

## Unit 5 PRODUCT DESIGN AND DEVELOPMENT

Q.1) List down different methods of economic analysis of product and explain break even analysis.

- Methods of Economic Analysis:
  - Break-Even Analysis
  - Cost-Benefit Analysis
  - Life Cycle Cost Analysis
  - Sensitivity Analysis
  - Payback Period Analysis
  - Return on Investment (ROI) Analysis
  
- Break-Even Analysis: Break-Even Analysis is a way to find out when a product will start making a profit.
- It worked in such a way:
  - Calculate your fixed costs (expenses that stay the same).
  - Calculate your variable costs (expenses that change with production).
  - Calculate your selling price (how much you sell the product for).
  - Use the formula: Break-Even Point (BEP) = Fixed Costs / (Selling Price - Variable Costs)
  - Example
    - ✓ Fixed Costs: Rs1,000
    - ✓ Variable Costs: Rs 5 per unit
    - ✓ Selling Price: Rs 10 per unit
  
    - ✓  $BEA = \text{Rs } 1,000 / (\text{Rs } 10 - \text{Rs } 5)$
    - ✓  $BEA = \text{Rs } 1,000 / \text{Rs } 5$
    - ✓  $BEA = 200 \text{ units}$

Q.2) What is Rapid prototyping? Define and enlist various methods of prototyping.

- Rapid Prototyping is a process of quickly creating a working model or prototype of a product or design.
- This allows for testing, iteration, and refinement before investing in full-scale production.
- Methods of Prototyping:
  - 3D Printing: Creating physical objects from digital designs using layer-by-layer printing.
  - CNC Machining: Using computer-controlled machines to cut and shape materials like metal, wood, or plastic.
  - Computer-Aided Design (CAD): Creating digital prototypes using software, allowing for virtual testing and iteration.
  - Virtual Prototyping: Creating digital prototypes using software, allowing for virtual testing and iteration.
  - Rapid Tooling: Creating molds and tools quickly using 3D printing or CNC machining, allowing for rapid production of prototypes.

**Q.3) Explain Simulation driven design**

- Simulation drawing design is a way to create and test virtual models of products, systems, or processes before building the real thing.
- Steps involved:
  - Create a virtual model: Use computer-aided design (CAD) software or other tools to create a digital model of the product or system.
  - Define the simulation parameters: Set up the conditions for the simulation, such as the environment, materials, and forces involved.
  - Run the simulation: Use specialized software to run the simulation, which can include tests such as stress, motion, or thermal analysis.
  - Analyze the results: Examine the simulation data to see how the product or system performed under the simulated conditions.
  - Refine the design: Use the insights gained from the simulation to make changes and improvements to the design.
- Benefits:
  - Reduced prototyping costs
  - Improved product performance
  - Increased safety

**Q.4) Write on make vs buy decision in product development with example.**

- It refers to an act of using cost benefit to make strategic choice between manufacturing a product in house or purchasing from an external supplier.
- It arises when a producing company pays a dimensioning capacity experience problem with current supplier, or see changing demand.
- Make: Cost of making product in house
  - Production cost.
  - Extra labor cost
  - Monitoring cost.
  - Storage requirement cost.
  - Water product disposal cost.
- Cost of buying products:
  - Product purchase price.
  - Sales tax change.
  - Shipping cost.
  - Inventory holding cost.
  - Ordering cost.
- It used to compare the cost and benefit that a cure by producing a good or service internally against a cost and benefit that results from subcontracting.
- Make or buy decision reward from with competitive advantage and reduce the cost production and capital investment.
- Benefits:
  - Lower cost and higher capital investment.
  - Source of competitive advantage.

**Q.5) Differentiate between product testing ,product validation ,and product verification,**

Parameter.	Product testing	Product validation.	Product verification.
Definition	Process of identifying defect in the product by testing	Ensures the product midday end user need an expectation	Ensure that product has been built as per specific requirement and design.
Focus	Detecting fault and issues in the product functionality.	Checking if the product solves the intended problem.	Checking the compliance with design and technical specification.
Objective.	To identify errors, bugs or defects in product	To confirm the product is useful and meet users need.	To confirm the product was built correctly.
Timing	Performed during and after product development	Perform after product development and testing	Performed during development at various stages.
Question answered	Does the product work correctly?	Does the product meet the user expectation?	Is the product made according to the specification?
Examples.	Functional testing, performance testing, stress testing	User acceptance, testing, field testing,	Designed review inspection, code review,

Q.6) Write a short note on additive manufacturing.

- Additive manufacturing is a modern manufacturing process where objects are created by adding material layer by layer, rather than cutting or shaping material like in traditional methods.
- It is often called 3D printing because it uses digital models to print physical objects.
- Materials like plastic, metal, or ceramics are used in additive manufacturing.
- The process begins with designing the object on a computer using CAD (Computer-Aided Design) software.
- Then, the design is sent to a 3D printer, which builds the object one layer at a time.
- This technology is popular because it allows for creating complex shapes, reduces material waste, and speeds up the development of prototypes and customized products.
- It is used in industries like aerospace, healthcare, automotive, and even in creating tools and household items.
- Advantages:
  - Creating complex shapes and structure that cannot be produced with traditional manufacturing method.
  - Reduce material waste.
  - Enable rapid prototyping and production, reducing lead time and increase productivity.
- Disadvantages:
  - High equipment cost.
  - It is limited to a specific range of materials which can restrict its applications.
  - Its products can be difficult to inspect and quality control due to complex geometry.

Q.7) List down different design simulation technique and explain a new one.

Design Simulation Techniques:

- Finite Element Analysis (FEA)
- Computational Fluid Dynamics (CFD)
- Multibody Dynamics (MBD)
- Thermal Analysis
- Structural Analysis
- Dynamic Simulation
- Kinematic Simulation
- Static Simulation

- Finite Element Analysis (FEA): is a simulation technique used to analyze the behavior of complex systems, such as mechanical structures, under various loads and conditions.
- It worked in such a way:
  - Modeling: create a digital model of a system or structure.
  - Meshing: Divide the model into smaller elements, called finite elements.
  - Analysis: Apply loads and conditions to the model and analyze the behavior of each element.
  - Results: Visualize the results, such as stress, strain, and displacement, to understand the system's behavior.
- Benefits:
  - Reducing prototyping cost.
  - Improved accuracy
  - Increased efficiency.

Q.8) What is production capacity planning? Explain step followed in planning.

- Production capacity planning is the process of determining the maximum amount of products or services that a company can produce within a given period of time.
- Steps Followed in Planning:
  - Identifying the company's production target and objective.
  - Forecast customer demand and analyze historical sales data.
  - Evaluate company's current production capacity, including equipment, labor and materials.
  - Determine constraint at limit production capacity, such as equipment capacity or labor shortage.
  - Create a plan to increase or adjust production capacity to meet demand.
  - Implement the capacity plan and continuously monitor production level adjusting the plan as needed.

Q.9) defined letter of intent, purchase order and product costing in vendor development.

- Letter of Intent (LOI):
  - A Letter of Intent is a non-binding agreement between two parties that outlines the terms of a potential deal.
  - In vendor development, an LOI is often used to express interest in purchasing a product or service and to negotiate terms before signing a formal contract.
- Purchase Order (PO)
  - A Purchase Order is a formal document that outlines the terms of a purchase, including the product or service being purchased, the quantity, price, and delivery terms.
  - In vendor development, a PO is used to place an order with a supplier and to confirm the terms of the purchase.
- Product Costing
  - Product Costing is the process of calculating the total cost of producing a product.
  - In vendor development, product costing involves calculating the cost of materials, labor, overhead, and other expenses associated with producing a product.
  - This information is used to determine the price of the product and to negotiate with suppliers.

Q.10) Why homologation certificate is important in design and development. Explain with example.

- Homologation Certificates
- Homologation certificates are documents that prove a product meets the regulatory requirements of a particular country or region.
- Importance of Homologation Certificates:
  - Ensure Compliance: With local regulations and standards.
  - Reduce Risk: Of product recalls, fines, and legal issues.
  - Increase Market Access: By demonstrating compliance with local regulations.
- Example
- Let's say you design and manufacture electric cars in India, and you want to export them to Europe.
- To sell your cars in Europe, you need to obtain a homologation certificate from the European Union (EU). This certificate confirms that your cars meet EU safety and environmental regulations.
- To get the certificate, you'll need to:

1. Test your cars according to EU regulations.
2. Provide documentation, such as technical specifications and test reports.
3. Obtain certification from a recognized EU testing authority.