Course Abstract

Design Engineering – 1B (2140002) (4th Semester)

Module 2: Applying Design Thinking

Name of the Discipline & the Programme: ***Every discipline of the Engineering***

Usual time of occurrence: ***4th Semester***

Duration: ***Six (6) months***

Course category: ***Core - Basic***

Credits: ***03***

Examination Pattern: ***Only Practical/Viva exam at end of semester***

Prerequisites: ***Design Engineering – 1A***

Relevance

This is a revision course designed for those who have undergone the fundamentals of Design Thinking process in 3rd semester.

Objective: Applying Design Thinking

The course aims to validate the learnings from previous semester of the understanding Design Thinking, by translating the concepts into exercises. Here branch specific topics need to be selected by students and refine their learning for Design Thinking phases.

Course Contents

In the 3rd semester, students have learnt the basic Design Thinking methodology in DE-1A and undergone the phases of the same with necessary tools and techniques using various framework and canvases. In 3rd semester, students have worked upon general topic/domain irrespective of their branch, now in 4th semester they need to select **branch specific existing artefact/component** for Reverse Engineering and modify/redesign it as per the User's needs using Design Thinking. There are two basic objectives of introducing RE: (1) Students will learn some basic concept from their branch and relate all stages/phases of Design Engineering with their regular core subjects of particular branch in current or further semester/s as one of the key objectives of Design Engineering subject is to absorb Design Thinking approach into core engineering subject for practical learning (2) they will use Design Thinking process again to refine the learning. In this module also whole Design Thinking process will be used by students, but more emphasis on Ideation and initial Product Development phase. The content is divided into week-wise activities to better understand the course and to give enough time to all the

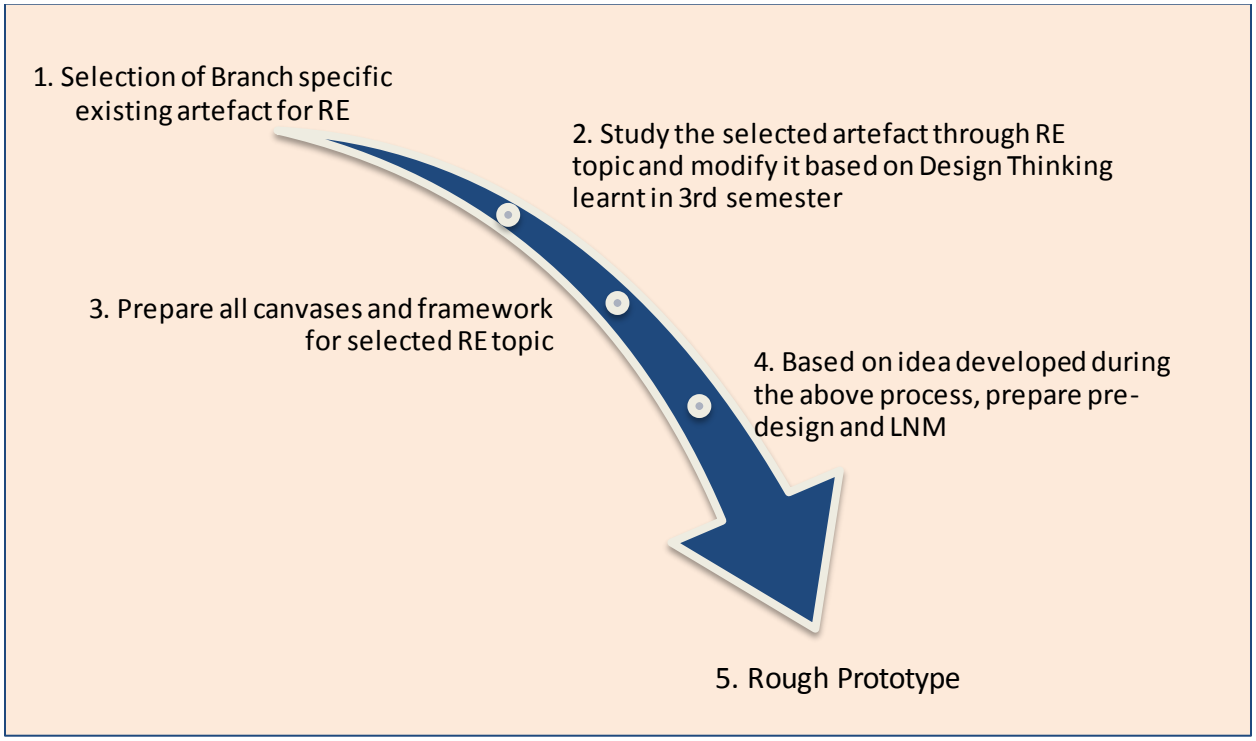
learning aspects, but depending upon the type and nature of projects, students and guide may re-schedule the activities.

Students in 4th semester need to follow below week-wise activities to complete the course requirement for 4th semester.

Design Thinking Process – with Tools & Techniques			
Module 2: DE-1B Applying Design Thinking			
Broad segment	**Week**	**Description**	**Operational need**
Domain/Topic Selection	1	○ Branch Specific existing topic selection for Reverse Engineering (This topic must be different from 3rd sem topic) ○ Team Selection (you can change your team member here)	○ Brief lecture/exercise ○ In this semester, student will use Design Thinking process learnt in 3rd semester to modify the selected RE topic
Reverse Engineering (RE)	2, 3	○ Reverse Engineering – Detailed study for Branch Specific learning ○ Dissemble the existing selected artefact/product/component/process /system to study technical aspects and design detail	○ Brief lecture/exercise ○ Hands-on practice sessions with cases /examples
Empathization Phase	4, 5	○ **Observation:** Through AEIOU framework and other Ethnography tools available ○ **Immerse via Role Playing** ○ **Interview:** ✓ Formal and Informal interview ✓ Students may use Stanford methods given in below link - http://dschool.stanford.edu/wp-content/uploads/2013/10/METHODCARDS-v3-slim.pdf ○ Modification for existing artefact/product/component/process /system based on User's need ○ Preparation of Mind Map, Empathy Map	○ Students need to visit their domain/place where they can interact with user for getting insights. Minimum 3-4 field trips will be required to get better insights on users' needs. ○ Based on User's need, students need to redesign/modify the selected existing artefact/product/component/process/system for RE

Note: For details of activities on various phases, students should consider the 3rd semester week-wise table, as Design Thinking process will be same with different projects.			
Ideation Phase	6, 7, 8	○ Preparation of Ideation canvas based on modification considered at Empathy phase ○ **Learning Tools:** ✓ Learning by analogy, artefactual, heuristic and gestalt model ○ Combination of Ideas from opportunity mapping ○ Preparation of Ideation canvas	○ Students will work on their Ideation canvas (min 3 hours continuous workshop)
Product Development Phase	9, 10	○ Preparation of Product Development Canvas (PDC) to modify existing product ✓ Product Experience ✓ Product Functions ✓ Product Features ✓ Components ○ Sketching of mock concepts in log book ○ Discussion on PDC ○ **SCAMPER tool**	○ Students will work on their PD canvas (min 3 hour continuous workshop) ○ Students team will discuss on their PDC with other groups and faculty guide and get the feedback ○ Refinement of PDC after discussion
	11	○ Customer/User Revalidation (Reject/Redesign/Retain) ○ Refinement	○ Till 12th week of course, student team will consult Users/Stakeholders for their inputs on concept and incorporate necessary changes
Pre-Design & Rough Prototype	12, 13	○ Pre-Design with LNM ○ Prototype (Here strategy is to fail fast to succeed fast)	○ Building the solutions exercises ○ Iterate, Iterate, Iterate…..
Feedback & Final Report	14	○ Feedback & Final Report	○ As per the feedback received from Users/Stakeholders/other student groups/guide, student teams need to modify their design and further action plan. ○ Report writing should be continuous activity throughout the semester

Description of activities for DE – 1B (4th semester)



Reverse Engineering (Tear Down Lab approach)

Reverse Engineering, also called as *Back Engineering*, is the processes of extracting knowledge or design information from anything man-made and re-producing it or reproducing anything based on the extracted information. The process often involves disassembling something (a mechanical device, electronic component, computer program, or biological/chemical/organic matter) and analysing its components and workings in detail [1].

Activity 01 - Select Branch Specific artefact/component and Disassemble it

Each group has to select one branch specific component/product/artefact/program for reverse engineering activity for their DE-1B project and modify the same based on extracted information as per User's needs. This activity is to learn about some basic technical aspects involved in designing something related to particular branch.

[1] https://en.wikipedia.org/wiki/Reverse_engineering

Steps need to follow for Reverse Engineering (but not limited to, it may vary as per selected topic/project):

1. Select branch specific artefact/component
2. Disassemble it for learning the technical/engineering aspects involved in it
3. Apply Design Thinking approach to find out the Unmet needs of User related to selected artefact/component
4. Follow phases of Observation, Empathy, Ideation and Product Development by preparing related canvases/frameworks
5. Modify/redesign the artefact/component to meet Users unmet needs

After *Reverse Engineering study*, with extracted information from branch specific artefact/component, Students' team need to apply Design Thinking approach learnt in 3rd semester (all phases of 3rd semester DE-1A would repeat here) to modify/redesign that selected artefact/component based on User's unmet needs. Here one need to make all canvases and framework again as topic is different than 3rd semester.

Activity 02 – User Feedback based refinement and redesign (Using Design Thinking Process learnt in 3rd semester, for further refinement of learning)

After Reverse Engineering phase, Students must have to verify their revised concepts of selected artefact/component with the user before investing their time and efforts further. This will help students to verify their concepts and help in clarifying the insights that they need for implementing their idea. Students will again visit the domain/area of their selected artefact/component for reverse engineering and verify their modification approach taken up in the PD canvas with the user for functions, features and components. At this stage, one may find that one has to modify the prepared Canvases on the basis of feedback given by user.

After carrying out the feedback analysis, students are required to verify the important aspects, in line with the context of five principles, namely:

i. Technological,
ii. Aesthetic,
iii. Ergonomics,
iv. Environment, and
v. Cost.

For the design problem, each of their components, functions and features of the proposed solution will be checked using the above five principles. This verification may lead to modification and improving of their concept.

Activity 03 - Prior art search

Each student will search at least 2 most relevant research and development work through journals, patent databases, literature of similar products and any other resource, which can provide information related to their product/ idea/ concept. The students are expected to read thoroughly these documents and make a summary (2-3 pages) of the work described in the documents in their own words. *This exercise will ensure, to some extent, the novelty of the idea, as well as enable students to understand on-going works in the field, relevant to their project.*

Phase 2: Pre-Design

Now, after getting feedback from Users on the modification requirements and finalization on which concept the team will work, students need to work on Pre-Design phase. Basic Pre-design calculations which roughly decide size/shape/material requirements/manufacturing process/design specifications/applicable standards etc. needs to be identified. Students' need to work on identifying the learning needs in Phase 2 that would help to complete the projects further as well as in their professional career. These needs would be mostly industrial/practical needs which are not included in the regular BE syllabus and are important for the students' to learn the skillsets required by the industry.

Activity 04 - Learning Need Matrix (LNM)

Every group of students, with the guidance of their Faculty Guide, need to identify at this stage, the needs for the generic learning, required while they develop their idea. The learning requirements will depend upon and may be specific for the concept/idea for their solution. This will help students to do the research in a timely manner so that they are able to obtain the specific learning/ understanding, they would require for designing the product.

With understanding of the basic branch/ project related subjects, (after having discussions with and the guidance of their Faculty Guide) students will be able to identify *tools/ use of software/ applicable standards/ material / design specifications/ theories/ principles/ methods/ experiments* related needs to be acquired by them to complete their projects successfully.

After identifying the specific learning that will be required to develop their idea/product/concept further, the students have to distribute learning requirements among the members of the group and each member has to learn minimum one component of LNM, in consultation with the Faculty Guide. Students need to make LNM and include it in their report. LNM would include four major aspects as below:

1. Theories/ Methods/ Application Process Involved/ Mathematical Requirement
2. Applicable Standards and Design Specifications/ Principles & Experiments
3. Software/ Tools/ Simulation Methods/ Skill
4. Components Materials' & strengths criteria (Exploration- varieties/testing requirements)

Basic instructions for LNM:

a) The requirements of the core discipline should be identified, may be in relation with the topic of projects, to better correlate the learnings. At the same time the group has to work out the learning needs of the inter-disciplinary domains. The learning ***responsibilities shall be distributed*** equally among the group members. Also all learnings requirement to be brought on a mutually fixed ***timeline.***

b) Here do not concentrate only the requirements that are useful for current project, but aim for gaining practical learning/skillset that is required by industry, but try to learn gradually all the required skills before graduation.

c) Students (along with faculties) shall identify practical limitations due to non-coverage in syllabus to develop their product and focus on the same from the early stages (i.e. Sem. 4) so that development (manufacturing level detailing) of their project, as desired, can be finished.

d) Student must learn **at-least one** component in Sem. 4 which may be learnt in greater details in the rest of the semesters. The students, with the help of the Faculty Guide, will need to prioritize the learning needs and the level of understanding required. However, basis of interest, students may learn more than one components identified in LNM.

e) The students may prepare a comprehensive LNM for the learning needs for their idea/ concept/projects. Also, they may prepare one LNM showing assigned learnings to each individual. Ideally, students need to prepare timeline for all the stages of LNM by the end of the 4^{th} semester with aim of learning at least one component by each group members.

Proof of Concept

This would be the very early stage of prototyping technique where the objective is "To succeed faster, you need to fail fast" to save on energy, time and money. So failure in projects shall be welcomed by students and faculty members to learn from it.

Activity 05 – Dirty Mock-ups/ Fast-prototype/ Schematic plan

The students shall be preparing the rough prototype/ schematic plan on the product/ concept they wish to develop. Here, the students need to show the very basic design calculations/ mathematical aspects (estimated) in the process report, involved in the product development,

based on which the rough prototype/ schematic plan has been prepared. The students shall be expressing their concept/ idea in a clear and understandable form through description, figures, calculations, drawings, model etc. They may also use animations, pictures, drama, skits or video-clips to explain the idea. By doing this students will learn and understand the technical and feasibility aspects of their concept.

Upon preparation of the fast-prototype/ schematic plan on the concept they wish to develop, it needs to be verified by involving some actual users. The students may take their rough prototype to the user and discuss their conceptual thoughts and verify whether the user's expectations are along with the anticipated lines. This inter-action may require the inclusion of any missing or overlooked functions and/or features. Based on such discussions, students will further perform refinement in their design.

Submissions by the end of 4th semester shall be:

A. Process Report comprising:
   a. Introduction (Reverse Engineering – Selection and disassembling of artefact/component)
   b. Preparation of canvases using Design Thinking based on reverse engineering exercise
   c. Feedback analysis with the user shall be clearly included in the report
   d. Summary of findings of Prior Art Search on their purpose/project theme (2 summary papers per student)
   e. Summary of the learning from Reverse Engineering activity
   f. Basic Pre-design calculation which roughly decided size/shape/material requirement/manufacturing process/design specifications/applicable standards
   g. Summary on validation process and refinement in the first-prototype
   h. Any other important aspects you feel should be included

B. Learning Needs Matrix (LNM)
   a. Summary on learning needs by students in the 4th Semester shall be included in report with allocation of learning requirements among the members of the group
   b. With timeline and semester specific learning by team members

C. Fast-prototype model/Conceptual Plan-Layout for process related branches

Note: As per the guidelines and evaluation schemes given in this document, students need to prepare report for their projects. Separate report format will not be provided by University.

Appendix 1: The END SEMESTER Evaluation Scheme for

Design Engineering – 1B (2140002) (4th Semester)

BE – II year – all branches

To,

The Principals/ Directors of Colleges/ Institutes, the Heads of Departments and GTU/Design Engineering coordinators:

Students deserve a proper practical/ viva/ project examination of the work that they have done over the semester (or over the year for a 2-semester project).

It is the responsibility of the University and Colleges that all its examinations are conducted fairly, sincerely and with due diligence.

So please look into the following:

1. Please make proper arrangements so that all the examinations start in-time. If due to any reason, the exam should not start at the right time, please inform the examiners that they should take extra time. But in no case the viva/ practical exam be conducted in a hurry without giving sufficient time for evaluation of every student. If an exam is scheduled to be held over two days, please make the necessary arrangements.

2. The University expects the Deans (and or special teams headed by the Dean or his/ her nominee) to visit the Colleges during the practical/ viva examinations.

3. Please see that all the necessary help and information is provided. Please receive them so that they can do their job properly without wasting their time in searching for the place and in contacting the concerned examiners and students. If they should want to visit the laboratories/ workshops, please make the necessary arrangements.

4. Please inform the external examiner that he/ she must note down **the best 3 projects of the department** and convey the details of such projects by uploading the details of the project or/ and the complete project report on the University's server or send it to design@gtu.edu.in.

5. In case Internet or the server should not work, please provide the technical help to the external examiner for preparing a CD of the reports of the best three projects of every department and please make arrangements to deliver the CD to the examination department of the University.

PROCESS OF EVALUATION: At the ensuing 4th semester examinations, the work of the students in Design Engineering - 1B is to be evaluated by VIVA and the evaluation is to be out of 80 marks.

A Viva-Voce examination will be conducted at the end of the semester by a team of two examiners, one of whom will be an internal Faculty Member, who may have taught the subject (Internal examiner must remain the same throughout the entire of examination for batch). The other will be an external examiner to be appointed by the University. Both examiners must be trained in Design Thinking through the FDP conducted by University.

(Please note that all the other practical and viva voce examinations at the end of the 4th semester will be conducted internally by the College/ Institute.)

EVALUATION SCHEME:

Sr. no.	Particular	Sub-Head Weightage
1.	**Phase 1: Reverse Engineering (RE)** ✓ Selection of Branch specific component/product/artefact/program ✓ Disassembly/Analysis of the component/product/artefact/program and learning about the topic	15
2.	**User Feedback based refinement and redesign of the RE topic based on 3rd semester learning** ✓ Understanding of User's need for Reverse Engineering topic and preparation of canvases/framework for this topic (AEIOU, Mind Mapping, Empathy mapping, ideation, product development) ✓ Prior art search (Two Papers study and summary reports) ✓ Summary of the learning from Reverse Engineering activity	15
3.	**Phase 2: Pre-Design** ✓ Learning Need Matrix (LNM) and the skill set learnt in this semester so far ✓ Basic Pre-design calculation which roughly decide size/shape/material requirement/manufacturing process/design specifications/applicable standards	15
4.	**Phase 3: Proof of Concept** ✓ Dirty Mock-ups/ Fast-prototype/ Schematic plan	15
5.	**Log book** (Individual completed log book, duly signed by guide regularly)	10
6.	**Report:** (Compilation of work, Future action plan, Question and Answer, Communication Skill)	10
		80

Note:

- ✓ Total Marks for the subject: 100 (Practical viva – 80 (External – 40 & Internal – 40), Internal continuous evaluation – 20)
- ✓ Minimum passing marks: 40/80
- ✓ Ratio of evaluation by internal & external examiner appointed: 50% in each sub-head
- ✓ Examiner essentially needs **to evaluate the learning process** of the student during the semester, not only the final outcome. As outcome is important for any project but during the student stage, projects are intended for practical learning and "Learning by doing" is the Mantra for Design Engineering subject *(One should celebrate the failure also and learn from it to get success).* So please evaluate the process properly with giving sufficient time for each project.
- ✓ Students need to explain all canvases prepared in hard copy to the panel of examiners (internal and external).
- ✓ Power point presentation is not mandatory.