state, quasi-static and reversible processes.
  11. The Carnot engine, its efficiency, entropy and the Clausius theorem. The T-S plot.
  13. Surplus, capital, economic analogue of thermodynamical laws and thermodynamical variables.
  14. Internal energy, the Helmholtz function, Maxwell relations and entropy in economics.

• Assignments:
  1. Growth of IBM, its revenue, human resource and profit.
  2. Growth of HP, its revenue and human resource. Interpolation of its missing data.
  3. Reading assignment on select topics.
References (based on the chronology of the lectures)

- Technical books and book chapters:
  2. F. Reif, *Fundamentals of Statistical and Thermal Physics*, Levant, Calcutta

- Non-technical books:

- Articles/Papers/Monographs/Notes:
  3. H. Ben-el-Mechaiekh & R. W. Dimand (Translators), *The 1938 Monograph on Speculation and the Calculus of Probability – Louis Bachelier*


- **Passing references:**


