MCE 518 OPERATIONS RESEARCH

History of Operations Research:

The first formal activities of Operations Research (OR) were initiated in England during World War II, when a team of British scientists set out to make scientifically based decisions regarding the best utilization of war materiel. As a formal discipline, operational research originated in the efforts of military planners during World War II. In the decades after the war, the techniques were more widely applied to problems in business, industry and society. Since that time, operational research has expanded into a field widely used in industries ranging from petrochemicals to airlines, finance, logistics, and government, moving to a focus on the development of mathematical models that can be used to analyse and optimize complex systems, and has become an area of active academic and industrial research.

Meaning/ Definition of Operations Research:

Operations research, or **operational research** in British usage, is a discipline that deals with the application of advanced analytical methods to help make better decisions. It is often considered to be a sub-field of mathematics. The terms **management science** and **decision science** are sometimes used as synonyms.

Operations Research (OR) is an interdisciplinary branch of applied mathematics and formal science that uses methods like mathematical modeling, statistics, and algorithms to arrive at optimal or near optimal solutions to complex problems.

From a practical point of view, OR can be defined as an art of optimization, i.e., an art of finding minima (minimizing cost) or maxima (maximizing benefits) of some objective function, and — to some extend — an art of defining the objective functions. OR is often referred to as "the science of better".

Applications of OR

- Critical path analysis or project planning: identifying those processes in a complex project which affect the overall duration of the project
- Facility planning/layout: designing the layout of equipment in a factory
- Network optimization: for instance, setup of telecommunications networks to maintain quality of service during outages
- Allocation problems
- Facility location
- Assignment Problems:
- Routing, such as determining the routes of buses so that as few buses are needed as possible
- Supply chain management: managing the flow of raw materials and products based on uncertain demand for the finished products
- Efficient messaging and customer response tactics
- Automation: automating or integrating robotic systems in human-driven operations processes

- Globalization: globalizing operations processes in order to take advantage of cheaper materials, labor, land or other productivity inputs
- Transportation: managing freight transportation and delivery systems
- Scheduling:
- Blending of raw materials in oil refineries

OR Tools/Techniques/Methods

Some of the primary tools used in OR are

_ statistics (statistical analysis),
_ optimization,
_ probability theory,
_ queuing theory,
_ game theory,
_ graph theory,
_ decision analysis,
_ simulation

PHASES OF OR

[1] Problem definition
[2] Model construction
[3] Data gathering
[4] Solution
[5] Implementation

Step 1: Problem definition: The OR analyst first defines the organization's problem. This includes specifying the organization's objectives and the parts of the organization (or system) that must be studied before the problem can be solved. In this stage the decision problem is expressed in both qualitative and quantitative terms. The observable results and the underlying causes are identified. Five major characteristics of the system are identified, namely:

i. ***Measure of effectiveness*** (performance measure): quantifiable measurement **(numerical value)** for the comparison of result obtainable under different external conditions and different decisions.
ii. ***Variables*** (controllable and uncontrollable variables; deterministic and random variables): Variables are characteristics of the system that takes on different values and affects the performance of the system over the range of values. Controllable variables are those the decision maker can control deterministic variables are not chance dependent (may be known with certainty) while random variables are chance dependent (each comes from a probability distribution)
iii. ***Parameter:*** Is a characteristic that takes on only one value during the foreseeable operation of the system but may change its value when different alternatives are studied.
iv. ***Objective:*** The direction in which the decision maker wants it to move (usually, maximize benefits or minimize costs). The value of the objective function becomes the measure of effectiveness of the total system.

v. ***Constraints:*** The restrictions imposed upon the system by resource availability, external conditions, technologies involved…

Step 2: Model construction: Development of a mathematical description of the decision problem to reflect the characteristics of the issues involved. Types of mathematical models include, simulation (discrete and continuous), optimization (classical optimization and mathematical programming e.g. linear programming, non-linear programming, dynamic programming, integer programming, multi-objective decision making such as goal programming, compromise programming, etc…). Pertinent questions and what supply answers.

i. "What's best?" **mathematical programming**
ii. "What happened?" **statistics.**
iii. "What if?" **simulation**
iv. "What will happen?"**forecasting**
v. "What would an expert do and why?" **expert systems.**

Step 3: Data gathering: collects data to estimate the values of the parameters that affect the organization's problem.

Step 4: Solution: Solution of OR models are obtained in several ways e.g. graphical, calculus, algorithms…

Step 5: implementation: Present the results to decision-maker for implementation