INTRODUCTION: Mechanical Metallurgy

- Uses the principle of mechanics and of metallurgy with the objective of rationalizing, predicting and modifying to describe the response of metals to loads.

- The central theme is structure - properties - performance triangle. Changes in one are inseparably related to changes in the others; these changes are introduced by processing.

STRUCTURE ↔ PROPERTIES ↔ PERFORMANCE

PROCESSING
General Review

• The subject strength, deformation and fracture of materials can be approached from either of two perspectives:

(a) Engineering Mechanics or Continuum approach
   - Assumes that materials are isotropic and homogeneous
   - Applies mathematical methods, using global parameters to determine stress state and materials response to external forces.
General Review Cont’d. . .

(b) Materials Science or **Microscopic** approach
- Deals with the understanding of the mechanical properties based on the knowledge of the deformation process on the atomic scale.
Tensile Response of Materials
• When subjected to external load, most metals (materials) will in general exhibit the following sequence of responses depending on the magnitude of the applied forces and the material characteristics:

(a) Elastic Deformation
   - Energy is recoverable,
   - Atomic bonds are not broken and
   - Material obeys Hooke’s Law

(b) Plastic Deformation
   - Energy is non-recoverable,
   - Atomic bonds are broken and
   - Hollomon’s equation can be used to describe the $\sigma - \varepsilon$ curve

(c) Fracture -
A typical representation of the $\sigma - \varepsilon$ curve is shown in Figure 1.1
Tensile Test

The objectives include:

• To study the relationship between stress and strain of ductile and brittle materials, when loaded in uniaxial tension.

• To determine several mechanical properties, and these are:
  – Elastic properties
  – Flow or Plastic properties
  – Fracture properties
Figure 1-1(a) Typical engineering stress-strain behavior to fracture, point F. The tensile strength $TS$ is indicated at point M. The circular insets represent the geometry of the deformed specimen at various points along the curve.