**Four Phases of Design Cycle
Dr. Kamal Sarkar
November 7, 2018**

1. **Phase One: Problem Formulation**
* **Elevator Speech**
* **Market Analysis**
* **Competitive Products**
* **Needs, Wants, & Constraints**
* **Goals & Objectives**
* **QFD (Quality Function Deployment)**
1. **Phase Two: Concept Development**
* **Functional Decomposition**
* **Critical Sub-functions**

**Design Criteria**

**Concept Variants**

* **Sub-function Selection by Pairing Method on a Scale of 6**
* **Concept generation**

**Methodology**

**Various Conceptual Designs**

* **Concept Selection**
* **Detailed drawings with Dimension & Units**
* **Model Prototype**

**Four Phases of Design Cycle (Continued) Updated Nov 7, 18**

1. **Phase Three: Design Embodiment**
* **Design for Performance**

**Critical Engineering Parameters**

**Engineering Equations including Nomenclature and Units**

**Engineering Solutions for Each critical Parameters**

**Graphical displays of Engineering Solutions**

**Optimum Solutions of Each Critical Engineering Parameters**

* **DfX (Design for X)**

**Design for Safety**

**Design for Environment**

**Design for Manufacturability & Assembly**

**Design for Reliability**

**Design for Ergonomics**

**Design for Retirement**

* **D-FMEA & P-FMEA (Failure Modes and Effects Analyses for Design & Process)**
1. **Phase Four: Design Validation**
* **Engineering Economics**

**Bill of Material**

**Prototype Cost**

**Product Cost**

**Comparisons & Analysis of Product Cost, QFD Cost, & Cost of**

 **Competitive Products**

* **Quality Control (QC) of**

**Individual Components, Manufactured Parts, & Sub-assemblies**

**Final Inspection of the Product for “Sanity Check”**

* **Quality Control for Interfaces & Software as needed**
* **Quality Control of Final Product**

 **“Sanity Check”**

 **Critical Tests**

 **Test Formats**

 **Test Protocols**

 **Test Forms**