# MATERIAL SCIENCE (MEE102B)

## Module: 5
## Economics of Engineering materials

# Introduction

# Introduction

- **Economics** and **engineering** are closely **related**. **Economics** has been defined as the social science of earning a living. **Engineering** may be defined to be physical science applied to helping groups of men to make a better living
- Economics is the social science that describes the factors that determine the production, distribution and consumption of goods and services. Engineering economy is a subset of economics for application to engineering projects. alternatives to accomplish a defined purpose are available

- Engineering economics poses numerous benefits because it allows those in industry to make strategic decisions for their companies. … These are essential for **engineering economics** because they provide the foundation for **engineers** to make good decisions in the business environment.

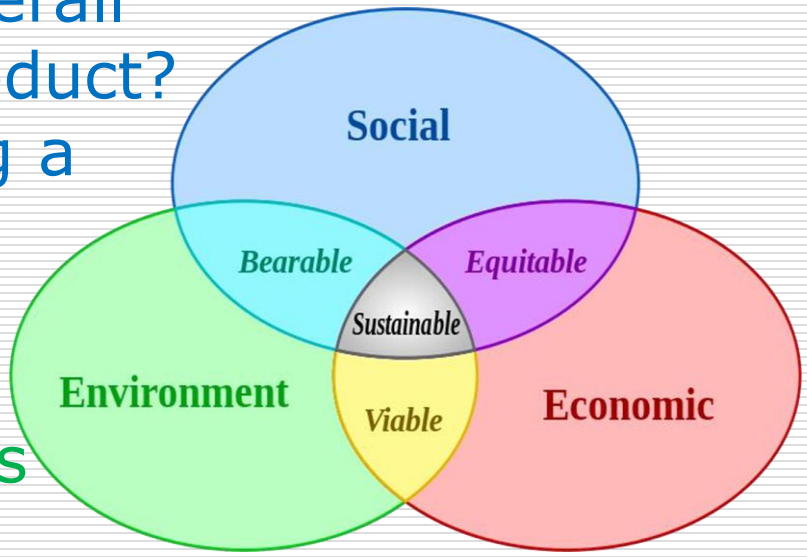
- Understanding the relation between Engineering Materials and Economical factors is of prime importance

# Engineering Material Science: Recap..

- Materials science, also commonly termed materials science and engineering, involves the discovery and design of new materials.
- Material Science is the investigation of the relationship among processing ,structure , properties & performance of materials
- **Materials engineering** is mainly concerned with the use of this fundamental knowledge to design and to produce **materials** with properties that will meet the requirements of society. As subjects of study, **materials** science and **materials engineering** are very often closely related.

# Issues to address..

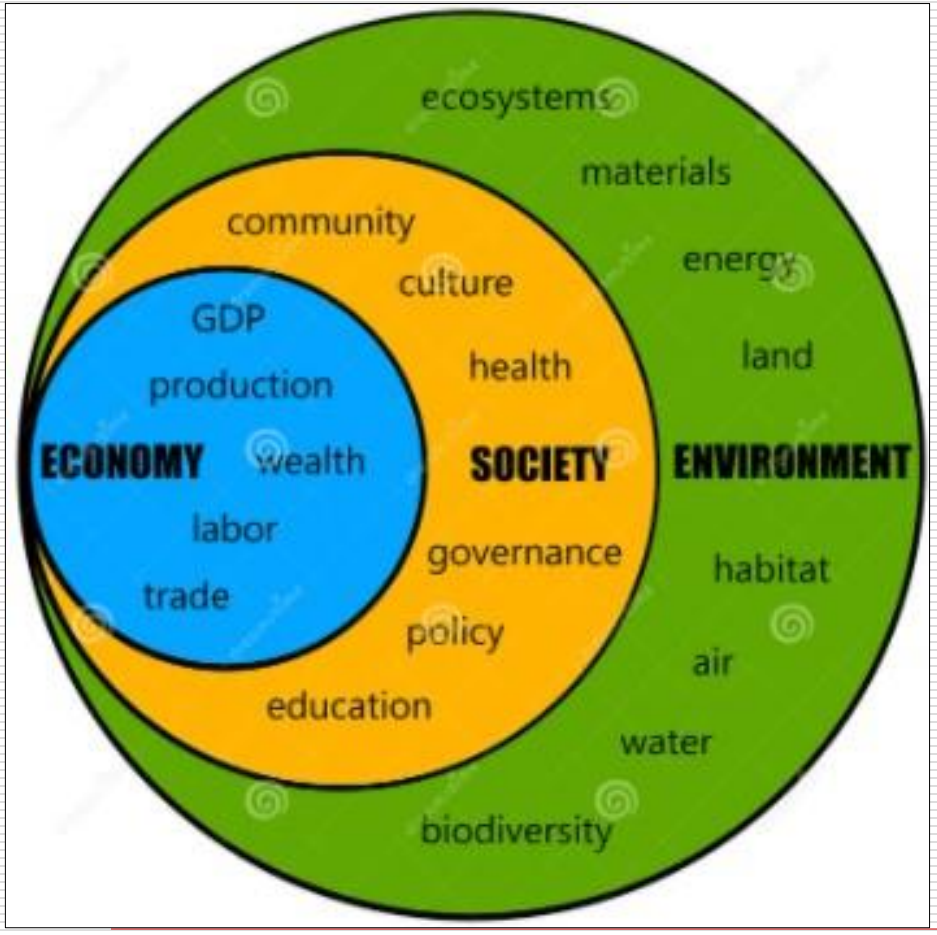
- What factors affect product cost?
- What factors determine the overall environmental impact of a product?
- For which materials is recycling a viable option?
- What is "green design"?
- Economic considerations
- Environmental and social issues
- Recycling issues
- Life cycle analysis and its use in design

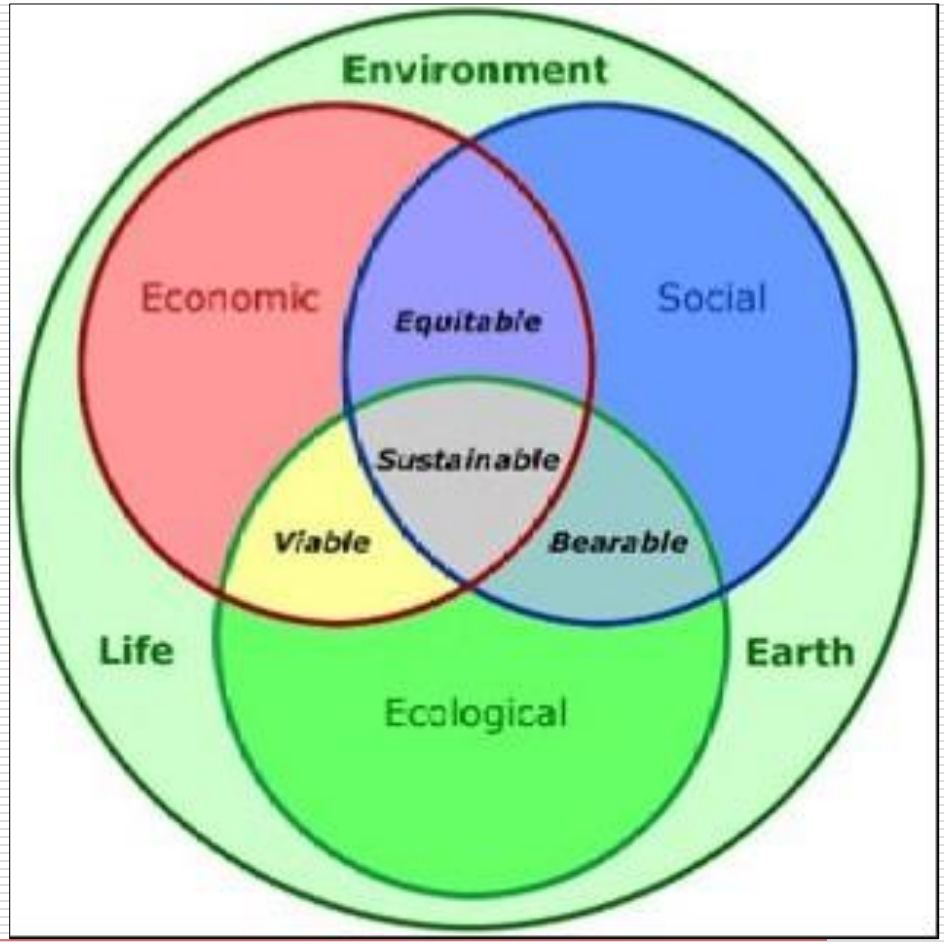


# Sustainability Development Goals (SDGs)



# Considerations in Product Design



# Revising types of Materials for considering impact on Ecosystem

## Metals

- good conductors of electricity and heat
- lustrous appearance
- susceptible to corrosion
- strong, but deformable

## Ceramics & Glasses

- thermally and electrically insulating
- resistant to high temperatures and harsh environments
- hard, but brittle

## Polymers

- very large molecules
- low density, low weight
- maybe extremely flexible







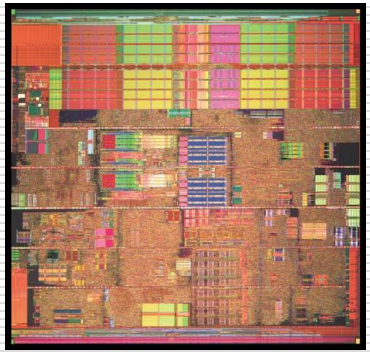

# Revising types of Materials for considering impact on Ecosystem

## Biomaterials

- implanted in human body
- compatible with body tissues

## Semiconductors

- electrical properties between conductors and insulators
- electrical properties can be precisely controlled



## Composites

- consist of more than one material type
- designed to display a combination of properties of each

# Economic Considerations

- Economics of engineering a component / system depends on three factors: component design, material usage, and manufacturing costs.
- All these three factors are inter-related i.e. one or two might influence the choice of others.
- Manufacturing of a component starts from conception, design, material selection.
- Material life starts from extraction, forming into a component, service, and disposal.
- Inspection, packing, and transportation adds onto the increase the cost of a product.

# Environmental Issues

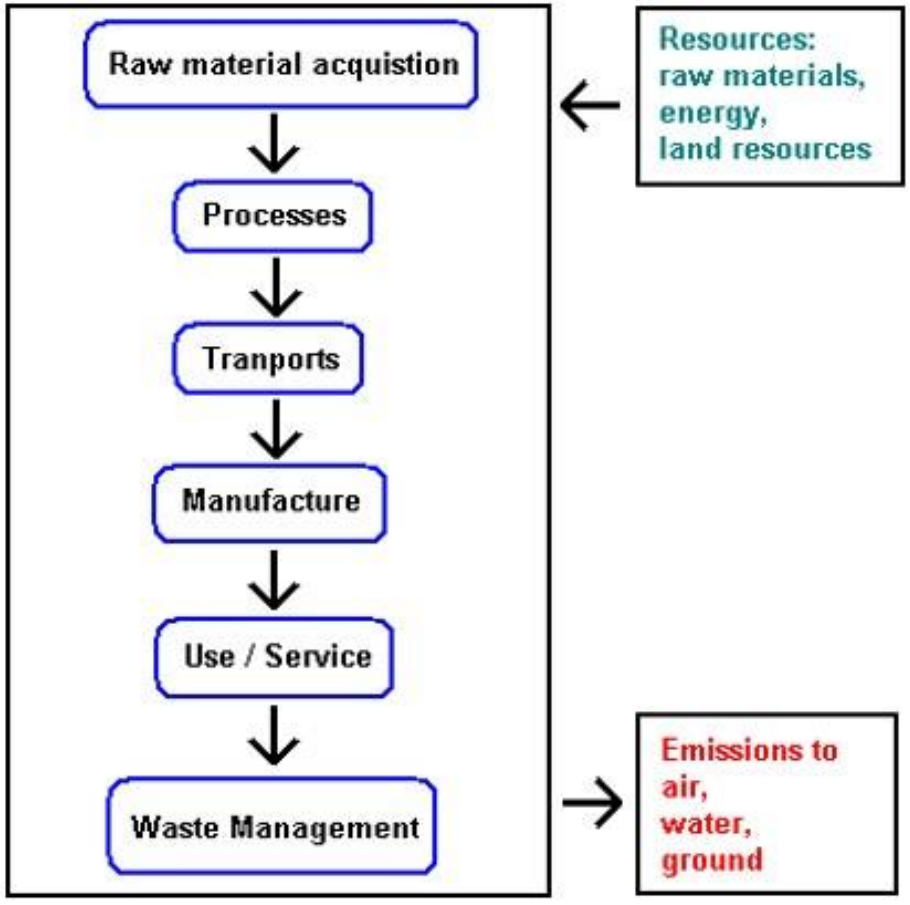
# *Environmental considerations*

- Manufacturing of a product does have impact on environment in many ways.
- This is because resources required to produce a product comes from different parts of the world.
- Along with these, detrimental effects of industrialization also spread its wings to various parts of the world.
- A material used to produce a product goes through number of stages / phases.
- These include extraction of raw materials from natural resources through production, use during the service, and finally its disposal. It is some times known as cradle-to-grave life cycle of a material.

# Social Issues.....?

- **Raw materials and energy** are prime components for manufacturing a product.
- However, they are **limited in nature!**
  Hence, **materials and energy need to conserved.**
- Material life cycle involves interactions and exchanges among materials, energy and the environment including the society.
- Social issues of material usage relates to weather, distribution, and safe waste disposal.
- Products are needed to be designed and manufactured such that they are environmentally friendly, and easy to recycle. In case of disposal into environment, products need to be bio-degradable.

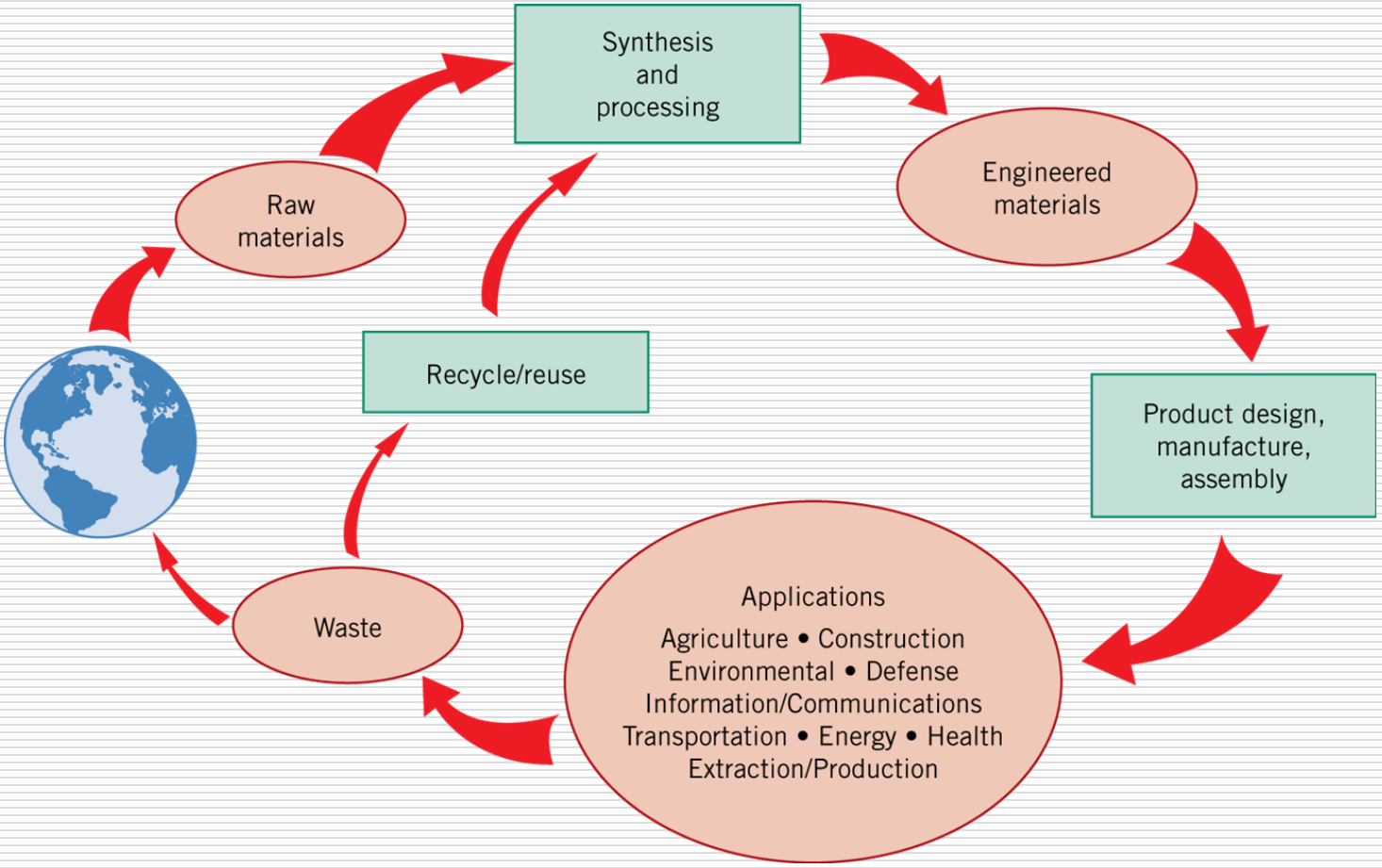
# Life Cycle Model




# Materials Life Cycle

- Raw materials are first extracted from natural earthy resources through drilling, mining, etc.
- Later-on these are subjected to purification, refining to convert them into metals, ceramics, rubber, fuel, etc.
- These primary products are further processed to obtain engineered materials like metallic alloy, glass, plastics, semi-conductors, etc.
- Now the engineered materials are shaped, heat treated to make components which are assembled into products, devices that are ready for use by society.
- During the service, products become **old, out fashioned, break down**, or **may not serve the purpose efficiently**. So they are discarded. This competes the life cycle.

# Total Materials Cycle



# Materials Life Cyle

**Important points for materials engineers to consider:**

-- component design
-- materials selection
-- manufacturing process

Environmental and societal impacts of production are significant engineering design issues

**Life cycle assessment of products involves**

-- extraction
-- synthesis/processing
-- product design/manufacture
-- application
-- disposal

- Recyclability and disposability issues are important in materials science and engineering
- **Ideally, a material should be at best recyclable, and atleast biodegradable or disposable**

# Life Cycle Analysis (LCA)

- Industrial approach to assess the environmental performance of products is termed as life cycle analysis / assessment (LCA).
- The complex interaction between a product and the environment is dealt with in the Life Cycle Assessment (LCA) method. It is also known **Ecobalance.**
- One important reason for undertaking an LCA study is that there are growing concerns about a variety of environmental issues as expressed by public opinion, political bodies, and industry.
- LCA systematically describes and assesses all flows to and from nature, from a cradle to grave perspective.
- LCA is not only product-orientated; it is also quantitative and thus seemingly objective. Thus, it was no longer necessary to reply on simple rules of thumb.

# LCA use in Design

- LCA is a technique for assessing the environmental aspects and potential impacts associated with a product by completing an inventory of relevant inputs and outputs of a product system; evaluating the potential environmental impacts associated with those inputs and outputs;
- Interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.
- With respect to product design, there is a need to understand how a product impacts on the environment.
- To develop truly sustainable products, it must be possible to assess which design solution is environmentally preferable.

# Recycling Issues

- Metals and alloys tend to get corroded up to some extent i.e. bio-degradable. However, some of them are toxic. On the other hand, most metals and alloys are recyclable.
- Ceramics / glasses are, however, are hardly recycled. It is because their raw materials are inexpensive, and recycling process is time consuming and expensive.
- Plastics are mostly recycled, and just disposed through land- fills. Thermo-plastic polymers are easily recycled up on heating to higher temperatures. On the other hand, recycling of thermo-set plastics is much more difficult. Hence these are usually disposed. Thus, there is a trend to use alternative materials which are recyclable. Ex.: thermo-plastic elastomers in place of traditions rubber.

# Green Design

- **Reduce** – redesign the product to use less material

  example: PET bottles with thinner walls.

- **Reuse** – fabricate the product of a material that can reused.

  example: refillable bottles and shipping containers, grind up old tires for use as much as possible.

- **Recycle** – reprocess the material into a new product

  example: convert PET bottles to carpet fibers

- Refuse and Respect

# THANK YOU