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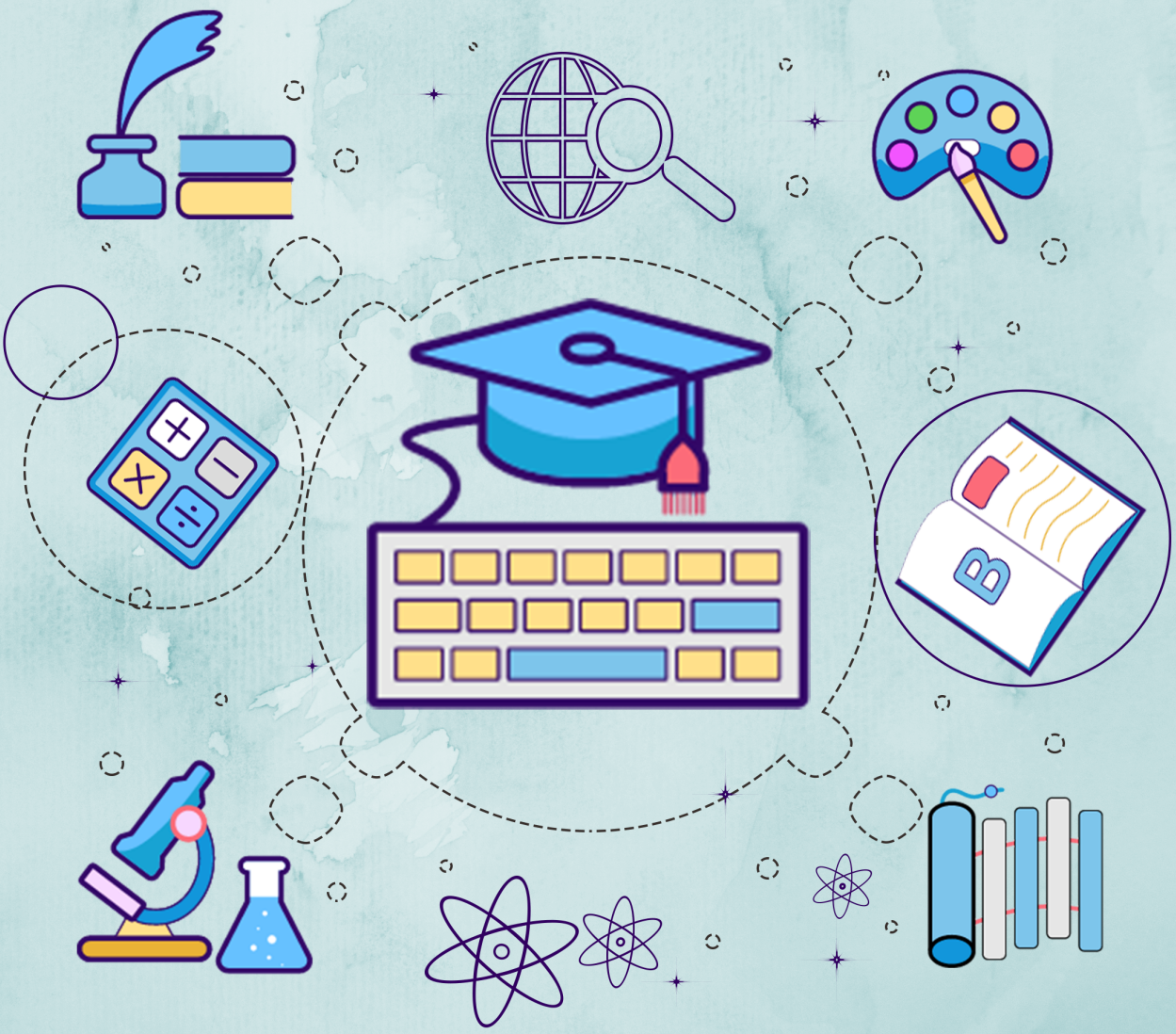

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KTU S4 CSE NOTES

DESIGN AND ENGINEERING (EST 200)

Module 1

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MODULE 1

ENGINEERING

Engineering is the application of scientific, economic, social and practical knowledge in order to invent, build, design, develop and maintain various devices, systems, machines, structures and processes.

DESIGN

A plan or drawing produced to show the look and function or workings of an object before it is made.

ENGINEERING DESIGN

- Engineering design is the process of devising a system, component, or process to meet desired needs.
- It is an iterative design making process in which the basic sciences, mathematics and engineering sciences are applied to optimally convert resources to meet a stated objective.

DESIGN LEVELS

ADAPTIVE DESIGN

- Mostly designer's work will be concerned with the adaptation of existing designs.
- There are branches of manufacturing in which development has practically ceased, so that there is hardly anything left for the designer to do except make minor modifications, usually in the dimensions of the product.
- Design activity of this kind demands no special knowledge or skill, and the problems presented are easily solved by a designer with ordinary technical training.
- Example: Elevator, Washing Machine etc.

DEVELOPMENT DESIGN

- Considerably more scientific training and design ability are needed for development design.
- The designer starts from an existing design, but the final outcome may differ markedly from the initial product.
- Example: Development could be from a manual gearbox in a car to an automatic one, from the traditional tube-based television to the modern plasma and LCD versions, Wired telephone to mobile phone etc.

NEW DESIGN

- Only a small number of designs are new designs. This is possibly the most difficult level in that generating a new concept involves mastering all the previous skills in addition to creativity and imagination, insight, and foresight.
- Example: Design of the first automobile, airplane, camera etc.

CAUSE FOR FAILURES IN MOST ENGINEERING DESIGNS

- Incorrect or overextended assumptions
- Poor understanding of the problem to be solved
- Incorrect design specifications
- Faulty manufacturing and assembly
- Error in design calculations
- Incomplete experimentation
- Error in drawings
- Inadequate data collection

PHASES OF DESIGN PROCESS

Figure 1.1: Phases of Design Process

The phases involved in design process includes six phases as shown in Figure 1.1.

1. **Identifying Customer needs**: First identify what the customer is expecting the system. This can be done in the following ways.

Client request:

- A client may submit a request for developing a product or artifact.
- The customer need should be expressed clearly.
- The client may know only the type of product that they need.
- Example: I need a Table

Modification of an existing design

- Client may ask modifications in the existing product.
- They may ask for customization in certain products.
- They may ask to change shape, functionalities, material used etc.
- Example: Different coffee brands uses different flavours,

Generation of new product

- Profit oriented companies always do research to generate entirely new concepts and products so that they can rule the market.
- Example: Design variants of televisions with new features and build materials.

2. Setting design objectives – Identify the design objectives. Perform feasibility analysis, market study abd document the finalized design objectives.

Conduct feasibility analysis

- **Technical feasibility:** Ensuring whether the requirements can be implemented using the existing technology or not.
- **Economic feasibility:** Ensuring whether the requirements can be implemented within the allotted budget or not.
- **Schedule feasibility**: Ensuring whether the requirements can be implemented within the allotted time or not.
- **Social feasibility**: Ensuring whether the developing product may affect the society in a harmful manner or not.

Perform market analysis

- Analyze the market and identify the competing products and its exciting features.
- Identify the supplementary features that may be expected from this product.

Document the finalized design objectives

- Document all the finalized requirements / design objectives.
- This document act as an agreement between the customer and the manufacturer.
- Example: System Requirement Specification (SRS) document.

3. Identifying design constraints – Identify the various constraints that exist which may affect the design process.

Functional constraints

- These constraints impose a limit on the proposed working principle of the product
- Example: Energy requirement, Materials used, Overall geometry and aesthetics etc.

Manufacturing constraints

- The direct production limitations are due to equipment/raw materials deficiency, methods involved in manufacturing, labour shortage etc.

Safety constraints

- These constraints impose a direct threat to the product or to the user.
- Example: Operational safety constraints, Environmental constraints, Safety issues due to inevitable human errors etc.

Time and economic constraints

- Customer always expect quick delivery of the product with minimum cost.
- Demand of the product also leads to time and economic constraints. Example: Vaccine for COVID.

Legal Ethical and Quality constraints

- The end product should be approved by various organizations or Quality Control (QC) and Quality Assurance (QA) agencies to ensure its quality and safety
- Example: ISO, ISI, Food Safety and Standards Authority of India (fssai)

Ergonomics and Aesthetic constraints

- Product should be user friendly, attractive, visually pleasing and easy to use.

4. **Establishing functions** – Identify all the functionalities to be performed by the system.

- Identifying all the functions to be performed by the proposed product.
- Identifying the functions to be carried out to implement this product.
- Performing risk analysis in the implementation phases.
- Functions can be:
    1) **Engineering functions**: Cost estimation, Production design, Concept design, Simulation or 3D models etc.
    2) **Manufacturing functions:** Assembly, determination of tools and machineries for production, purchasing raw materials, Allotting labour etc.
    3) **Quality control functions:** Auditing, Check for regularity and safety, Design auditing, energy auditing etc.
    4) **Commercial functions**: Service-related aspects, Marketing, Sales, Warehousing, Packing and shipping etc.

5. **Generating design alternatives**

- For a design problem, there will be multiple solutions.
- For example: We can design a mobile phone in different modes: Touch screen phone, Keypad phone etc.
- Every design solution has its own pros and cons.

6. Choosing the best feasible design

- From the various design alternatives, the designer has to choose the best feasible design by considering the various trade-off aspects.

CASE STUDY 1 – CARRY BAG

CASE STUDY 2 – WRIST WATCH

Problem: Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.

Solution

1. Identifying and detailing customer requirements.

- ✓ It should show the accurate time.
- ✓ It can be tied on the wrist.

2. Setting design objectives

- ✓ Ensure whether we can design a wrist watch using existing technology, allotted budget and time schedule.

3. Identifying design constraint

- ✓ It should have a strap / chain to tie on the wrist.
- ✓ Should follow the quality guidelines like ISI / ISO standards.

4. Establishing functions

- ✓ It should display time accurately.
- ✓ It should be cell/battery/ solar powered.
- ✓ It should have a strap / chain to tie on the wrist.
- ✓ It should be simple and light weight.

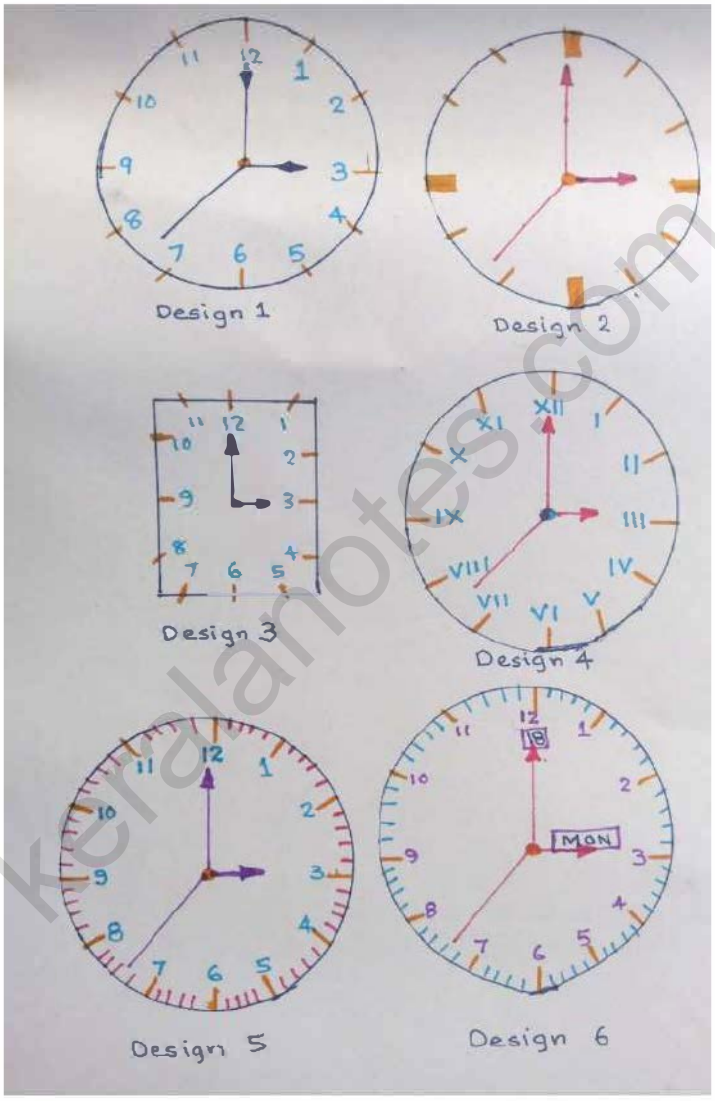
5. Generating design alternatives

Possible alternatives in mode: Analog watches, Digital watches, Smart watches

Possible alternatives in strap: Leather strap with different colors, Chain strap with different colors

Possible shapes of dial: Round, Rectangle, Oval, Square etc.

Number pattern in dial: Numbers like 1,2...12 or Roman numbers like I, II .... XII.



6. Choosing the best design

In the above designs of analog 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 and hour.