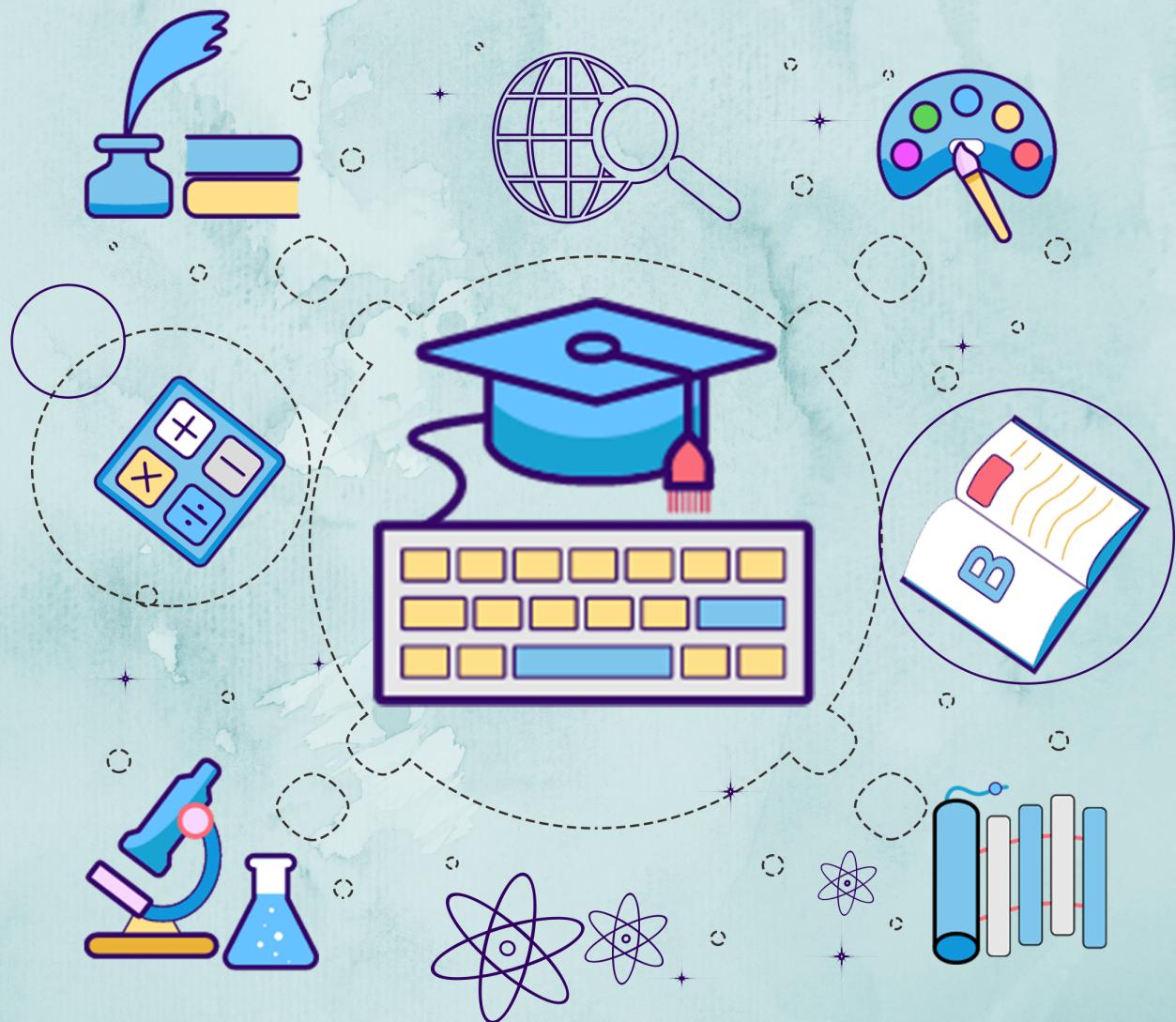


# Kerala Notes



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## KTU S4 CSE NOTES

# DESIGN AND ENGINEERING (EST 200)

## Module 2

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## MODULE 2

### DESIGN THINKING

- Design thinking is simply “a process for creative problem solving”
- Design thinking is a non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test.

### ITERATIVE DESIGN THINKING PROCESS STAGES

- Consist of five phases—Empathize, Define, Ideate, Prototype and Test.
- It is most useful to solve problems that are ill-defined (unclear) or unknown.

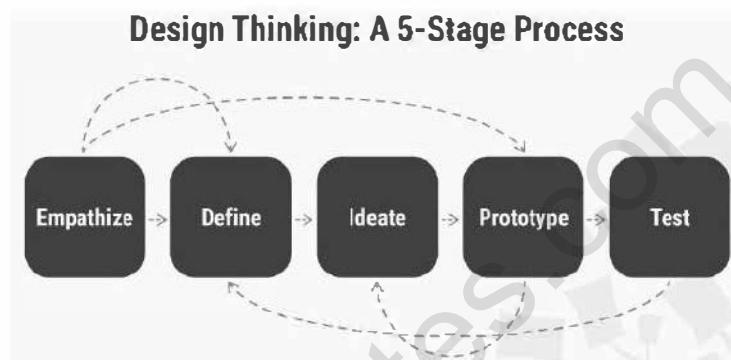


Figure 2.1: 5-stage process involved in design thinking

#### 1. Empathize

- Designer should gain an empathetic understanding of the problem that they are trying to solve, typically through user research.
- Empathy is crucial to a human-centered design process such as design thinking because it allows you to set aside your own assumptions about the world and gain real insight into users and their needs.
- Place yourself as an end user and identify the user expectations and needs.

#### 2. Define

- It's time to accumulate the information gathered during the Empathize stage.
- You then analyze your observations and synthesize them to define the core problems you and your team have identified. These definitions are called problem statements.
- The problem definition should be clear and unambiguous.
- Define the objectives or user requirements

#### 3. Ideate

- The solid background of knowledge from the first two phases means you can start to “think outside the box”, look for alternative ways to view the problem and identify innovative solutions to the problem statement you've created.
- Brainstorming is particularly useful here.

#### 4. Prototype

- This is an experimental phase. The aim is to identify the best possible solution for each problem found.
- Designer team should produce some inexpensive, scaled-down versions of the product (or specific features found within the product) to investigate and validate the ideas they generated.
- This could involve simply paper prototyping, simulations, 3D models, animations etc.

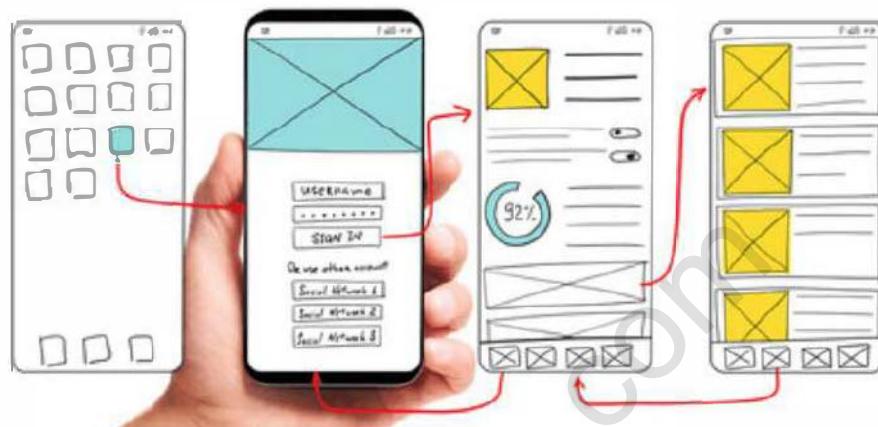


Figure 2.2: Paper prototyping of a Mobile app



Figure 2.3: 3D models

#### 5. Test

- Evaluators rigorously test the prototypes.
- Although this is the final phase, design thinking is iterative: Teams often use the results to redefine one or more further problems.
- So, they can return to previous stages to make further iterations, alterations and refinements – to identify the best alternative solution.

## 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.



## DESIGN THINKING AS DIVERGENT – CONVERGENT QUESTIONING

- Design thinking is an iterative approach and we follows two generic patterns of design thinking: Divergent thinking and Convergent thinking.
- **Divergent thinking** is the process of thinking that explores multiple possible solutions in order to generate creative ideas. i.e. Think for all possible ways to reach a solution.
- **Convergent Thinking** is the process of figuring out a concrete solution to any problem. i.e. Thinks for a final solution.
- Table 2.1 shows the differences between divergent & convergent thinking.

Table 2.1: Difference between Divergent – Convergent thinking process

Convergent Thinking	DivergentThinking
<b>Convergent Thinking</b> is the process of figuring out a concrete solution to any problem.	<b>Divergent thinking</b> is the process of thinking that explores multiple possible solutions in order to generate creative ideas.
It's a straight forward process that focuses on figuring out the most effective answer to a problem.	In contrast, divergent thinking refers to opening the mind in various directions and trying out multiple solutions for a problem.
Its characteristics include •Speed •Accuracy •Logic	Its characteristics include •Spontaneous •Free-flowing •Non-linear
Convergent thinking helps to find out the best possible answer to any problem, which are accurate most of the time, and no room for ambiguity is left.	Although Divergent thinking keeps the options open, a completely accurate answer isn't identified.

## CONVERGENT – DIVERGENT THINKING – CASE STUDY OF BULB



Figure 2.4: Convergent – Divergent thinking of electric bulb

### DIVERGENT THINKING – CASE STUDY OF PEN

List out some uses of pen other than writing

- ✓ as a straw
- ✓ as a toy "telescope" for kids
- ✓ To rewind cassette tape
- ✓ as an improvised stabbing weapon
- ✓ As a paper punch
- ✓ Use as a ruler
- ✓ To make a smart phone stylus
- ✓ To make a whistle



### DIVERGENT THINKING – CASE STUDY OF FORK

List out some uses of fork other than eating aid.

- ✓ Scramble things
- ✓ Mix things
- ✓ Stir stuff
- ✓ Poke things or people
- ✓ Give it to a small farmer as a pitch fork
- ✓ Scratcher
- ✓ Get something out of a fire
- ✓ Murder weapon
- ✓ Tool of torture
- ✓ Prop something open



### DESIGN THINKING AS A TEAM

- In order to get best and creative solutions, design thinking process is generally performed as a team activity.
- Every member may raise their own ideas and solutions.
- The team will analyze the pros and cons of each solution or design and then finalize the best suitable solution.
- But during design thinking as a team activity, conflicts between team members may arise. So It is very important to resolve these conflicts.

### CHARACTERISTICS OF AN EFFECTIVE TEAM

- Team goals are as important as individual goals.
- The team understands the goals and is committed to achieving them.
- Trust replaces fear, and people feel comfortable taking risks.
- Respect, collaboration, and open-mindedness are prevalent.
- Team members communicate readily; diversity of opinions is encouraged.
- Decisions are made by consensus and have the acceptance and support of the members of the team.

## STEPS IN RESOLVING CONFLICTS

1. Prepare the resolution
2. Understand the situation
3. Reach agreement

### Step 1: Prepare for resolution

- **Acknowledge the conflict** – The conflict has to be acknowledged before it can be managed and resolved. The tendency is for people to ignore the first signs of conflict, perhaps as it seems trivial, or is difficult to differentiate from the normal, healthy debate that teams can thrive on. If you are concerned about the conflict in your team, discuss it with other members. Once the team recognizes the issue, it can start the process of resolution.
- **Discuss the impact** – As a team, discuss the impact the conflict is having on team dynamics and performance.
- **Agree to a cooperative process** – Everyone involved must agree to cooperate in to resolve the conflict. This means putting the team first, and may involve setting aside your opinion or ideas for the time being. If someone wants to win more than he or she wants to resolve the conflict, you may find yourself at a stalemate.
- **Agree to communicate** – The most important thing throughout the resolution process is for everyone to keep communications open.

### Step 2: Understand the situation

- **Clarify positions** – Whatever the conflict or disagreement, it's important to clarify people's positions. Whether there are obvious factions within the team who support a particular option, approach or idea, or each team member holds their own unique view, each position needs to be clearly identified and articulated by those involved.
- **List facts, assumptions and beliefs underlying each position** – What does each group or person believe? What do they value? What information are they using as a basis for these beliefs? What decision-making criteria and processes have they employed?
- **Analyze in smaller groups** – Break the team into smaller groups, separating people who are in alliance. In these smaller groups, analyze and dissect each position, and the associated facts, assumptions and beliefs.
- **Convene back as a team** – After the group dialogue, each side is likely to be much closer to reaching agreement. The process of uncovering facts and assumptions allows people to step away from their emotional attachments and see the issue more objectively. When you separate alliances, the fire of conflict can burn out quickly, and it is much easier to see the issue and facts laid bare.

### Step 3: Reach agreement

- Now that all parties understand the others' positions, the team must decide what decision or course of action to take. With the facts and assumptions considered, it's easier to see the best of action and reach agreement.

## PREVENTING CONFLICTS

- Dealing with conflict immediately – avoid the temptation to ignore it.
- Being open – if people have issues, they need to be expressed immediately.
- Practicing clear communication – articulate thoughts and ideas clearly.
- Practicing active listening – paraphrasing, clarifying, questioning.
- Practicing identifying assumptions – asking yourself "why" on a regular basis.
- Not letting conflict get personal – stick to facts and issues, not personalities.
- Focusing on actionable solutions – don't belabor what can't be changed.
- Encouraging different points of view – insist on honest dialogue and expressing feelings.
- Not looking for blame – encourage ownership of the problem and solution.
- Demonstrating respect – if the situation escalates, take a break and wait for emotions to subside.

## DESIGN THINKING APPROACH CASE STUDY 1 – DRUG TROLLEY IN HOSPITALS

Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how divergent –convergent thinking helps in the process. Provide your rationale for each step using hand sketches only.

### Solution:

**Objective:** To design a drug trolley that can be used in hospitals.

**Intended users:** Hospital staff like nurses.

**Scope / Domain:** Hospitals

### **Expected functionalities:**

- [1] It should have wheels as we need to move it from one room to another.
- [2] It should have racks to keep the medicines.
- [3] It should be light weight with sleek design so that we can move it easily.

### **Exciting functionalities:**

- [1] The wheel should have a lock such that it can be prevented from moving when not in use.
- [2] It should have racks with closing doors or lids.
- [3] It should have separate rack for keeping drugs for each room patients.
- [4] It should have a facility to dispose medicinal waste like used cotton, syringe etc.
- [5] It should have an open table on the top to keep case diary/charts of patients.

### Possible Designs using Divergent thinking process

#### Model 1:

**Pros:**

- ⌚ Simple and Light weight
- ⌚ Easier to keep medicines and boundaries are provided in all 3 sides which prevents from medicines falling down while moving.

**Cons:**

- ⌚ Difficult to sort out medicines for each room.
- ⌚ No doors for racks and no open table.
- ⌚ Wheels have no locks



#### Model 2:

**Pros:**

- ⌚ Simple and Light weight
- ⌚ Easier to keep medicines

**Cons:**

- ⌚ Difficult to sort out medicines for each room.
- ⌚ No doors for racks and no open table.
- ⌚ Wheels have no locks
- ⌚ As there are no boundaries, there is a high chance of falling down the medicines while moving.



#### Model 3:

**Pros:**

- ⌚ Simple and Light weight
- ⌚ Easier to keep medicines as boundaries and lids are there for each rack.

**Cons:**

- ⌚ Difficult to sort out medicines for each room.
- ⌚ Wheels have no locks



#### Model 4:

**Pros:**

- ⌚ Simple and Light weight
- ⌚ Easier to keep medicines as drawers are used.
- ⌚ An open table is there on the top to keep case diary/charts of patients.
- ⌚ Wheels have locks

**Cons:**

- ⌚ Difficult to sort out medicines for each room.
- ⌚ No option for disposing clinical wastes.



### **Model 5:**

**Pros:**

- ⌚ Simple and Light weight
- ⌚ Easier to keep medicines as drawers are used.
- ⌚ An open table is there on the top to keep case diary/charts of patients.
- ⌚ Have both open and closed racks to keep drugs accordingly.

**Cons:**

- ⌚ Difficult to sort out medicines for each room.
- ⌚ No option for disposing clinical wastes.
- ⌚ No lock for wheels



### **Model 6:**

**Pros:**

- ⌚ Simple and Light weight
- ⌚ Easier to keep medicines and sort out medicines for each patient as different partitions are provided for each room.
- ⌚ Have both open and closed racks to keep drugs accordingly.

**Cons:**

- ⌚ No open table is there on the top to keep case diary/charts of patients
- ⌚ No option for disposing clinical wastes.
- ⌚ No lock for wheels



### **Model 7:**

**Pros:**

- ⌚ Simple and Light weight
- ⌚ Easier to keep medicines and sort out medicines for each patient as different partitions are provided for each room.
- ⌚ Have both open and closed racks to keep drugs accordingly.
- ⌚ Have facility to dispose clinical wastes.
- ⌚ Have open table to keep patient charts / records.
- ⌚ Have locks for wheels.



### **Choosing the best design**

Model 7 can be chosen as the best design as it incorporates all the expected functionalities as well as exciting functionalities of a drug trolley.

**Model Question paper**

**Page 1 of 2**

**Reg No.: \_\_\_\_\_ Name: \_\_\_\_\_**

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY  
THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION**

**Course Code: EST 200**

**Course Name: DESIGN AND ENGINEERING**

**Max. Marks: 100 Duration: 3 Hours**

**PART A**

**Answer all questions, each question carries 3 marks  
Use only hand sketches**

- (1) Write about the basic design process.
- (2) Describe how to finalize the design objectives.
- (3) State the role of divergent-convergent questioning in design thinking.
- (4) Discuss how to perform design thinking in a team managing the conflicts.
- (5) Show how engineering sketches and drawings convey designs.
- (6) Explain the role of mathematics and physics in design engineering process.
- (7) Distinguish between project-based learning and problem-based learning in design engineering.
- (8) Describe how concepts like value engineering, concurrent engineering and reverse engineering influence engineering designs?
- (9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?
- (10) Explain how economics influence the engineering designs?

**(10x3 marks = 30 marks)**

**Part B**

**Answer any ONE question from each module. Each question carry 14 marks**

**Module 1**

- (11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.  
**or**  
(12) Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

### Module 2

- (13) 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.

**or**

- (14) Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

### Module 3

- (15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

**or**

- (16) Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

### Module 4

- (17) Show the development of a nature inspired design for a solar powered bus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

**or**

- (18) Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

### Module 5

- (19) Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

**or**

- (20) Describe the how to estimate the cost of a particular design using ANY of the following:  
 i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) an electrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

**(5x14 marks =70 marks)**