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Assignment 1

Intern - Product Design

Questions:-

1) What are different types of plastics?

Answer:-

1) Polyethylene Terephthalate (PET or PETE)

This is a very common kind of plastic. It is lightweight, robust, and usually transparent, and it is frequently used in food packaging and textiles (polyester).

Beverage bottles, food bottles/jars (salad dressing, peanut butter, honey, etc.), and polyester clothes or rope are among examples.

2) High-Density Polyethylene (HDPE)

Polyethylene is the most widely used plastic in the world, but it is divided into three types: high-density, low-density, and linear low-density. High-Density Polyethylene is a robust and chemically resistant polymer that is perfect for cartons, containers, pipes, and other building components.

Milk cartons, detergent bottles, cereal box liners, toys, buckets, park seats, and stiff pipes are among examples.

Medical bags and tubing are a common Polyvinyl Chloride product.

3) Polyvinyl Chloride (PVC or Vinyl)

This strong and stiff plastic is resistant to chemicals and weathering, making it ideal for building and construction applications; yet, because it does not transmit electricity, it is commonly used in high-tech applications such as lines and cable. It's also commonly utilised in medical applications since it's impermeable to germs, easy to clean, and offers single-use applications that help to prevent infections in healthcare. On the other hand, we must remember that PVC is the most hazardous material to human health, since it is known to leach harmful poisons during its whole existence (eg: lead, dioxins, vinyl chloride).

Examples: Plumbing pipes, credit cards, human and pet toys, rain gutters, teething rings, IV fluid bags and medical tubing and oxygen masks.

4) Low-Density Polyethylene (LDPE)

HDPE that is softer, clearer, and more flexible. It is frequently used as a liner within beverage cartons, as well as in corrosion-resistant work surfaces and other items.

Examples: Plastic/cling wrap, sandwich and bread bags, bubble wrap, garbage bags, grocery bags and beverage cups.

5) Polypropylene (PP)

This is one of the most long-lasting forms of plastic. It is more heat resistant than some others, making it perfect for food packing and food storage that is designed to contain hot goods or to be cooked itself. It's flexible enough to bend, yet it holds its shape and strength for a long period.

Examples: Straws, bottle caps, prescription bottles, hot food containers, packaging tape, disposable diapers and DVD/CD boxes (remember those!).

Polystyrene, more commonly known as styrofoam.

6) Polystyrene (PS or Styrofoam)

This stiff plastic, often known as Styrofoam, is low-cost and insulates effectively, making it a standard in the food, packaging, and construction sectors. Polystyrene, like PVC, is regarded as a hazardous material. It is easily capable of leaching dangerous pollutants such as styrene (a neurotoxic), which may subsequently be absorbed by food and consequently consumed by people.

Examples: Cups, takeout food containers, shipping and product packaging, egg cartons, cutlery and building insulation.

7) Other

Examples: Eyeglasses, baby and sports bottles, electronics, CD/DVDs, lighting fixtures and clear plastic cutlery.

2) What is DFM? Why do we need to consider DFM during the design phase?

Answer:-

Design for Production (DFM) is the process of designing parts, components, or products for ease of manufacturing with the end objective of producing a better product at a cheaper cost. This is accomplished through simplifying, optimising, and improving the product design.

We need to consider DFM throughout the design phase because DFM entails efficiently developing or engineering an object, usually at the product design stage, when it is easier and less expensive to do so in order to lower manufacturing costs. This enables a manufacturer to detect and avoid errors or anomalies.

3) List key DFM considerations for plastic part design.

Answer:-

Key DFM Considerations for plastic design part are as follows:-

1. Process
2. Design
3. Material
4. Environment
5. Compliance/Testiing

4) What is GD&T and why is it important?

Answer:-

Geometric Dimensioning and Tolerancing (GD&T) is a design technique and production mechanism that assists engineers and designers in communicating how to bring a part design to life. The drawing is the controlling document that guarantees the vendor is producing exactly what the customer's design wants.

5) What are plastic manufacturing technologies? Explain each in brief

Answer:-

Plastic Manufacturing Technologies are as follows:-

A) Injection moulding:-

Injection moulding is a method of making components by injecting molten material into a mould, or mold. Injection moulding may be done with a variety of materials, the most frequent of which being metals, glassware, elastomers, confections, and thermoplastic and thermosetting polymers.

B) Extrusion:-

Extrusion is a method of producing items with a definite cross-sectional profile by forcing material through a die with the appropriate cross-section.

C) Rotational Molding:-

It involves a heated hollow mould is filled with a charge or shot weight of material for rotational moulding. The mould is then slowly rotated, causing the softened material to distribute and adhere to the mould walls.

D) Plastic Extrusion:-

Plastics extrusion is a high-volume manufacturing method that involves melting raw plastic and forming it into a continuous shape. Pipe/tubing, weatherstripping, fence, deck railings, window frames, plastic films and sheeting, thermoplastic coatings, and wire insulation are all produced through extrusion.

E) Vacuum Forming:-

Vacuum forming is a streamlined version of thermoforming in which a sheet of plastic is heated to a forming temperature, stretched over a single-surface mould, then vacuum-forced against the mould. This method may be used to make permanent things out of plastic, such as turnpike signs and protective coverings.

6) What are different technologies of rapid prototyping?

Answer:-

Rapid prototyping (RP) encompasses a wide range of manufacturing processes, the majority of which rely on layered additive manufacturing. Other RP technologies include **high-speed machining, casting, moulding, and extruding.**

These are some technologies of Rapid Prototyping:-

- Stereolithography (SLA)
- Selective Laser Sintering (SLS)
- Fused Deposition Modeling (FDM)
- Selective Laser Melting (SLM)
- Laminated Object Manufacturing.
- Digital Light Processing.
- Binder Jetting.

7) Can we use the 3D printed parts for functional requirements? Please explain.

Answer:-

3D printing is a versatile process that can be used to create everything from desk trinkets to functional parts that can be sold to **customers**. It would only make sense that the way you approach printing changes depending on what the part will be used for.

With 3D printing, We can **produce functional shapes and requirements**, all while using less material than traditional manufacturing methods.

Manufacturing & Engineering

- Automobiles
- Jewelry
- Onshoring
- Spare & Replacements Parts
- Aerospace
- Glasses and Eyewear
- Shoes
- Fashion and Smart Clothing (On the Horizon)
- Dentistry
- Surgery

8) What is ingress protection? What makes the enclosures ingress protective?

Answer:-

Ingress protection ratings or IP ratings, refer to the level of protection offered by an electrical enclosure, against solids and liquids. It is defined in IEC standard 60529 which classifies and rates the degree of protection provided by mechanical casings and electrical enclosures against intrusion, dust, accidental contact, and water. It is published by the International Electrotechnical Commission.

The following Reasons makes the Enclosures Ingress Protective:-

Ingress protection ratings or IP ratings, refer to the level of protection offered by **an electrical enclosure**, against solids and liquids. In an environment where dust or water could damage electronic components, a sealed enclosure is used to prevent such ingress and safe house the electronics.

Ingress Protection Classification			
First Number		Second Number	
IP	Protection Provided	IP	Protection Provided
0	No Protection	0	No Protection
1	Protected against solid objects up to 50mm e.g. accidental touch by hands	1	Protected against vertically falling drops of water e.g. condensation
2	Protected against solid objects up to 12mm e.g. fingers	2	Protected against direct sprays of water up to 15 degrees from the vertical
3	Protected against solid objects over 2.5mm e.g. tools	3	Protected against direct sprays of water up to 60 degrees from the vertical
4	Protected against solid objects over 1mm e.g. wires	4	Protected against water sprayed from all directions - limited ingress permitted
5	Protected against dust - limited ingress (no harmful deposit)	5	Protected against low pressure jets of water from all directions - limited ingress permitted
6	Totally protected against dust	6	Protected against strong jets of water e.g. for use on ship decks - limited ingress permitted
		7	Protected against the effects of immersion between 15cm and 1m
[illegible]		8	Protected against long periods of immersion under pressure

9) What is the difference between design and simulation?

Answer:-

- A model is a physical or digital object that represents a system of interest. A model is comparable to but simpler than the system it depicts, while attempting to approximate as closely as feasible the majority of the same prominent aspects of the genuine system. A excellent model strikes a careful balance between realism and simplicity. Manipulation is an essential characteristic of a model. A model can be physical (such as a physical architectural home scale model, a model aircraft, a fashion mannequin, or a model organism in biology research) or intellectual (such as a computer model, a statistical or mathematical model, or a business model).
- **Modeling** is the act of building a model.
- A **Simulation** is the process of studying the behaviour and performance of a real or theoretical system using a model. Models can be used in simulations to investigate current or projected system features. A simulation's objective is to investigate the properties of a real-life or fictional system by altering variables that cannot be manipulated in a real system. Simulations enable the evaluation of a model in order to optimise system performance or to generate predictions about a real-world system. Simulations can be used to investigate features of a model of a real-world system that would otherwise be too difficult, too large/small, too fast/slow, inaccessible, too risky, or inappropriate to participate in.
- Simulating is the act of using a model for a simulation.

10) Write the stepwise procedure for FEA simulation. Assume whatever is necessary

Answer:-

- Step 1 – The component.
  - Establish the FE mesh with set coordinates, element numbers and node numbers
  - The discretized FE model must be situated with a coordinate system
  - Elements and nodes in the discretized FE model need to be identified by “element numbers” and “nodal numbers.”
  - Nodes are identified by the assigned node numbers and their corresponding coordinates
- Step 2 – The loads.
  - Primary unknown quantity - The first and principal unknown quantity to be obtained by the FEM
  - Eg: Stress analysis: Displacement {u} at nodes

- In stress analysis, The primary unknowns are nodal displacements, but secondary unknown quantities include: strains in elements can be obtained by the "strain-displacement relations," and the unknown stresses in the elements by the stress-strain relations (the Hooke's law).

- Step 3 – Boundary conditions.
  - Interpolation function is called "shape function in some literatures
  - There are different forms of interpolation functions used in FEM. The elements using the linear interpolation functions are called "Simplex elements" are the simplest form and the most commonly used in FE formulation.

- Step 4 – Modelling issues and assumptions
  - The element equation relates the induced primary unknown quantity in the analysis with the action. Eg. In a structural stress analysis, Force {F} is the action, Displacement {u} at nodes is the primary unknown and Stresses {σ}& Strains {ε} are secondary unknown.
  - These are the generally two methods used to derive the element equations:
    - The Rayleigh-Ritz method, and
    - The Galerkin method

- Step 5 – Building and solving the FEA model.
  - This step assembles all individual element equations derived in Step 4 to provide the "Stiffness equations" for the entire medium.
  - Mathematically, this equation has the form, [K]{q} = {R} where [K} is overall stiffness matrix.

- Step 6 – Post-processing the FEA model.
  - Use the inverse matrix method to solve the primary unknown quantities {q} at all the nodes from the overall stiffness equations. {q} = [K]-1{R}
  - Else, use the Gaussian elimination method or its derivatives to solve nodal quantities {q} from the equation: [K]{q} = {R}

- Step 7 – Post testing and verification.

Solve for secondary unknowns.
Display and Interpretation of Results
Tabulation of results
Graphic displays: (1) Static with contours. (2) Animations