GUJARAT TECHNOLOGICAL UNIVERSITY

Course Abstract for

DESIGN ENGINEERING – 1B

(4TH SEMESTER)

Course Initiated by:

Centre for Industrial Design

(OPEN DESIGN SCHOOL)

For any query, please write us at: design@gtu.edu.in

Design Engineering – 1B (3140005) (4th Semester)

Module 2: Applying Design Thinking

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

Course category: ***Compulsory/Core - Intermediate***

Examination Pattern: ***Internal evaluation/viva at the end of semester***

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

				Credit				Marks				
Subject code	**Subject Name**	**Category**	**Sem.**	**L**	**T**	**P**	**Total**	**E**	**M**	**I**	**V**	**Total**
3140005	DE - 1B	Project Work	4	0	0	2	1	0	0	20	80	100

*L=lectures, T=tutorial, P=Practical, E=Theory External, M=Theory Internal, I=Practical Internal, V=Practical External, OJT=On Job Training is equivalent to Practical

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 the understanding design thinking course by translating the concepts into exercises. Here branch specific topics need to be selected by students, apply reverse engineering, modify existing solutions 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 and worked upon general topic/domain irrespective of their branch. Now in 4th semester, they need to select **branch specific existing artefact/solution, apply Reverse Engineering (RE) and modify/redesign** it as per the User's needs using Design Thinking. There are three core objectives of introducing RE and integrating Design Thinking with it: (1) Students will learn some basic concepts 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 imbibe Design Thinking approach into core engineering subject for practical learning, (2) they will use Design Thinking process again to refine their learning and (3) some of the existing solutions will be modified/redesigned through

DE projects which can be helpful to user/society. In this module also whole Design Thinking process will be used by students, but more emphasis on Ideation and initial Product Development phases. 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 allocate more/less time to the activities.

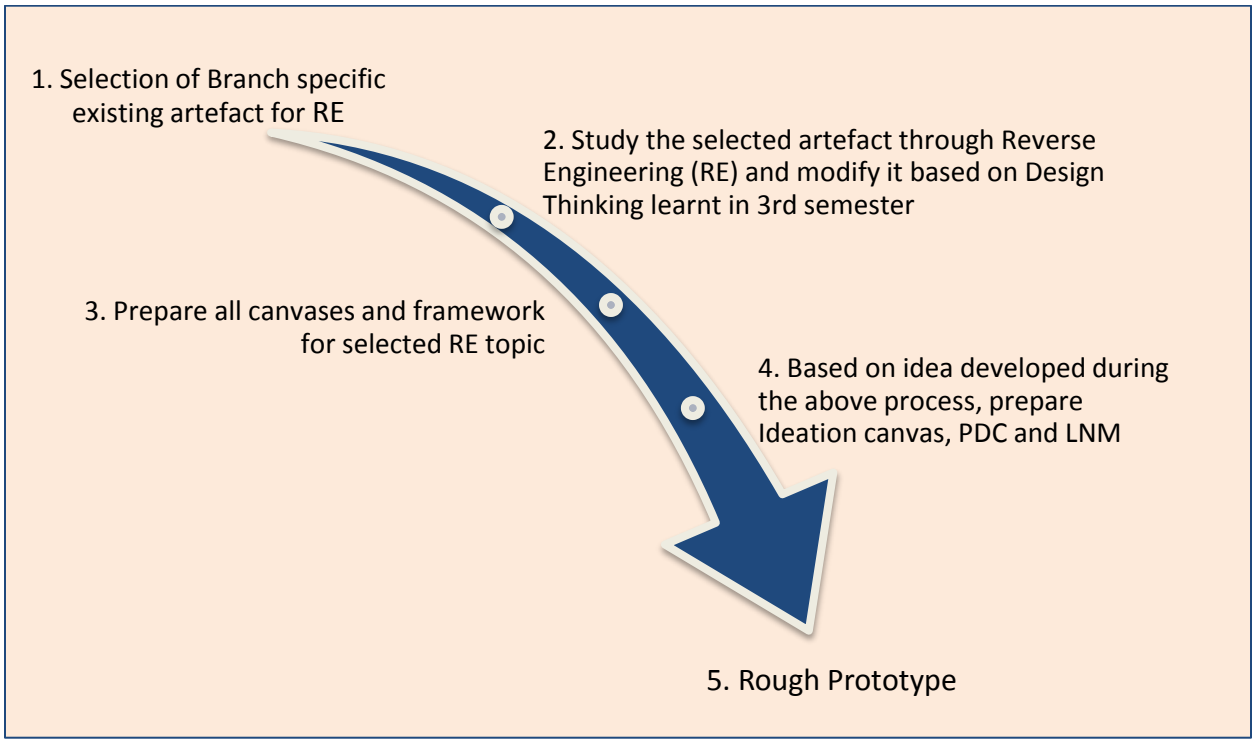
Students in 4th semester need to follow week-wise activities as mentioned below to complete course requirements.

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 may change your team member here in 4th sem)	○ 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 topic ○ Dissemble the existing selected artefact/product/component/process/system to study technical aspects and design detail involved ○ Identify issues related to existing solutions	○ Brief lecture/exercise ○ Hands-on practice sessions with cases /examples ○ Reverse engineering document link is given in General Guidelines document
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	○ Students need to visit their domain/place where they can interact with user for getting insights. ○ Here, observation can be of direct user of the selected solutions, manufacturer and dealer or from point of view

		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 ○ Secondary research/Prior art search (prior art search is continuous activity and can be used in any phase to strengthen the idea) ○ Group wise presentation followed by Discussion ○ Define Problem statement (format is given in reference PPT on DE portal) ○ Verification of problem identified by team through users/stakeholders	of repairer/maintenance person/services provider. 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 guideline, 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 Ideation canvas ○ Sketching of rough ideas ○ Preparation of Ideation canvas	○ Students will work on their Ideation canvas ○ Ideation activities shall be performed in class with team members under guidance of teacher

Product Development Phase	9, 10	○ Preparation of Product Development Canvas (PDC) to modify existing product ✓ Product Experience ✓ Product Functions ✓ Product Features ✓ Components ○ Discussion on PDC	○ 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	○ Learning Need Matrix (LNM) ○ Detail design and refinement ○ Prototype (Here strategy is to fail fast to succeed fast)	○ Building the solutions exercises ○ Iterate, Iterate, Iterate….. ○ LNM document link is given in General Guidelines document
Feedback & Final Report	14	○ Upload duly signed Continuous Assessment Card ○ Feedback, Online certificate generation through DE portal ○ 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].

[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 existing artefact/component/process/system/solution
2. Disassemble/Understand it for learning the technical/engineering aspects involved in it
3. Identify issues related to selected existing solution and try to modify it using Design Thinking approach
4. Apply Design Thinking approach to find out the Unmet needs of User related to selected artefact/component

5. Follow phases of Observation, Empathy, Ideation and Product Development by preparing related canvases/frameworks
6. Modify/redesign the artefact/component to meet Users unmet needs

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

Each group has to select one branch specific existing artefact/component/process/system/solution 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.

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 identified problems 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 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 the 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 the concept, 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 these skillsets required by the industry.

Activity 04 - Learning Need Matrix (LNM)

Learning Needs Matrix will help students to **identify the learning requirements that are much needed in industry or in their career** at an early stage along with *prioritization of specific learning*. Every students individually or in team, with the guidance of their Faculty Guide/Industry mentor, would identify the industrial skills for the generic learning. The learning requirements may depend upon and may be specific for the concept/idea for their solution **or** completely independent as per their choice and the field in which they wish to pursue their career. 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/solutions.

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 or to

succeed in their professional career after graduation. Students can maintain the same LNM sheet till final year (8th sem) and learn the specific skill sets that they want to pursue at each semester. As per change in requirements and learning needs at each semester, LNM may be refined and versions of it shall be prepared and present to examiners during final viva exam. The semester wise allocation for each skill sets need to be done by students and guide. Priority learning shall be taken up as per the core subject of each semester. Internal Guide will track and evaluate the learnings of students through LNM. Students may co-learn the skill sets with other students.

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 or independently, 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 and not included in the syllabus and 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 interest/idea/concept/projects. Ideally, students need to prepare timeline for all the stages of LNM by the end of the 4th 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 interaction 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 (RE) – Selection and disassembling of artefact/component)
   b. Images 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. AEIOU framework
C. Mind Map
D. Empathy Map
E. Ideation Canvas
F. Product Development Canvas (PDC)
G. 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

H. Rough prototype model/Conceptual Plan-Layout for process related branches
I. Individual Log Book (duly signed by faculty guide)
J. Continuous Assessment Card for Internal Evaluation (Document separately available on GTU website)

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, students and faculty members may create their own creative formats. However, in general guidelines document uploaded on GTU website, there are some report format links are given which may help for report format.

Appendix 1: The END SEMESTER Evaluation Scheme for

Design Engineering – 1B (3140005) (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 scheduled 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. *As it came to University's notice that some examiners and colleges are completing viva exam in 1 or 2 hours' time of entire class which is not acceptable in any case and it's immoral practice for any education institute. So all stakeholders need to take extra care of this issue.*

3. Please see that all the necessary help and information is provided to examiner. 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 departments and students. If they wish to visit the laboratories/workshops, please make the necessary arrangements.

4. Please inform the 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 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/BE section 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 through **Internal Viva exam and the evaluation is to be out of 80 marks.** Institute may organize inter-department viva or project show case so students would get various expert opinions to motivate them.

For 4th semester, internal Viva-Voce examination will be conducted at the end of the semester by **a team of three examiners - One internal guide, one inter/own departmental faculty, one industry expert (industry expert may be optional but recommended).** Internal examiners/teachers must be trained in Design Thinking through the FDP conducted by University.

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) **Continuous Assessment Card** for Internal Evaluation (Complete and duly signed by guide regularly)	10

6.	**Report:** Compilation of work report (process report), Online Certificate generated through DE Portal, Future action plan, Question and Answer, Communication Skill, Attitude	10
		80

Note:

- ✓ Total Marks for the subject: 100 (Internal end semester viva exam – 80 & Internal continuous evaluation – 20)
- ✓ Minimum passing marks: 40/80
- ✓ 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 Design Thinking process and their learning properly with giving sufficient time for each project.
- ✓ Students need to explain all canvases prepared in hard copy to the panel of examiners.
- ✓ Power point presentation is not mandatory.

For any query & suggestions, kindly contact course coordinator:

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