Slide 3 – Models

# Slide 4 – Mathematical models

Using these abstractions we build a model which is a simplified but is a profound description of the physical system. It is simplified in the sense that only the required details are taken into account that are necessary for describing a particular behaviour of the system while neglecting others irrelevant things while at the same time profound and precise in the sense it is stated in the language of mathematics and involves mathematical rigor.

**Newtonian mechanics**

**Quantum mechanics**

# Slide 5 – Modelling process

Give example

**Abstraction** – these models are simplified reflections of reality. Models that are too realistic may be very difficult to deal with.

**Analysis/simulation** – analysis leads to analytical solutions whereas simulation in computers is done with the help of numerical methods. So the usefulness of mathematical models (or the art of building mathematical models has become easy) predicting nature of physical systems has become more easy to deal with.

**Validation** – checking the model is good enough. Measurements from the actual physical system are compared to predictions of the model.

# Slide 6

Traditionally, the formal modelling of systems has been via a mathematical model, which attempts to find analytical solutions enabling the prediction of the behaviour of the system from a set of parameters and initial conditions. Computer simulation is often used as an adjunct to, or substitution for, modelling systems for which simple closed form analytic solutions are not possible.

Slide 7 – static models

As I explained earlier, there are two types of models – static and dynamic. Static models are those that does not evolve over time or to be more explicit does not evolve over any variable and only **presents steady state condition** of the situation.

As an example lets calculate the magnetic field of a line wire carrying current at every point on the 2D plane. So here is the biot-savart law.

Slide 11 - Dynamical system

* What is a dynamical system
  + Systems that evolve over time
  + A small step rule which determines the future states of the system given the present states – evolutionary law, deterministic law.
* How to solve differential equations.
  + Variable step runga kutta method.

Slide 12 – modelling a particle in eletromag field

* What to model and why
  + Given initial position and E and B want to find out what will be position of particle after t time.
  + Give E and B what is the trajectory of particle?
  + How does that trajectory varies with mass of particle??
* Deterministic rule
  + Get the future states and plot that in matlab.

Static model

Dynamical models

Particle in crossed magnetic field n electric field.

Deterministic chaos

Lorenz attractor

Julia set

Chaos in Julia set

Stochastic system

Monticarlo simulations

Magnetocaloric effect.