FASAL

Name – Om Adikrao More

Reg. No. –18BME0410

College – Vellore Institute of Technology

Assignment 1

Q1: What are different types of plastics?

The plastic is mainly categorized in 6 types.

- Polyethylene Terephthalate
- High-Density Polyethylene
- Polyvinyl Chloride
- Low-Density Polyethylene
- Polypropylene
- Polystyrene

There are also some recent researches in the field of plastic, compounds like Bisphenol A which doesn't come in this category are also been under use in applications like Sun glasses.

- **PET**

  Plastics that belong to group number one are made out of polyethylene terephthalate or PET. It holds the number one spot because of its widespread utility. It is mostly used for food and drink packaging purposes due to its strong ability to prevent oxygen from getting in and spoiling the product inside.

  It's usually picked up through most curbside recycling programs and has a tremendously positive track record! In fact, PET bottles are the most widely recycled plastic in the world!

- **HDPE**

  Technical name - High-Density Polyethylene – it's an incredible resistant resin used for grocery bags, milk jugs, recycling bins, agricultural pipe, but also playground equipment, lids, and shampoo bottles among others. Because it's made with long unbranched polymer chains it's much stronger and thicker than PET. Also, it is relatively hard and resistant to impact and can be subjected to temperatures of up to 120 °C without being affected. As far as its disposal is concerned, HDPE is accepted at most recycling centers in the world, as it is one of the easiest plastic polymers to recycle.

- **PVC**

  Polyvinyl chloride is the world's third-most widely produced synthetic plastic polymer. It comes in two basic forms: rigid and flexible. In its rigid form, PVC is largely used in the building and construction industry to produce door and window profiles and pipes (drinking and wastewater). When mixed with other substances, It can be made softer and more flexible and applied to plumbing, wiring, and electrical cable insulation and flooring.

- **LDPE**

  Contrary to HDPE, LDPE is characterized by low-density molecules, giving this resin a thinner and more flexible design. It has the simplest structure of all the plastics, making it easy and cheap to produce. Used in plastic bags, six-pack rings, various containers, dispensing bottles, and most famously for plastic wraps, is not often recycled through curbside programs.

- **PP**

  Polypropylene is the second-most widely produced commodity plastic and its market is forecasted to grow even more in the following years. Hard and sturdy, it can withstand high temperatures and is found in tupperwares, car parts, thermal vests, yogurt containers, and even disposable diapers.

  Fun fact: because it is VERY resistant to fatigue, PP is usually used for living hinges (the thin piece of plastic that allows a part of a product to fold or bend from 1 to 180 degrees).

- **PS**

  Polystyrene is the sixth type of plastic on the list and it can be solid or foamed. It is a very inexpensive resin per unit weight and easy to create, for these reasons it can be found everywhere: from beverage cups, insulation, packing materials to egg cartons and disposable dinnerware. Perhaps better known by its commercial name – Styrofoam – it’s highly inflammable and dangerous as it can leach harmful chemicals, especially when heated (which often happens because, as it’s found in disposable take-out containers, people oftentimes microwave it to heat up the food inside it).

Q2: What is DFM? Why do we need to consider DFM during the design phase?

Design for manufacturing (DFM) is important because it's about creating the process for the product as much as the product itself. The design impacts every single part of production, from costs to timing to eventual customer satisfaction. Any creator who wants to bring a new product to market needs to partner with a company that has a DFM focus.

A poor design can create a domino effect that makes it impossible to manage even the smallest of production runs. Without considering manufacturing in design, the producer opens themselves up to a lot of mistakes, which could have been

The purpose is to choose the right material, right surface treatment, right quality level, and the right construction.
By looking at these variables, the product development team can develop the optimal manufacturing process (Yang and El-Haik, 2008). The Design for Manufacturing methodology should also evaluate the feasibility and cost of manufacturing the product. When working with Design for Manufacturing , designers usually selects processes and materials based on their own experiences. This could make the product unnecessary expensive. Quality Function Deployment (QFD)and Computer-Aided Design(CAD)are helpful tools that will ease the design process. It is important that the designers and engineers have detailed knowledge about up – to - date available manufacturing processes and materials so that they can make the right decisions.

A dire need to consider them during design phase is due to following reasons-

1. It simplifies the design and reduce the number of parts because for each part, there is an opportunity for a defective part and an assembly error. The probability of a perfect product goes down exponentially as the number of parts increases.
2. To Standardize and use common parts and materials to facilitate design activities, to minimize the amount of inventory in the system, and to standardize handling and assembly operations.
3. For Design for ease of fabrication. Select processes compatible with the materials and production volumes.
4. Design within process capabilities and avoid unneeded surface finish requirements

Q3: List key DFM considerations for plastic part design.

Design for Manufacturing (DFM) describes the process of designing or engineering a product to reduce its manufacturing costs, allowing potential problems to be fixed in the design phase which is the least expensive place to address them.

1. **Considering Material Shrink Rate**

   Shrinkage is the contraction of the molded part as it cools after injection. All materials have different shrink rates depending on resin family (amorphous vs. crystalline materials), mold design, and processing conditions. Resin may also shrink differently depending on direction of flow.

2. **Draft**

   How features of a part are formed in a mold determines the type of draft needed. Features formed by blind holes or pockets (such as most bosses, ribs, and posts) should taper thinner as they extend into the mold.

3. **Uniform Wall Thickness**

   Uniform wall thickness throughout a part (if possible) is essential to avoid thick sections. Designing non-uniform walls can lead to warping of the part as the melted material cools down.

4. **Radii to Edges**

   In addition to main areas of a part, uniform wall thickness is a crucial design element when it comes to edges and corners. Adding generous radii to rounded corners will provide many advantages to the design of a plastic part including less stress concentration and a greater ability for the material to flow.

5. **Ribs**

   The advantage of using ribs is that they increase the strength of a part without increasing the thickness of its walls.

6. **Draft Angle**

   How features of a part are formed in a mold determines the type of draft needed. Features formed by blind holes or pockets (such as most bosses, ribs, and posts) should taper thinner as they extend into the mold.

7. **Finishing**

   Surface finish options for plastic injection molded parts vary depending on part design and the chemical make-up of the material used.

Q4: What is GD&T and why is it important?

Geometric dimensioning and tolerancing, often referred to as GD&T, is a symbolic language used on engineering drawings and models to define the allowable deviation of feature geometry. The language of GD&T consists of dimensions, tolerances, symbols, definitions, rules, and conventions that can be used to precisely communicate the functional requirements for the location, orientation, size, and form of each feature of the design model. Thus, GD&T is an exact language that enables designers to "say what they mean" with regard to their design models. Production can then use the language to understand the design intent and inspection looks to the language to determine set up requirements.

Importance of GD&T

- Saving Money — GD&T enhances design accuracy by allowing for appropriate tolerances that maximize production. For many projects, the process provides extra or bonus tolerances, further increasing cost effectiveness.
- Ensuring Dimensional and Tolerance Requirements — By explicitly stating all design requirements, a thorough GD&T process guarantees accurate fulfillment of all dimensional and tolerance specifications.
- Assisting Digital Design Methods — Clear, concise GD&T data is readily adaptable to digital design programs, including nearly universally used 2D and 3D CAD files.
- Offering Uniformity and Convenience — As a single, consistent language, GD&T reduces guesswork and interpretation while ensuring consistent geometries across design and manufacturing.
- Providing Accurate Communication — Today's intricate designs demand the most accurate and reliable communication. GD&T enables designers, manufacturers, and inspectors to communicate clearly with one other, saving time and making the process more efficient.

Q5: What are plastic manufacturing technologies? Explain each in brief?
3D Printing

3D printers create three-dimensional parts directly from CAD models by building material layer by layer until a complete physical part is formed.
It involves 3 major steps-
1. Print setup
2. Printing
3. Post Processing

- **CNC Machining**
  CNC machining includes mills, lathes, and other computer-controlled subtractive processes. These processes start with solid blocks, bars, or rods of metal, or plastic that are shaped by removing material through cutting, boring, drilling, and grinding.

- **Polymer Casting**
  In polymer casting, a reactive liquid resin or rubber fills a mold which reacts chemically and solidifies. Typical polymers for casting include polyurethane, epoxy, silicone, and acrylic.

- **Rotational Molding**
  Rotational molding (also called rotomolding) is a process that involves heating a hollow mold filled with powdered thermoplastic and rotated around two axes to produce mainly large hollow objects. Processes for rotomolding thermoset plastics are available as well, however less common.

- **Vacuum Forming**
  Vacuum forming is a manufacturing method where a plastic is heated and formed, typically using a mold. Vacuum forming machines vary in size and complexity from low-cost desktop devices to automated industrial machinery.

- **Injection Molding**
  Injection molding (IM) works by injecting molten thermoplastic into a mold. It is the most widely used process for mass manufacturing of plastic parts.

- **Extrusion**
  Extrusion molding works by pushing plastic through a die. The shape of the die is a cross-section of the final part.

- **Blow Molding**
  Blow molding is a manufacturing technique used to create hollow plastic parts by inflating a heated plastic tube inside a mold until it forms into the desired shape.

Q6: What are different technologies of rapid prototyping?

Yes , there are many technologies that helps the rapid prototyping. Categorically they are hardware setup which makes the data of CAD into actual 3D figure. There are 7 known technologies

Stereolithography (SLA)

Stereolithography is one of the oldest and most popular commercial 3D printing methods in the industry. This process uses UV light to convert photosensitive liquid into 3D solid plastics. These layers are derived from two-dimensional cross sections of the 3D CAD model and controlled with a software file format called .stl.

Selective Laser Sintering (SLS)

SLS is an additive manufacturing method that uses a high-power laser to fuse powdered thermoplastics into parts. These parts are formed on a build plate one layer at a time. Because the support is surrounded on all sides of the powder media, additional structures are not needed

Fused Deposition Modeling (FDM)

FDM printers use a thermoplastic filament to create 3D objects. The filament is then melted inside the barrel of a printing nozzle. Once it becomes hot liquid resin, it is laid down layer-by-layer. Before an object can be printed, it has to be converted into a format the 3D printer can comprehend, which is typically an .STL format.

Selective Laser Melting (SLM)

Another form of powder bed fusion, SLM is an industrial process that requires carefully controlled conditions. This approach utilizes a high-power laser to melt and fuse metallic powders. Common metal powders may include titanium, stainless steel, maraging steel and cobalt chrom

Laminated Object Manufacturing

In LOM, materials like plastic, paper or metal are laid out across a build platform by a system of feed rollers. With each layer, a computer-controlled laser or other cutting device traces out the pattern. The build platform then drops by one-sixteenth of an inch, which is the typical thickness of one layer, and a new laminate is glued on top and the process continues.

Binder Jetting

A relatively new rapid prototyping 3D printing process, binder jetting printing systems offer larger build volumes than many other power bed technologies on the market. Over a horizontal print bed covered in metal powder, hundreds of nozzles spray micro-fine droplets of a liquid binder to form a single layer. This layer is then compacted with a roller, re-coated with powder and then sprayed for the next layer.

Digital Light Processing

This type of technology is comparable to SLA printing. It cures the resin with a more conventional light source but also requires support structures and post-build curing.The approach is generally faster and a more shallow reservoir of photoresin can be used, which also cuts down on costs.

Q7: Can we use the 3D printed parts for functional requirements? Please explain.

Yes, 3d printed parts can be used for functional applications. For example, aerospace functional parts are also 3d printed and used in aircraft. A few examples of parts that can be produced with 3D printing include air ducts (SLS), wall panels (FDM) and even structural metal components (DMLS, EBM, DED). For industries like aerospace and defence, where highly complex parts are produced in low volumes, 3D printing is ideal. Using the technology, complex geometries can be created without having to invest in expensive tooling equipment. This offers aerospace OEMs and suppliers a cost-effective way to produce small batches of parts cost-effectively. 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.

Q8: What is ingress protection? What makes the enclosures ingress protective?

Ingress Protection rating (or just IP rating), is an international standard (IEC 60529) used to rate the degree of protection or sealing effectiveness in electrical enclosures against intrusion of objects, water, dust or accidental contact. The degree to which the electrical equipment prevents the entry, i.e. ingress, of liquids and solids is known as its ingress protection rating. If a liquid and/or solid particle enters into electrical equipment it may not only be harmful to the equipment, it may also be dangerous to the operator.

The first digit following the IP indicates the level of protection of enclosed equipment against ingress of solid foreign objects, and against people accessing hazardous parts such as electric conductors.

The second digit following IP in the code rating shows the level of equipment protection inside the enclosure against water ingress.

Q9: What is the difference between design and simulation?

Design: Design modelling is creating a model which represents an object or system with its all or subset of properties. A model may be exactly the same as the original system or sometimes approximations make it deviates from the real system.

Simulation: Simulation is a technique of studying and analyzing the behaviour of a real world or an imaginary system by mimicking it on a computer application. A simulation is works on a mathematical model that describes the system. In a simulation, one or more variable of the mathematical model is changed and resulted changes in other variables are observed. Simulations enable users to predict the behaviour of the real world system.

Q10: 10. Write the stepwise procedure for FEA simulation. Assume whatever is necessary.

Stepwise procedure for FEA simulation:

S1: Modelling

The part is modelled omitting complicated geometrical features. This is the first and the most crucial step in any analysis.

S2: Material definition

The material properties are defined in this step. These material properties depend on the type of analysis that needs to be carried out.

S3: Loads applied

This step is about the definition of external forces acting on the part or the body force by virtue of the weight of the component.

S4: Boundary conditions

This step is mainly done to reduce the complexity of the problem from an engineering sense.

S5: Meshing

The geometry is divided into smaller and simpler shapes called as finite elements.

S6: Solution

Discretization of the problem equations into solvable matrices which are solved by solver for unknown variables.

S7: Post-processing

Solved results are presented in form of contour plots and graphs.