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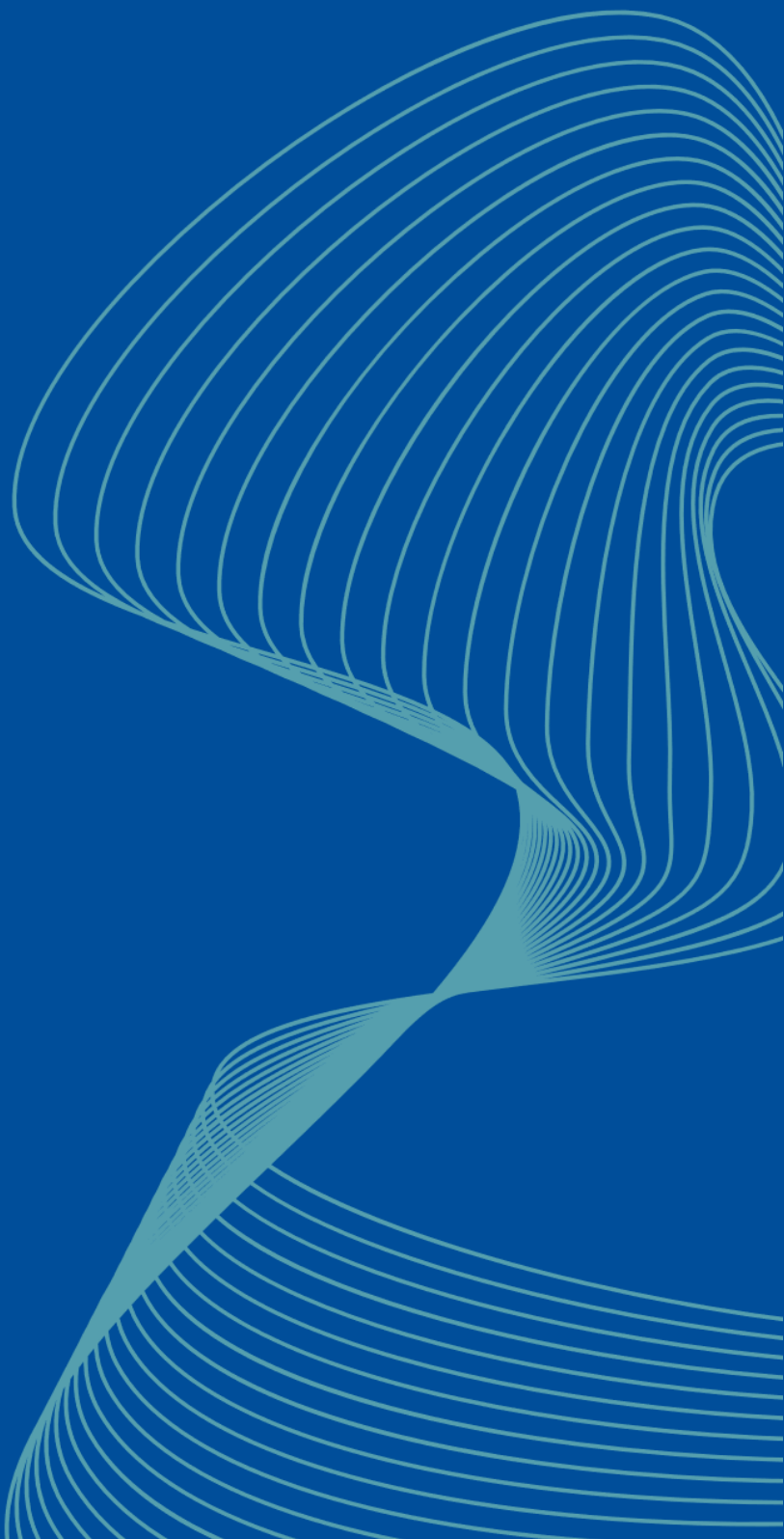
DECEMBER 2024

DESIGN ENGINEERING



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REFERENCES

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NOTE

ANY 14 MARKS QUESTIONS FROM EACH MODULE CAN BE WRITTEN IN SAME FORMAT AS GIVEN, ADD AS MANY POINTS U CAN AND INCLUDE DIAGRAMS

MODULE 1

3 MARK QUESTIONS

1. Differentiate between conceptual design and detailed design.

Conceptual design	Detailed design
1. Focuses on overall framework and feasibility.	1. Focuses on precise technical specifications
2. Provides approximate dimensions, shapes, and materials.	2. Provides exact dimensions, reinforcement details, and material grades.
3. basic questions of form and content for a design are established	3. specific details particular to the design are resolved.

2. Explain the design objective of _____ ?
3. List out three methods to select the best concept from many at the initial stage of design?
    - Compares multiple design concepts against a set of predefined criteria.
    - Identify the **Strengths**, **Weaknesses**, **Opportunities**, and **Threats** of each concept.
    - Breaks down the decision problem into a hierarchy of goals, criteria, and alternatives.
4. Define engineering design?

    Engineering design is a systematic, intelligent process in which engineers generate, evaluate, and specify solutions for devices, systems,
    or processes whose form(s) and function(s) achieve clients' objectives
    and users' needs while satisfying a specified set of constraints.

    In other words, engineering design is a thoughtful process for generating plans or schemes for devices, systems, or processes that attain given objectives while adhering to specified constraints.

5. What is the importance of systematic design.
    a. Ensures structured approach.

b. Improves problem understanding.
c. Enhances creativity.
d. Supports decision making.

6. What are the basic vocabularies in engineering design?

• Accuracy: The quality of being near to the true or desired value
• Analysis: Breaking an object or process into smaller parts to examine or evaluate systematically
• Argument: A persuasive defence for an explanation or solution based on evidence and reasoning
• Assessment: An evaluation of the cost, quality and/or ability of someone or something
• Causation: The relationship between cause and effect
• Claim: A response made to a question and in the process of answering that question
• Communicate: To share information orally, in written form and/or graphically through various forms of media

7. How to identify the customer requirements of design?

a. By conducting surveys and questionnaire.
b. By analysing user behaviour.
c. Analysis of existing products.
d. Market research.

8. Describe any three constraints that can occur in design process of a lunch box?

a. Material constraints: Selection of materials must balance cost, durability, safety, and thermal performance.
b. Functional constraints: The design must meet practical usability requirements.
c. Cost constraints: The lunch box must be affordable to manufacture and purchase while meeting quality expectations.

9. Define design objectives to be considered in the design of a table lamp?

a. Functionality: Provide adequate and adjustable lighting for various tasks such as reading, studying, or decorative purposes.
b. Aesthetics: Enhance the visual appeal of the space where it is used.
c. Ergonomics: ensure ease of use and comfort of user.
d. It must be durable .

10. Explain the three objectives in the design of a glass bottle for Ayurvedic medicine.

a. Ensure the bottle preserves the medicinal properties of the Ayurvedic formulation over time.
b. Make the bottle easy to handle and use for consumers and practitioners.
c. Reflect the authenticity and quality of Ayurvedic medicine while appealing to consumers.

14 mark problem

Q. Show the designing of a _____, going through the various stages of the design process. Use hand sketches to illustrate the processes?

Reference: wrist watch

Step 1: Identify the need / problem and constraints

Needs/problem

- to check the time whenever we want
- should be able to carry on wrist all the time
- simple and minimum weight
- must be wrapped around your wrist all the time
- should be able to check current date and day

Step 2 : Setting objectives

- Provide accurate and reliable timekeeping while offering additional features as required.
- Ensure the watch is comfortable to wear for extended periods.
- Ensure the watch can withstand daily wear and environmental factors.
- Create an attractive design that aligns with the target audience's preferences.
- Provide a balance between affordability and quality.

Step 3: Constraints

- must be small size that can fit in the wrist
- time needle must be small but visible

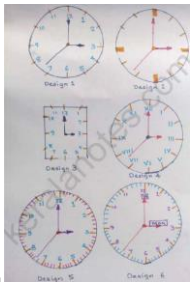
- date and day must be included
- sweat, water and corrosion resistant
- strap must be made of leather

Step 4: Establishing functions

- it should display time accurately
- it should be cell, battery or solar powered
- it should have a strap or a chain
- it should be light weight

Step 5: Generating design alternatives

- Modes:
  - ❖ Analogue
  - ❖ Digital
  - ❖ Smart watches
- Strap :
  - ❖ Chain
  - ❖ Leather
  - ❖ Rubber
  - ❖ Silicon
- Colour
  - ❖ Silver
  - ❖ Gold
  - ❖ Black
  - ❖ Brown
- Shapes of dial
  - ❖ Hexagonal
  - ❖ Square
  - ❖ Circular
- Number pattern etc….



Step 6: Choosing best design

In the above designs of analogue watches, Design 6 can be considered as best as it uses number system 1,2 ... 12 which is understood for common people. It has detailed minutes and seconds mapping of time. It
shows the current date and day. It has all the three needles like second , minute, hour

Module 2

3 MARK QUESTIONS

1. Explain the importance of Empathize stage in the design thinking process with examples?

   RESEARCH YOUR USERS NEED

   Observe

   • How users interact with their environment.

   • Capture quotes, behaviours and other notes that reflect their experience.

   • Notice what they think, feel, need

   Engage

   • Interviews scheduled or ad-hoc

   • Learn how to ask the right questions

   Example: **Designing a Smartwatch for Elderly Users**

   It should have health tracking

   Heartbeat monitors etc.

2. Explain the role of mathematics and physics in the Engineering design process?

   a. Role of mathematics in design engineering
      1. Modelling and simulation
      2. Optimisations
      3. Structural analysis
      4. Data analysis

   b. Role of physics
      1. Material science
      2. Thermodynamics
      3. Working mechanics

3. Differentiate conventional thinking and creative thinking?

Aspect	Conventional Thinking	Creative Thinking
Approach to Problem-Solving	Follows **established methods** and **norms**.	Encourages **out-of-the-box** and **innovative** approaches.

Aspect	Conventional Thinking	Creative Thinking
Process	**Linear** and step-by-step, often using existing solutions.	**Non-linear** and flexible, focusing on exploration and new ideas.
Risk-Taking	**Avoids risk** by sticking to known methods.	**Embraces risk** and uncertainty, willing to experiment with new ideas.
Innovation	**Incremental** improvement, based on past experiences.	**Disruptive** innovation, creating new, original solutions.
Focus	Focuses on **efficiency** and **predictability**.	Focuses on **novelty**, **originality**, and breaking conventional boundaries.
Reliability	Aims for **consistent** and **stable** outcomes.	Tolerates **failure** as part of the process of discovery.
Suitability	Best for **routine** and **standardized** tasks.	Best for tackling **complex**, **undefined**, or **new** challenges.

4. List the techniques to improve the thinking process in a design team?

a. Brainstorming: A group technique where team members freely generate ideas without judgment or criticism. The goal is to encourage creativity and come up with as many ideas as possible.

b. Mind mapping: A visual tool to organize thoughts, ideas, and concepts around a central theme. It helps in breaking down complex problems and finding connections between ideas.

c. Reverse thinking: A technique where the team looks at a problem from the opposite perspective, such as asking, "What would make this design fail?" or "How can we make it worse?"

5. what are the most popular techniques used in convergent thinking?

a. Cost benefit analysis
b. Feasibility study
c. Prototyping and testing

6. Describe three steps to facilitate design thinking in your team.

a. **Empathise** : The first step in Design Thinking is to understand the needs, challenges, and experiences of the end-users or stakeholders. This step involves conducting user research to gather insights about their behaviours, pain points, and desires. It could include activities such as interviews, surveys, observations, or immersion experiences.
b. **Ideate** : Once the problem is well understood, the next step is to brainstorm and generate a wide range of ideas. This step encourages divergent thinking, where the team explores many possibilities without judgment. The goal is to generate creative, innovative, and diverse solutions before narrowing them down.
c. **Prototype and test** : Prototyping involves building simple, tangible representations of ideas. These can be low-fidelity (e.g., sketches, models) or high-fidelity (e.g., functional prototypes).

7. How can a design be communicated through engineering sketches and drawings?

- **Quick Visualization**: Engineering sketches are often used to capture initial ideas and concepts. They allow engineers and designers to quickly visualize a design without the need for detailed drawings.
    - **Hand-drawn sketches**: These are fast and flexible tools for brainstorming. They are ideal for conveying rough concepts, layouts, and configurations in a way that stimulates discussion and refinement.
    - **Perspective drawings**: Sketches that show the design in 3D, offering a sense of depth and spatial relationships, which can help others see how components fit together.
- **How It Helps**:
    - Provides a fast, flexible way to explore and communicate ideas.
    - Allows for quick iteration and modification.
    - Stimulates creativity and dialogue among team members.

8. Explain how conflict in team environment helps in better design of products?

a) Conflict often arises from differing viewpoints, backgrounds, and expertise. These differences, if approached positively, can lead to more creative and innovative solutions.
b) Conflict often arises when team members spot potential flaws or risks in a design concept that others may overlook or assume are solved.
c) A healthy conflict encourages debate, where ideas are tested and scrutinized. This critical evaluation helps refine designs to make them more robust and viable

14 MARK QUESTION

REFERENCE: SCHOOL BAG

Q: Explain the design thinking process of designing school bag?

DESIGN THINKING ITERATIVE APPROACH CASE STUDY – BAG FOR COLLEGE STUDENTS

Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

Solution:

Objective: To design a bag for college students in limited budget.

1. Empathize

[1] It should have a facility to carry books, tiffin and other small articles.
[2] It should be closed.

2. Define

[1] It should have separate racks for keeping books and tiffin
[2] It should have zips to lock.
[3] It should be light weight with sleek design.

3. Ideate

[1] It should have separate racks for keeping books and tiffin
[2] It should have zips to lock.
[3] It should be light weight with sleek design.
[4] It should have a compartment to keep the laptop.
[5] It should have a compartment on the outer side to keep water bottles.
[6] It should have a small pouch on the outside to keep necessary things like pen, keys, chargers etc.
[7] The shoulder strap should be of soft material.
[8] It should be waterproof so that it can be used in rainy season too.
[9] It should have an inner secret pouch to keep money or any other important thing.

4. Prototype

The 2D prototype is shown on the right.

5. Test

Ensure that all the expected functionalities are incorporated in the product. The above prototype has separate racks for keeping books and laptop. It has a water bottle holder. The shoulder strap is made of soft sponge material. The material used is waterproof polyester. It is light weight and has sleek design.

MODULE 3

MARKS QUESTION

1) Enumerate any six points to be considered while preparing a presentation?
   a) A title slide : that identifies the client(s), the project, and the design team or
   b) organization responsible for the work being presented. This slide should include company logos.
   c) A roadmap : for the presentation that shows the audience the direction that the
   d) presentation will take. This can take the form of an outline, a flowchart, a big picture slide, and so on.
   e) A problem statement: which includes highlights of the revised problem statement that the team produced after research and consultation with the client.
   f) Background material on the problem: including relevant prior work and other materials developed through team research. References should be included but may be placed in a slide at the end of the presentation.
   g) The key objectives of the client and users : as reflected in the top level or two of the objectives tree.
   h) The key constraints that the design must meet.

2) What is visual communication in design?

   Visual communication in design engineering refers to the use of visual elements—such as images, diagrams, sketches, drawings, charts, symbols, and other graphical representations—to convey information, ideas, or concepts related to the design process.

   It plays a critical role in bridging the gap between abstract ideas and their real-world application, helping engineers, designers, and stakeholders understand and interpret complex technical information efficiently.

3) Why prototyping is important in the design process ?
   a) Prototyping is a critical aspect of the design process in **design engineering** because it allows designers and engineers to translate abstract concepts into tangible models or working versions of a product.

b) It provides a hands-on approach to test, validate, and refine a design before full-scale production.
c) It reduces the risk and uncertainty.
d) Enhances user experience and usability.

4) Compare the features of a layout drawing and a detailed drawing?

Aspect	Layout Drawing	Detailed Drawing
Definition	A layout drawing is a high-level, schematic representation of the design that shows the general arrangement of components or parts in a system or product.	A detailed drawing provides comprehensive and precise information about individual components, including dimensions, materials, and specifications.
Purpose	To show the overall configuration, relationships, and positioning of parts or systems within a larger design.	To provide exact measurements, material specifications, and construction details necessary for manufacturing and assembly.
Level of Detail	Offers a general view of the design with minimal details. Focuses on placement and the big picture rather than intricate specifications.	Highly detailed, with all necessary dimensions, tolerances, material types, and construction specifications for producing the parts or systems.
Scale	Often drawn to a smaller scale, providing an overview of the design layout without detailed measurements.	Typically drawn to a larger scale with precise measurements and detailed views of individual components.

5) What are factors to be considered in preparing technical reports to communicate a design efficiently?

When preparing **technical reports** to communicate a design efficiently in **design engineering**, several factors must be considered to ensure the report is clear, accurate, and effectively conveys the necessary information to its intended audience. Here are the key factors to consider:

1. **Audience Understanding**
   The level of technical expertise of the target audience must be taken into account. A report for engineers may use more technical language and detail, while a report for non-technical stakeholders (e.g., management or clients) should be written in simpler terms.
2. **Clear Structure and Organization**
   A well-organized report typically includes sections such as the title, abstract, introduction, methodology, results, discussion, conclusion, and references. Each section should be clearly labeled and logically ordered.
3. **Clarity of Purpose**
   The report should clearly state the design's objectives, scope, and the problem it aims to solve. The purpose of the design process and any underlying assumptions should be made explicit.
4. **Accurate Data and Technical Details**

14 MARKS QUESTION

Design a foldable steel table. Draw the detailed 2D drawings of the same with design detailing, scale drawings and dimensions. Use only hand sketches. (14 marks)

SCHEME Explanation – 6 marks, Figure – 5 marks, design detailing, scale drawings and dimensions – 3 marks.

Problem statement : To draw a detailed 2d drawing of foldable table.

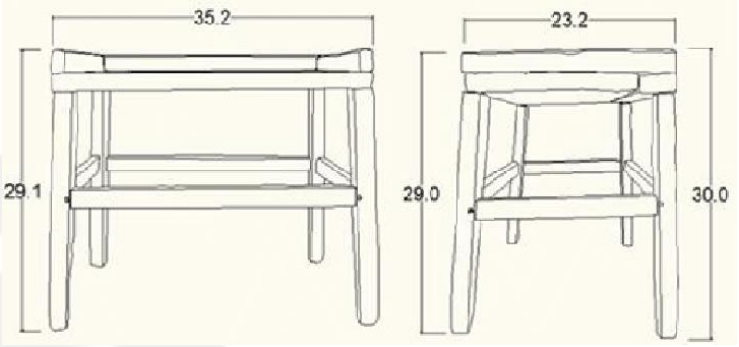
Objective (Tips: add as many points you can)

- Table should be foldable
- Light weight
- Adequate height
- Portable

Constraints (Tips: add as many points you can

- Material should be steel
- Should be foldable and portable
- Cost should be minimum (under Rs 500)
- As per the constraints the materials used must be steel. Since steel is a light weight material it can also aid for the function portability.

DIAGRAMS



Testing etc……

MODULE 4
3 MARK QUESTIONS

1) Explain the difference of project-based learning from problem-based learning?

Here's a comparison between **Project-Based Learning (PBL)** and **Problem-Based Learning (PBL)** in a column format:

Aspect	Project-Based Learning (PBL)	Problem-Based Learning (PBL)
Definition	An instructional methodology where students work on a project over an extended period, typically producing a tangible product or solution.	A learning method where students solve a real-world problem by investigating and researching, leading to an understanding of the subject.
Focus	Focuses on creating a final product, presentation, or outcome that addresses a real-world challenge or need.	Focuses on solving a specific problem, leading to deeper understanding and critical thinking.
Approach	Often interdisciplinary, involving multiple subjects or skills, and requires students to apply knowledge in a practical context.	Primarily focuses on a single problem, encouraging students to apply specific disciplinary knowledge to solve it.

Summary:

- **Project-Based Learning (PBL)** emphasizes creating a tangible output through a long-term process, often crossing disciplinary boundaries.
- **Problem-Based Learning (PBL)** is more focused on solving a specific, often complex problem using inquiry, research, and critical thinking, typically within a shorter time frame.

2) Describe how modular design approach ?

Modular design is an approach in which a product is designed for assembling in module-wise fashion.

• Modular products are the artifacts that are composed of many modules

• These modules function together to get the overall function of the product.

• Modular products can be machines, assemblies and components that fulfil various overall functions through the combination of distinct building blocks or modules.

• In a modular product (or modular system), the overall function performed by the product is the results achieved through a combination of discrete units (modules).

3) Describe the use of value engineering in the design process?

Value Engineering (VE) is a systematic method used in the design process to optimize the **value** of a product, project, or system by improving its function while reducing costs without compromising quality or performance. The goal is to achieve the best balance between cost, performance, and quality through creative thinking and collaboration.

Technique for improving the value of the product, project and process

• The term value defined as the ratio of function to cost

Value = function/cost

4) Explain how to estimate the cost of a particular design?

1. **Identify and Break Down the Design into Components**
   Start by dividing the design into smaller, manageable parts. These parts could include raw materials, components, subassemblies, and finished products.
2. **Material Costs**
   List all the materials required for each part and determine the quantity needed for each. Identify the cost of each material
3. **Labor Costs**
   Estimate the amount of labour required to manufacture, assemble, and test the product. Include both direct labour (workers involved in actual production) and indirect labour (supervisors, quality control, engineers).

5) Enumerate six features of a modular design?

1. **Interchangeability**
   Modules are designed to be interchangeable, meaning that they can be swapped in and out of the system without affecting the overall functionality
2. **Standardization**
   Modular components follow standardized sizes, shapes, interfaces, and other specifications, ensuring that parts can be easily integrated across various designs.
3. **Scalability**
   Modular systems can be easily expanded or contracted by adding or removing modules, allowing for scalable designs based on user needs or requirements

4. **Flexibility**
   The modular approach allows for flexibility in terms of design customization. Different modules can be combined in various configurations to create a product that meets specific needs or preferences.
5. **Simplified Maintenance and Upgrades**
6. **Parallel Development**
   Different modules can be developed independently by different teams or manufacturers, which accelerates the overall development process.

6) Concurrent engineering is better than sequential engineering- Justify?

Faster Time-to-Market: CE allows parallel work across departments, reducing delays and accelerating product development, whereas SE follows a linear, step-by-step process.
Improved Product Quality: CE promotes early cross-functional collaboration, allowing design and manufacturing issues to be addressed upfront, resulting in higher-quality products. SE might uncover issues only in later stages, leading to costly revisions.
Better Communication and Collaboration: CE encourages continuous interaction among all teams, improving coordination and decision-making. In SE, communication is often limited to handoffs between departments, which can lead to misunderstandings.
Reduced Costs: By considering manufacturing constraints and costs early, CE helps optimize resources and avoid expensive changes later, whereas SE often leads to unanticipated cost increases due to late-stage revisions.

7) Explain life cycle design?

Life Cycle Design (LCD) in design engineering refers to the process of designing products with a focus on their entire life cycle—from concept to disposal. It aims to minimize environmental impact, maximize resource efficiency, and reduce costs throughout the product's life span.

Key Aspects of Life Cycle Design:

1. **Material Selection**: Choosing sustainable, recyclable, or less resource-intensive materials to reduce environmental impact.
2. **Energy Efficiency**: Designing products that consume less energy during manufacturing, operation, and disposal.
3. **Manufacturing Impact**: Reducing waste, emissions, and energy consumption during the production process.

4. **Product Use**: Ensuring the product is durable, energy-efficient, and easy to maintain, extending its useful life.
5. **End-of-Life Considerations**: Designing products for easy disassembly, recycling, or environmentally responsible disposal to reduce waste.

8) Describe how aesthetics is important in design process?

Importance of Aesthetics in Design Engineering:

a) User Appeal: A visually attractive product can create a positive emotional connection with users, making it more desirable. Aesthetics influence perceptions of quality and functionality, which can impact consumer choice.
b) Brand Identity: The aesthetic design helps establish and communicate a brand's identity. A product's look and feel can set it apart in a competitive market, reflecting the brand's values and targeting the right audience.
c) Functionality and Usability: A well-designed aesthetic can improve the ergonomics and usability of a product. For example, intuitive shapes, textures, or button placements can make a product more user-friendly.
d) Market Differentiation: Unique, innovative, or aesthetically pleasing designs can help a product stand out in a crowded market, creating a competitive advantage.
e) Emotional Response: Aesthetics can evoke emotions, enhance user experience, and even contribute to user satisfaction. The right design can make a product feel more enjoyable to use.

9) Explain bio mimicry in design with an example?

1. **Sustainable Solutions**: Nature has evolved efficient, sustainable methods for solving complex problems. Biomimicry allows designers to create products that are environmentally friendly by mimicking nature's sustainable processes, such as energy efficiency or waste reduction.
    - **Example**: The **Lotus Leaf Effect**—lotus leaves have a natural water-repelling surface. Designers have mimicked this by creating water-resistant coatings for buildings, clothing, and self-cleaning surfaces, reducing the need for chemical cleaners and water consumption.
2. **Efficiency and Optimization**: Nature is highly efficient, using minimal energy and materials to achieve optimal results. By observing

natural processes, designers can optimize human-made systems to reduce waste and energy use.
    - **Example**: The design of **velcro** was inspired by the way burrs from plants attach to animal fur. This biological mechanism led to the creation of a reusable fastening system, saving resources and providing a functional solution.
3. **Innovation through Nature's Adaptations**: Biomimicry encourages creative solutions by leveraging the adaptability and resilience of biological systems. Designers can adapt these solutions to innovate in a wide variety of industries.
    - **Example**: The **Eiffel Tower**'s structural design was inspired by the branching patterns of trees, allowing it to be lightweight yet strong, optimizing material use while maintaining structural integrity.

10) Illustrate advantages of reverse engineering in design?

Reverse Engineering in design offers several advantages:

1. **Improved Product Design and Innovation**: By analyzing existing products, designers can identify strengths and weaknesses, leading to enhancements or new features for future designs.
2. **Cost and Time Efficiency**: It helps save time and reduce costs by reusing existing designs or components, allowing for faster production of spare parts or replication of products.
3. **Quality Control and Benchmarking**: Reverse engineering allows for the assessment of product quality and performance, helping set benchmarks and improve manufacturing standards.

14 MARKS QUESTION

Q1: Apply value engineering to a pen, and design a lightweight pen torch. Illustrate the solution using sketches. (14 marks)

Value of engineering is the technique for increasing the value of product, project & process. The term defined the ratio of function to the cost.

$$\text{Value} \quad \frac{function}{cost}$$

= Lets discuss the value of engineering to a

pen **Requirement/objective**

- ✓ To design a light weight pen torch
- ✓ Should be able write from one side
- ✓ A working torch in the other side

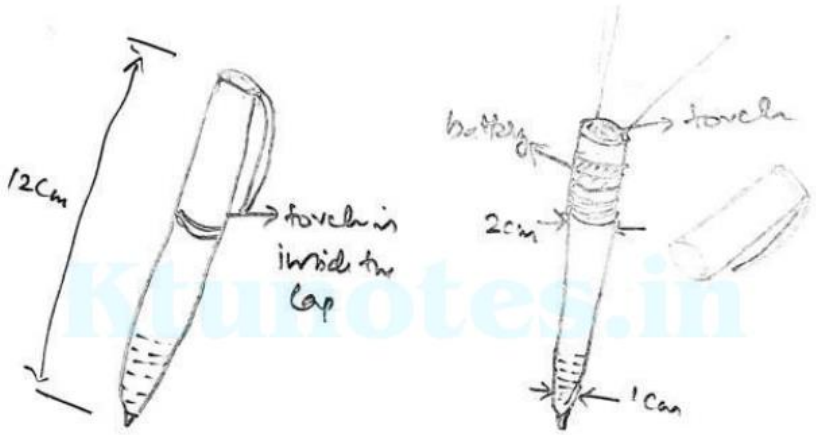
Functions

- ✓ Writing
- ✓ Can be also used as a torch when needed

Normally a pen's basic function is to write, but here we are adding one more function to the pen without increasing the cost of the product. This can increase the value of the product. The value of the product can be increased by either increasing the functions of the product or by reducing the cost of the product.

Ergonomic features of the pen

- ✓ To write with the pen the diameter of the holding side is reduced so that user can hold it easily
- ✓ There is a rubber grip is also placed at the writing side of the pen
- ✓ The torch is placed on the back side of the pen
- ✓ The design is like the pen cap can be removed and torch will be inside
- ✓ The torch cap can be removed to add batteries to the torch
- ✓ To lower the weight of the pen we used light weight plastic material



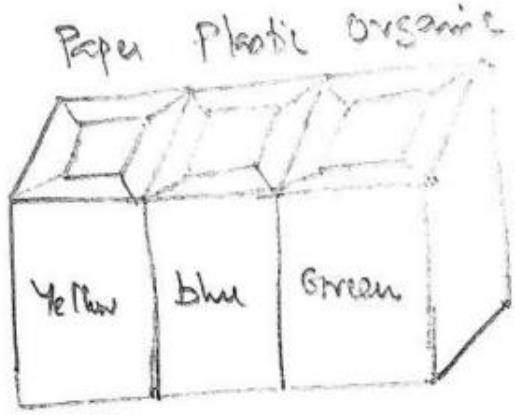
Q2: Design waste bins to be kept at bus stops for waste collection enabling source separation. The bin should be theft-resistant and protect the contents of the bin from external weather conditions. Design the bins with ergonomic consideration for waste collection workers. Sketch the design using hand drawings?

Objective/requirement

- ✓ To design a wate bins to be kept in the bus stop for waste collection.
- ✓ Source separation must be there (separate sections for separate waste)
- ✓ Must be theft resistant
- ✓ Protection from extreme weather condition
- ✓ Ergonomic consideration for waste collection workers

Design for source separation

For separation of the wastes, it is better to separate it from the time of the dumbing itself. So lets put separate opening for common separate waste. The common wastes can be separated in to three paper waste, plastic waste, organic waste. To distinguish the waste bin we can put separate colour for each bins. The common colour for these wastes are yellow, blue and green. The basic design of the waste bin is shown in the figure



- ✓ to protect the waste bin form thieves, we can make a permanent waste bin which is placed near the bus stop.
- ✓ The waste bin can be fixed to a location or wall with the help of a steel bars around it , as shown in the figure
- ✓ To protect waste bin from extreme weather conditions we can either place the waste bin under the bus stop roof or place a plastic sheet above the waste bin.

Ergonomic features of the bin

- ✓ To make the collection of waste easy by the waste collectors, the height of the waste bin can be given as 1 meter
- ✓ For easy retrieval of the waste a door is given at the top and side of the waste bin.
- ✓ Also can place a plastic bag inside the bin so that collectors can easily take the trash out.
- ✓ The bin fixed bars can be opened and lock by the collectors for easy bin management
- ✓ Different colures are given for the bin for better bifurcation of the garbage.

MODULE 5
3 MARKS QUESTIONS

1. Write note on importance of IPR in ensuring design, right?

Importance of IPR in Ensuring Design Rights:

a) **Protects Innovation**: IPR ensures designs are legally protected, preventing unauthorized copying and misuse.
b) **Provides Exclusive Rights**: Designers gain exclusive commercial rights to use, sell, or license their designs.
c) **Encourages Fair Competition**: It discourages counterfeiting and promotes ethical practices in the market.
d) **Builds Reputation**: IPR credits creators, enhancing their recognition and credibility.
e) **Enables Global Protection**: Designers can register designs internationally, opening licensing and revenue opportunities.

2. Explain how the sustainability aspect can be applied in the design of a handbag?

Sustainability in the Design of a Handbag:

a) **Eco-Friendly Materials**: Use sustainable materials such as recycled fabrics, organic cotton, or plant-based leather alternatives. These reduce environmental impact and ensure the handbag is biodegradable or recyclable.
b) **Durable and Long-Lasting Design**: Create a sturdy, timeless design to extend the product's lifespan, minimizing waste by reducing the need for frequent replacements.
c) **Ethical Manufacturing Practices**: Adopt energy-efficient production methods and partner with fair-trade suppliers to ensure the handbag is produced responsibly, reducing carbon footprints and supporting ethical labour.

3. How do ethics play a decisive role in engineering design?

Role of Ethics in Engineering Design:

a) **Ensuring Safety and Well-being**: Ethical design prioritizes user safety, reliability, and health. Engineers must design products that do not pose harm, ensuring compliance with safety standards and protecting users from risks.
b) **Promoting Sustainability**: Ethical considerations drive the use of eco-friendly materials, energy-efficient processes, and waste reduction, ensuring minimal environmental impact throughout the product's lifecycle.

c) **Fostering Fairness and Inclusivity**: Ethics ensures designs are inclusive and accessible to all users, avoiding discrimination and catering to diverse needs, such as people with disabilities.

4. List the factors affecting the cost of a product?
Factors Affecting the Cost of a Product in Design Engineering:

a) **Material Costs**: The type, quality, and quantity of materials used significantly impact the cost.
b) **Manufacturing Processes**: Complex processes, tooling, and production efficiency affect overall expenses.
c) **Labor Costs**: Wages, skill levels, and the number of personnel required influence costs.
d) **Design Complexity**: Intricate designs may require specialized tools or more development time, increasing costs.
e) **Market Demand**: High demand can drive bulk production, reducing per-unit costs; low demand may increase them.
f) **Logistics and Distribution**: Transportation, packaging, and storage add to the final cost.
g) **Regulatory Compliance**: Meeting safety, environmental, or industry-specific standards can involve additional costs.

5. Enumerate the features of a sustainable product?
Features of a Sustainable Product:

a) **Eco-Friendly Materials**: Made from renewable, recyclable, or biodegradable materials that minimize environmental impact.
b) **Energy Efficiency**: Designed to consume less energy during production, use, and disposal, reducing the product's carbon footprint.
c) **Durability and Longevity**: Built to last longer, reducing the need for frequent replacements and minimizing waste.

6. What is sustainable engineering?
Sustainable Engineering refers to designing and implementing engineering solutions that meet current needs without compromising the ability of future generations to meet their own.

a) **Environmental Responsibility**: Focuses on reducing pollution, conserving resources, and minimizing environmental impact through eco-friendly designs and processes.
b) **Economic Viability**: Ensures projects and products are cost-effective and efficient while supporting long-term sustainability goals.

c) **Social Equity**: Promotes inclusivity, ethical practices, and community well-being, considering the societal impact of engineering solutions.

7. What are design rights, and how can an engineer put it into practice?

Design Rights protect the visual appearance of a product, including its shape, pattern, configuration, or ornamentation. These rights ensure that the unique aesthetic aspects of a design cannot be copied or used without permission.

How Engineers Can Put Design Rights into Practice:

a) **Register Designs**: Engineers can secure design rights by registering their designs with the appropriate intellectual property office, providing legal protection against imitation.
b) **Incorporate Unique Features**: Ensure that product designs are original, distinctive, and non-functional (focused on appearance), qualifying them for protection under design rights.
c) **Monitor and Enforce Rights**: Regularly monitor the market for potential infringements and take legal action if necessary to protect the registered design.

8. How to estimate the cost of a particular design?

Estimating the Cost of a Design:

a) **Material and Manufacturing Costs**: Calculate the cost of materials and the expenses related to manufacturing processes, labor, and tools.
b) **Development Costs**: Include expenses for research, prototyping, testing, and design iterations.
c) **Overheads and Profit Margins**: Factor in administrative, marketing, and distribution costs, along with desired profit margins.

14 MARK QUESTION

Q1: Design a fan which automatically reduces speed or stops when the temperature reduces during the night for energy conservation. Use hand sketches to support your design.

Requirement/Objective

- To design a fan that reduce speed when temperature is low
- Fan should automatically stop when temperature is below certain level

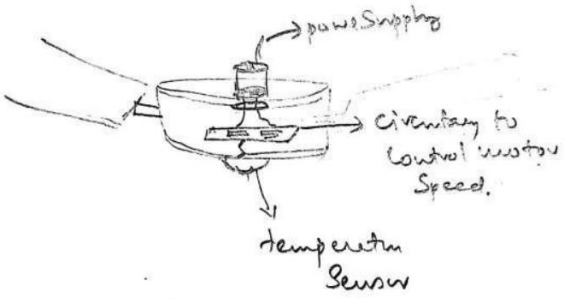
Solution steps

To design a fan that automatically controls its speed need a sensor system that can sense the temperature inside the room. Lets take the threshold temperature as 22 C. below that temperature the fan should automatically stop.

The sensor can be placed on the fan itself. The sensor must be exposed to the room then only it can detect the room temperature. Lets place it in the middle of the fan face, and the circuitry can be placed inside the fan.

We can set some temperature threshold for the sensory circuit.

Temperature reading	Speed of the fan
Above 27^{0}C	Speed 5
26^{0}C	Speed 4
25^{0}C	Speed 3
24^{0}C	Speed 2
23^{0}C	Speed 1
22^{0}C	OFF



The fan can also be controlled by the mobile app, because of the Bluetooth connectivity in the fan. The temperature settings can be controlled or set by the mobile application providing with the fan. The basic structure of the mobile application is shown in the figure

Q2: Describe how to estimate the cost of a pen and list the various parts. Show how the economics will influence the engineering designs. Use hand sketches to support your arguments. (14 marks)?

Objective

- ✓ To estimate the cost of the pen & show how the economics will influence the engineering design

For the estimation of cost we need to consider three types of cost

1. Labour cost
2. Material cost
3. Overhead cost

Let us consider a company is manufacturing 50000 pens for a month. In order to estimate the cost of the product manufacturing and distribution let us identify each costs.

The different parts of the pen consist of

- ✓ Body of the pen
- ✓ Point ball of the pen
- ✓ Ink
- ✓ Ink reservoir
- ✓ Cap of the

pen Materials needs

- ✓ Steel
- ✓ Plastics
- ✓ Ink

1. Making of ink
2. Body and other parts Moulding
3. Ink filling
4. Assembly of parts

From the above information we can estimate the cost of the product

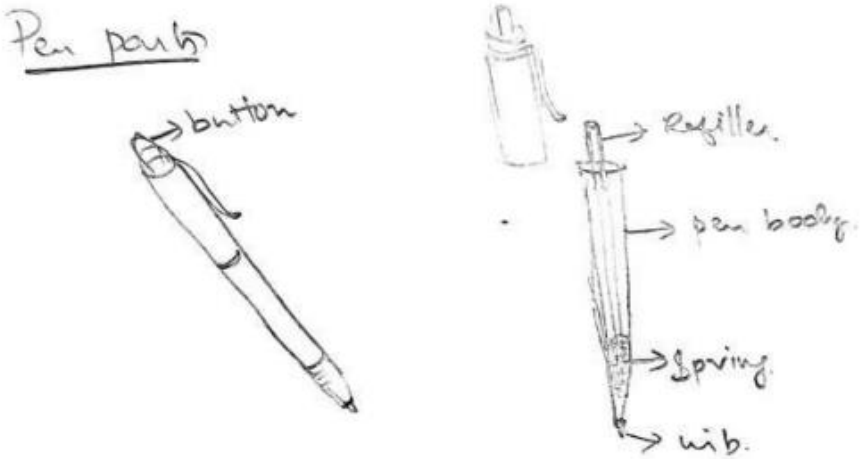
1. Labour cost estimation

Let us assume the labour cost for each dept as below

Labour section	No of Labour	Salary/month	Total cost
Ink making	2	5000	10000
Moulding	4	10000	40000
Ink filling	4	5000	20000
Final assembly	4	5000	20000
		Total	90000

2. Material cost estimation

Item	Quantity	Rate/kg	Total
Metal	2 kg	70	140



For the manufacturing of the pen nib we can use different materials but here we used the copper for reducing the higher cost. This will give the same performance as other materials and with less cost

Similarly, we can choose other materials too with good performance and less expense. Plastic materials are used as body material. if we make the pen's inside body as the ink carrier without ink spilling technique we can reduce the materials for refill.

Also reducing the size of the pen can reduce the expense.

By choosing the best product for manufacture as well as choosing experienced labours we can increase the design and productivity output. In this way we can reduce the product cost and increase the value of the product. Her we are able to sell the product Rs 3 per piece.