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						Hours			Credit	Max Marks				
Exp.	Subcode	Branch code	Eff_from	SubjectName	Category	Sem /Year	L.	T.	P.	Total	E	M	I	V	Total
⊞	3130004	36	2018-19	Effective Technical Communication	Humanities and Social Science	3	2	0	2	3	70	30	20	30	150
⊞	3130007	36	2018-19	Indian Constitution	Mandatory	3	2	0	0	0	50	0	0	0	50
⊞	3130008	36	2018-19	Design Engineering - I A	Project Work	3	0	0	2	1	0	0	20	80	100
⊞	3133601	36	2018-19	Introduction to Medicinal Chemistry, Biochemistry & Physiology	Specialized Subjects - I	3	4	0	0	4	70	30	0	0	100
	3133603	36	2018-19	Introduction to Glass & Ceramics-I	Specialized	3	4	0	0	4	70	30	0	0	100

					Subjects - I										
	3133604	36	2018-19	Introduction to colorants	Specialized Subjects - I	3	4	0	0	4	70	30	0	0	100
	3133606	36	2018-19	Fundamentals of Material & Energy Balance Calculations	Professional Core	3	4	1	0	5	70	30	0	0	100
	3133607	36	2018-19	Physical Chemistry	Basic Science	3	3	0	4	5	70	30	20	30	150
	3133608	36	2018-19	Basics of Fluid Flow	Engineering Science	3	3	1	2	5	70	30	20	30	150
	3133609	36	2018-19	Chemistry & Technology of Polymers	Specialized Subjects - I	3	4	0	0	4	70	30	0	0	100

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						Hours			Credit	Max Marks				
Exp.	Subcode	Branch code	Eff_from	SubjectName	Category	Sem /Year	L.	T.	P.	Total	E	M	I	V	Total
⊞	3140005	36	2018-19	Design Engineering 1 B	Project Work	4	0	0	2	1	0	0	20	80	100
⊞	3140509	36	2018-19	Pollution control & safety Management	Humanities and Social Science	4	3	0	2	4	70	30	20	30	150
⊞	3143610	36	2018-19	Organic Chemistry for Technologists	Basic Science	4	3	0	4	5	70	30	20	30	150
⊞	3143611	36	2018-19	Basics of Heat Transfer	Professional Core	4	3	1	2	5	70	30	20	30	150
	3143612	36	2018-19	Mechanical Operations	Professional	4	3	0	2	4	70	30	20	30	150

					Elective - I										
	3143613	36	2018-19	Particle and Fluid Particle processing	Professional Elective - I	4	3	0	2	4	70	30	20	30	150
	3143614	36	2018-19	Medicinal Chemistry-I & Microbiology	Specialized Subjects - II	4	4	0	2	5	70	30	20	30	150
	3143615	36	2018-19	Polymer & Rubber Synthesis and Analysis	Specialized Subjects - II	4	4	0	2	5	70	30	20	30	150
	3143616	36	2018-19	Chemistry of dyes intermediates	Specialized Subjects - II	4	4	0	2	5	70	30	20	30	150
	3143617	36	2018-19	Introduction to Glass & Ceramics-II	Specialized Subjects - II	4	4	0	2	5	70	30	20	30	150

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						Hours			Credit	Max Marks				
Exp.	Subcode	Branch code	Eff_from	SubjectName	Category	Sem /Year	L.	T.	P.	Total	E	M	I	V	Total
⊞	3150001	36	June 2020	Design Engineering - II A	Project Work	5	0	0	2	1	0	0	20	80	100
⊞	3150004	36	June 2020	Contributor Personality Development Program	Personality development Elective	5	2	0	0	2	70	30	20	30	150
⊞	3150005	36	June 2020	Integrated Personality Development Course	Personality development Elective	5	2	0	0	2	70	30	20	30	150
⊞	3153601	36	June 2020	Pharamceutical Chemistry	Specialized Subjects - III	5	4	0	2	5	70	30	20	30	150

	3153616	36	June 2020	Elements of Plant Design & Economics	Humanities and Social Science	5	3	0	0	3	70	30	0	0	100
	3153617	36	June 2020	Basics of Mass Transfer	Professional Core	5	4	0	2	5	70	30	20	30	150
	3153618	36	June 2020	Process Instrumentation Dynamics & Control	Professional Core	5	3	0	2	4	70	30	20	30	150
	3153619	36	June 2020	Synthesis of Thermoplastic	Specialized Subjects - III	5	4	0	2	5	70	30	20	30	150
	3153620	36	June 2020	Synthetic Colourants	Specialized Subjects - III	5	4	0	2	5	70	30	20	30	150
	3153621	36	June 2020	Glass Science & Technology	Specialized Subjects - III	5	4	0	2	5	70	30	20	30	150
	3153622	36	June 2020	Chemical synthesis for Technologists	Open Elective - I	5	3	0	0	3	70	30	0	0	100
	3153623	36	June 2020	Nano materials & Technology	Open Elective - I	5	3	0	0	3	70	30	0	0	100
	3153624	36	June 2020	Material science and Technology	Open Elective - I	5	3	0	0	3	70	30	0	0	100

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						Hours			Credit	Max Marks				
Exp.	Subcode	Branch code	Eff_from	SubjectName	Category	Sem /Year	L.	T.	P.	Total	E	M	I	V	Total
⊞	3160001	36	Dec-2020	Design Engineering II B	Project Work	6	0	0	2	1	0	0	20	80	100
⊞	3160002	36	Dec-2020	Contributor Personality Development Program	Personality development Elective	6	2	0	0	2	70	30	20	30	150
⊞	3160003	36	Dec-2020	Integrated Personality Development Course	Personality development Elective	6	2	0	0	2	70	30	20	30	150
⊞	3163608	36	Dec-2020	Technology of Dyeing	Specialized Subjects - V	6	3	0	2	4	70	30	20	30	150

	3163610	36	Dec-2020	Analytical Techniques	Professional Core	6	4	0	2	5	70	30	20	30	150
	3163612	36	Dec-2020	Fundamentals of Reaction Engineering	Professional Core	6	3	0	2	4	70	30	20	30	150
	3163613	36	Dec-2020	Formulation Technology of Liquids, Topicals and Solid Dosage forms	Specialized Subjects - IV	6	3	0	2	4	70	30	20	30	150
	3163614	36	Dec-2020	Synthesis of Thermosets	Specialized Subjects - IV	6	3	0	2	4	70	30	20	30	150
	3163615	36	Dec-2020	Synthetic Pigments	Specialized Subjects - IV	6	3	0	2	4	70	30	20	30	150
	3163616	36	Dec-2020	Refractories - I	Specialized Subjects - IV	6	3	0	2	4	70	30	20	30	150
	3163617	36	Dec-2020	Medicinal Chemistry - II and Medicinal Natural Products	Specialized Subjects - V	6	3	0	2	4	70	30	20	30	150
	3163618	36	Dec-2020	Polymer and Rubber Processing	Specialized Subjects - V	6	3	0	2	4	70	30	20	30	150
	3163619	36	Dec-2020	Whitewares-I	Specialized Subjects - V	6	3	0	2	4	70	30	20	30	150
	3163620	36	Dec-2020	Chemical Process Industries	Open elective - II	6	3	0	0	3	70	30	0	0	100
	3163621	36	Dec-2020	Corrosion Science & Technology	Open elective - II	6	3	0	0	3	70	30	0	0	100

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						Hours			Credit	Max Marks				
Exp.	Subcode	Branch code	Eff_from	SubjectName	Category	Sem /Year	L.	T.	P.	Total	E	M	I	V	Total
⊞	3170001	36	June 2021	Summer Internship	Project	7	0	0	0	2	0	0	20	80	100
⊞	3173614	36	June 2021	Refractories - II	Professional Elective - VI	7	3	0	2	4	70	30	20	30	150
⊞	3173616	36	June 2021	Chemical Engineering Thermodynamics	Professional Core	7	3	0	0	3	70	30	0	0	100
⊞	3173617	36	June 2021	Principles of Process Equipment Design	Professional Core	7	3	0	2	4	70	30	20	30	150
	3173618	36	June 2021	Technology of Sterile Dosage Forms and Pharmaceutical	Professional	7	3	0	2	4	70	30	20	30	150

				Packaging Technology	Elective - VI										
	3173619	36	June 2021	Polymer Blends and Composties	Professional Elective - VI	7	3	0	2	4	70	30	20	30	150
	3173620	36	June 2021	Technology of Pigments	Professional Elective - VI	7	3	0	2	4	70	30	20	30	150
	3173621	36	June 2021	Drug Delivery, Biotechnology, Validation Requirements and Regulatory Affairs	Specialized Subjects - VII	7	3	0	2	4	70	30	20	30	150
	3173622	36	June 2021	Sophisticated Testing of Polymers and Rubbers	Specialized Subjects - VII	7	3	0	2	4	70	30	20	30	150
	3173623	36	June 2021	New development in dyes	Specialized Subjects - VII	7	3	0	2	4	70	30	20	30	150
	3173624	36	June 2021	Physical Ceramics	Specialized Subjects - VII	7	3	0	2	4	70	30	20	30	150
	3173625	36	June 2021	Process Technology of Drugs and Intermediates and Nanotechnology	Specialized Subjects - VIII	7	3	0	2	4	70	30	20	30	150
	3173626	36	June 2021	Polymer Material, Properties and Structure	Specialized Subjects - VIII	7	3	0	2	4	70	30	20	30	150
	3173627	36	June 2021	New developments in Pigments	Specialized Subjects - VIII	7	3	0	2	4	70	30	20	30	150
	3173628	36	June 2021	Advanced Ceramics	Specialized Subjects - VIII	7	3	0	2	4	70	30	20	30	150
	3173629	36	June 2021	Green Technology and Sustainable Development	Open Elective - III	7	3	0	0	3	70	30	0	0	100
	3173630	36	June 2021	Renewable Energy Sources	Open Elective - III	7	3	0	0	3	70	30	0	0	100

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							Hours			Credit	Max Marks				
Exp.	Subcode	Branch code	Eff_from	SubjectName	Category	Sem /Year	L.	T.	P.	Total	E	M	I	V	Total
⊞	3183601	36	Dec 2021	Internship/Project	Project Work	8	0	0	24	12	0	0	100	100	200

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Evaluation scheme of (Industry Defined Project / User Defined Projects) for University Project Exam for 8th semester in B.E.

The examination for the project will consist of a presentation of the work, explanation of the work through power-point slides and viva-voce**.**

Case-1: Where the students and Guide contextually decide to complete the current project in upcoming academic years (relay model of projects) by students of upcoming batches or the same team in case the project is partially complete and it is needed to be taken further till it realizes its objectives.

Sr.No	**Description**	% weight age of Mark Distribution
1	Innovativeness and creativity within IDP as well as utility of the project for Industry/Academic or society	10
2	Review of Literature, Documentation of work & related studies about the project	15
3	Implementation Strategies	15
	Selection of Proper Tools / Techniques for Implementation	
4	Effectiveness of Work plan/ schedule/project planning	30
	Completed work and target achieved / output delivered/Future planning to complete rest of the objectives	
5	Content of the report	15
6	Soft Skills - Communication Skills, Team spirit (if working in group)	5
7	Question and Answer	10
	TOTAL	**100**

Case-2: Where the students and Guide had contextually decided to complete the project at the end of 8th semester and team is finishing the project in this academic year only.

Sr.No	**Description**	% weight age of Mark Distribution
1	Innovativeness and creativity within IDP as well as Utility of the project for Industry/Academic or society	10
2	Review of Literature, Documentation of work & related studies about the project	15
3	Implementation Strategies	10
4	Selection of Proper Tools / Techniques for Implementation	5
5	Effectiveness of adopted Work plan, work completed	20
6	Presentation of work during the entire academic year	15
7	Content of the report	10
8	Soft Skills - Communication Skills, Team spirit (if working in a group)	5
9	Question and Answer	10
	TOTAL	**100**

For Projects (IDP/UDP) individual student has to score 40% marks in the project examination.

The students have to submit the Final Project report (Soft and hard copy) before University Viva Examination in the 8th semester to the concerned department. A brief Report /Presentation is to be submitted to concerned authority before commencement of University Examinations.

For feasibility the teams have to show case a model /prototype during final exam in suitable branches.

- * * * *

Course Abstract

Design Engineering – 1A (2130005) (3rd Semester)

Module 1: Understanding Design Thinking

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

Usual time of occurrence: ***3rd Semester***

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

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

Credits: ***03***

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

Prerequisites: ***Optimistic mind-set, Enthusiasm of learning new things, Un-learning***

Relevance

This course is meant for beginners. The course is designed to initiate Design Thinking understanding for the 3rd semester students.

Objective: Understanding Design Thinking

The course aims to expose students to the basic process and framework of Design Thinking and relevant tools & techniques for Creativity & Innovation.

Course Contents

This Course is designed to give very basic understanding of the Design Thinking methodology. 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.

In Design Engineering – 1A, student will select **very basic and small, individual or team project irrespective of their branch.** This project would be from very general topic/domain like designing something for yourself/parents/Teacher/Friends (Whole class may select single project topic or similar topic in different small groups to have healthy competition among the class). This kind of basic project would give good understanding of Design Thinking process. **In this module, student will use whole Design Thinking process as shown in guideline document to complete their projects but here the learning objective or focus would be more on Observation or Empathy process.** So students need to give more time to these phases and then reach up to the rough prototype phase. Students in 3rd semester need to follow below week-wise activities to complete the course requirement for 3rd semester.

Design Thinking Process – with Tools & Techniques

Module 1: DE-1A Understanding Design Thinking

Broad segment	Week	Description	Operational need
Design Thinking Introduction	1	○ Overview, objective and goal of this course ○ What is Design Thinking? - Its importance, socio-economical relevance ○ Design thinking to foster innovation ○ Relevance of design and design thinking in engineering ○ Systematic problem identification & problem solving approaches	○ Brief lecture/exercise ○ Hands on exercise to understand attributes of Design Thinking
	2	○ Domain Selection (general topic/products) ○ Team Building Exercise ○ Log book, documentation strategy – introduction, importance, preparation	○ Brief lecture/exercise ○ Hands-on sessions with cases/examples ○ Individual logbook is required
	3	○ **Learning tools** ✓ Design in nature/Bio-mimicry ✓ Design as a System approach ✓ Design as listening tool for mapping users' unmet needs	○ Brief lecture/exercise ○ Next week Students need to present on the learning from these topics
Empathization Phase	4,5,6	○ **Observation:** Through **AEIOU** framework ✓ Orientation to Field Work – Need for field visit? ✓ What/How/Where to Observe ✓ Ethnographic tools and its usage ✓ What difference it will make if the problem solved - partially or fully? ✓ Could solution be worse than the problem? ✓ Key pain and pleasure points ✓ Understanding of User Contexts ✓ Log book exercise	○ Students will be introduced to different observation/scouting methods in the theory session in class for all four weeks in different sessions ○ Then during weeks, they need to visit their selected domain/place for getting insights and define problems. ○ Minimum 4-5 field trips will be required to get

		✓ Analysis of Data - Mind Mapping ○ **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	better insights on users' needs.
		○ Summary of AEIOU activity/inputs ○ Preparation of Mind Map, Empathy Map	○ Class as well as homework/field activity
Define Phase: Problem Definition by secondary research ,group work and presentation	7	○ Secondary research/Prior art search (prior art search is continuous activity and can be used in any phase to strengthen the idea) ○ Diachronic and Synchronic analysis ○ Group wise presentation followed by Discussion ○ Verification of problem identified by team through users/stakeholders	○ After rigorous and systematic field exercises, empathization and Secondary Research activities -student teams need to define their problem here (it can be further validate through Ideation phase)
Ideation Phase	8	○ Preparation of Ideation canvas ✓ Brainstorming (What, Why, How, When, For Whom) ✓ Situation/Context/Location ✓ Props/non-living things/tools/equipment ✓ Opportunity mapping	○ 2 hour – explanation of Ideation canvas to class ○ Then students will work on their Ideation canvas (min 3 hours continuous workshop)
	9	○ Combination of Ideas from opportunity mapping ○ *Design Thinking is a Convergent-Divergent process*	○ Student teams need to discuss their Ideation canvas with other teams, faculty guides and users and take feedbacks
	10	○ Prioritizing and finalizing Idea (After group discussion and consulting with faculty guide, student teams need to select their final problem & idea for further development)	○ Students team need to validate the final Problem & idea/concept with Users/Stakeholders after this activity

Product Development Phase	11	○ Preparation of Product Development Canvas (PDC) ✓ Product Experience ✓ Product Functions ✓ Product Features ✓ Components ○ Sketching of mock concepts in log book ○ Discussion on Product Development Canvas (PDC)	○ 1.5 hour – explanation of product development canvas to class ○ Then students will work on their PD canvas (min 3 hour continuous workshop) ○ Till 12th week of the course, Students team will discuss on their PDC with other groups and faculty guide ○ Refinement of PDC after discussion
	12	○ Customer/User Revalidation (Reject/Redesign/Retain) ○ Refinement	○ Till 13th week of the course, student team will consult the Users/Stakeholders for their inputs for concept finalization after various stages and incorporate necessary changes.
Proof of Concept	13	○ Rough Prototype ○ Here strategy is "fail fast to succeed faster"	○ Very early & rough prototype ○ Made up of paper, cardboard, thermocol etc. whichever material is available
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

Submissions by the end of 3rd semester shall be:

A. Process Report comprising:
   a. Introduction (Describe your project in detail including domain – type, place, why and how team selected this domain and why this domain is important in relation to Design Thinking/Human-Centered process etc.)
   b. Preparation of canvases based on different phase of Design Thinking
   c. Feedback analysis with the user shall be clearly included in the report
   d. Summary of findings of Prior Art Search on purpose/project theme (2 summary papers per student)
   e. Summary of the learning from Design Thinking
   f. Summary on validation process and refinement in the rough prototype
   g. 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. Rough prototype model/Conceptual Plan-Layout for process related branches
H. Individual Log Book (duly signed by faculty guide)

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-1A (2130005) (3rd 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 3rd semester examinations, the work of the students in Design Engineering – 1A is to be evaluated through 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 than DE subject, practical and viva voce examinations at the end of the 3rd semester will be conducted internally by the College/ Institute.)

EVALUATION SCHEME:

Sr. No.	Particular	Sub-Head Weightage
1.	**Understanding of Design Thinking methodology/ need** ✓ Importance of various Learning tools of Design Thinking	15
2.	**Observation towards Empathy** ✓ Field Activity/observation and outcome ✓ Mind Mapping-Summarization and data analysis ✓ Observation Technique (AEIOU Summary)	20
3.	**Log book** (Individual completed log book, duly signed by guide regularly)	10
4.	**Understanding of Canvases/Framework** ✓ AEIOU, Mind Mapping ✓ Empathy mapping ✓ Ideation Canvas ✓ Product development	15
5.	**Design Problem Definition** ✓ Secondary research/ Prior art search ✓ Diachronic and Synchronic analysis	10
6.	Compilation of work report (process report), 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.

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

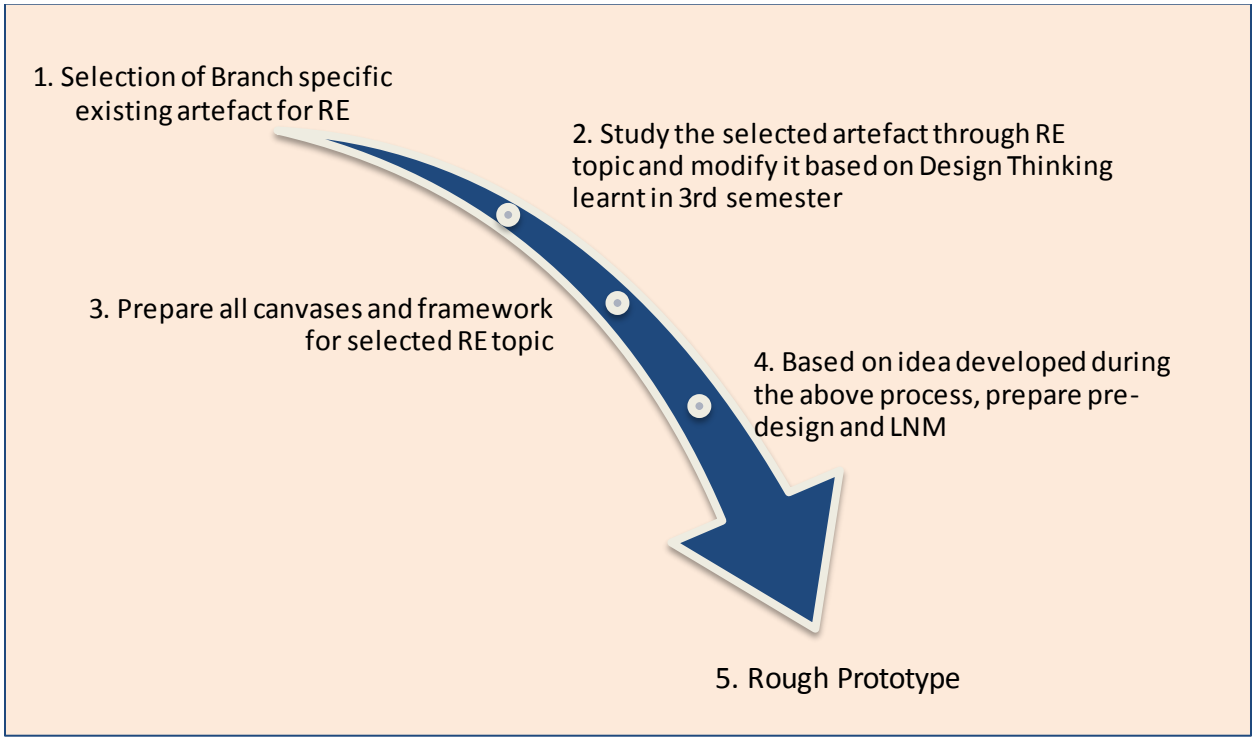
learning aspects, but depending upon the type and nature of projects, students and guide may re-schedule the activities.

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.

Course Abstract

Design Engineering – 2A (2150001) (5th Semester)

Module 3: Applying Design Thinking

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

Usual time of occurrence: ***5th Semester***

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

Course category: ***Core - Advance***

Credits: ***03***

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

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

Relevance

This is a mid-level course designed for those who have undergone the fundamentals of Design Thinking process in 2nd year and understand the importance and process completely.

Objective: Applying Design Thinking

The course aims to validate the learnings from the understanding Design Thinking course, by translating the concepts into exercises. In this module, students will work upon community based projects to validate their learning of Design Thinking process.

Course Contents

Students have learnt the fundamentals of Design Thinking methodology in 2nd year and successfully gone through the process twice while working on general as well as branch specific topics. Now in 5th and 6th semester, being a socially responsible engineer, students need to work on **community/society based project** using Design Thinking process. Here in 5th semester emphasis would be on Observation, Empathy, Ideation and Product Development; while in 6th semester emphasis will be on detail design, prototyping and validation of the solutions in real environment. At this stage, it is essential to identify parameters and check five basic design principles viz. 1) Technical, 2) Ergonomics, 3) Aesthetics, 4) Cost and 5) Environment keeping System Approach in mind. Designing something new involves several iterations on different stages/ components/ aspects. Before investing further resources in terms of time/ money/ manpower it is important to strengthen these five principles to advance for novelty. It will include several rigorous iterative efforts to make final product/process.

It is essential for students to enhance and refine their learning by using Design Thinking process, keeping System Approach in mind while working on projects.

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 5th semester need to follow below week-wise activities to complete the course requirement for 5th semester.

Design Thinking Process – with Tools & Techniques			
Module 3: DE-2A Applying Design Thinking			
Broad segment	**Week**	**Description**	**Operational need**
Orientation with revision of Design Thinking	1, 2	○ Domain Selection (Community/Society based topic) ○ Students need to decide their community/society based problem (here community people would be main stakeholder for the project) ○ Team Building Exercise ○ Log book	○ Brief lecture/exercise ○ Government, NGO or any Social agencies can be contacted for project ○ Individual logbook is required
Empathization Phase	3, 4, 5	○ **Observation:** Through AEIOU framework ○ **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	○ Students will use different observation/scouting methods for Observation and Empathy ○ Then, they need to visit their domain/place of interest for getting insights and define problems. ○ Several field trips will be required to get better insights on users' needs.
		○ Summary of AEIOU activity/inputs ○ Preparation of Mind Map, Empathy Map	○ Class as well as homework/field activity
Problem Definition by secondary	6	○ Secondary research/Prior art search ○ Diachronic and Synchronic analysis ○ Group wise presentation followed by	○ After rigorous and systematic field exercises, empathization and

research, group work and presentation		Discussion ○ Verification of problem identified by team through users/stakeholders	Secondary Research activities -student teams need to define their problem here (it can be further validate through Ideation phase)
Ideation Phase	7, 8, 9	○ Preparation of Ideation canvas ✓ Brainstorming (What, Why, How, When, For Whom) ✓ Situation/Context/Location ✓ Props/non-living things/tools/equipment ✓ Opportunity mapping ○ Combination of Ideas from opportunity mapping ○ *Design Thinking is a Convergent-Divergent process*	○ students will work on their Ideation canvas ○ Student teams need to discuss their combination of ideas from Ideation canvas with other teams, faculty guides and users and take feedbacks.
	10	○ Prioritizing and finalizing Idea (After group discussion and consulting with faculty guide, student teams need to select their final problem & idea for further development)	○ Students team need to validate the final Problem & idea/concept with Users/Stakeholders after this activity
Product Development Phase	11	○ Preparation of Product Development Canvas (PDC) ✓ Product Experience ✓ Product Functions ✓ Product Features ✓ Components ○ Sketching of mock concepts in log book ○ **SCAMPER tool**	○ students will work on their PD canvas ○ Till 12th week of the course, Students team will discuss on their PDC with other groups and faculty guide ○ Refinement of PDC after discussion
	12	○ Customer/User Revalidation (Reject/Redesign/Retain) ○ Refinement	○ Till 13th week of the course, student team will consult the Users/Stakeholders for their inputs on concept and incorporate necessary changes

Proof of concept	13	○ Pre-Design ○ Iteration & Modification based on feedbacks ○ Rough Prototype ○ Iterate, Iterate, Iterate…..	○ Design Thinking is iterative and experimental in nature, so before investing in material, money, resources and time, one should have all possible iterations
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

By the end of 5th semester, student's team will be ready with their well-defined Design Problem and probable solutions to that problem as shown in above table.

Submissions by the end of 5th semester shall be:

A. Process Report comprising:
   a. Introduction (Describe your project in detail including domain – type, place, why and how team selected this domain and why this domain is important in relation to Design Thinking/Human-Centered process etc.)
   b. Preparation of canvases based on different phase of Design Thinking
   c. Feedback analysis with the user shall be clearly included in the report
   d. Summary of findings of Prior Art Search on purpose/project theme (2 summary papers per student)
   e. Summary of the learning from Design Thinking
   f. Summary on validation process and refinement in the rough prototype
   g. 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. Rough prototype model/Conceptual Plan-Layout for process related branches
H. Individual Log Book (duly signed by faculty guide)

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 – 2A (2150001) (5th Semester)

BE III 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 5th semester examinations, the work of the students in Design Engineering – 2A 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 5th semester will be conducted internally by the College/Institute.)

EVALUATION SCHEME:

Sr. No.	Particular	Sub-Head Weightage
1.	**Observation towards Empathy** ✓ Field Activity/observation and outcome ✓ Mind Mapping-Summarization and data analysis ✓ Observation Technique (AEIOU Summary)	20
2.	**Log book** (Individual completed log book, duly signed by guide regularly)	10
3.	**Design Problem Definition** ✓ Secondary research/ Prior art search ✓ Diachronic and Synchronic analysis	10
4.	**Canvases/Frameworks** ✓ AEIOU, Mind Mapping ✓ Empathy mapping ✓ Ideation Canvas ✓ Product development	15
5.	Pre-Design Calculations	15
6.	Compilation of work report (process report), 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.

Course Abstract

Design Engineering – 2B (2160001) (6th Semester)

Module 4: Building the Solution

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

Usual time of occurrence: ***6th Semester***

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

Course category: ***Core - Advance***

Credits: ***03***

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

Prerequisites: ***Design Engineering – 1A, Design Engineering – 1B, Design Engineering – 2A***

Relevance

This is an advance level course designed for those who have undergone the fundamentals of Design Thinking process and understand the importance and process completely.

Objective: Building the Solution

The course aims to validate the learnings from the understanding Design Thinking course by translating the concepts into exercises. In this module, student will continue their work from 5th semester on Community based project and complete the Design Thinking cycle with emphasis on product development, detail design, prototyping and validation of the solutions in real environment.

Course Contents

Students have started community based projects and successfully gone through the process of Observation, Empathy, Ideation and initial stages of Product Development in 5th semester. Now in 6th semester, they will **continue their work** from concept to product development, detail design, prototyping and validation of the solutions in real environment. All students' team need to work towards final prototype and then test it in real environment. Final working model with YouTube video link is required for this module.

In 6th semester, students will consider various design considerations as described further in this document for detail design and then first prepare their models in software if required and then use prototyping techniques to further build the concepts. 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 6th semester need to follow below week-wise activities to complete the course requirement for 6th semester.

Design Thinking Process – with Tools & Techniques			
Module 4: DE-2B Building the Solutions			
Broad segment	**Week**	**Description**	**Operational need**
System level Design	1	○ Plan of Action in 6th semester ✓ Based on revalidation, feedback from last semester (5th semester) plan for future aspects	○ Discussion with faculty guide and modification based on feedbacks
Detailed Design	2, 3, 4	○ Detailed Design (including all aspects of products, material, process, resources, standards etc.)	○ Brief lecture/exercise ○ Very minute details of the concept will be considered ○ Prototyping techniques may be used to iterate
CAD Modelling & Analysis	5, 6, 7	○ CAD Modelling & Analysis (Branch specific software will be used depending on projects)	○ Software saves on time, money, resources etc. ○ Branch specific softwares must be provided by the college for students to use for their projects
Building the solutions	8, 9, 10, 11	○ Prototyping (sequential prototyping for iterations) ○ Customer Revalidation ○ Modification ○ Iterate, Iterate, Iterate…..	○ Prototype does not mean final product or working model but it is the process/phase to reach up to final product

Final Prototype	12	○ Final working model should be prepared (The projects that involve higher cost and limitations on technology should be allowed other ways of prototyping other than working model)	○ YouTube link of final working model is required for full mark
Project Fair	13	○ Open project showcase/fair for showing the projects for Students, faculty members, local people and industrialists	○ This fair should be open for all in surrounding area of college ○ It is compulsory to organize DE project fair
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

In the 6th semester, student's team will validate their concept and detailed design part with reference to (1) Design for performance, safety and reliability, (2) Design for Ergonomics and Aesthetics, (3) Design for Manufacturing & Assembly (DFMA), (4) Design for cost & Environment, (5) Modelling and Analysis of their design (6) Prototyping (7) Engineering Economics of Design, (8) Design for Use, Reuse and Sustainability and (9) Test the prototype. And additionally students will also learn topic like (10) *Ethics in Design*.

Following aspects should be taken into account while developing product.

1. Design for Performance, Safety and Reliability:

- ✓ *Design for performance:* The final product/process must perform for designed (projected in Product Development Canvas - PDC) features and functions as per the requirement of the user in actual working environment (revealed through rough-prototype validation).

- ✓ *Design for Safety:* Safety is the most important aspect of human centric product/process. Reasonable factor of safety should be taken into account considering all adverse and factual factors (Ideation canvas – location/context/situation may be referred back here) as there is human interaction with product/process in manifold circumstances.
- ✓ *Design for Reliability:* Reliability is the ability of a system or component to perform its required functions under stated conditions for a specified period of time[1]. Your final product/process should be reliable as required by the user and should perform its desired functions as required for desired time period.

2. Design for Ergonomics and Aesthetics:

- ✓ *Ergonomics* is all about designing for human factors/comforts wherever they interact with product/process and surrounding environments. According to the **International Ergonomics Association** within the discipline of ergonomics there exist domains of specialization: (a) ***Physical Ergonomics*** – is concerned with the human anatomy, bio mechanical and physiological ability and its relevance to the product and surrounding systems; (b) ***Cognitive Ergonomics*** – is concerned with the mental ability such as perception, memory, reasoning and response power as they affect the interactions between humans and products/systems ; (c) ***Organizational Ergonomics*** – is concerned with the optimization of socio-technical systems including organizational structures, policies and processes.
- ✓ *Aesthetics* is all about designing for physical appearance (looks) of the product. In current time, customers are willing to buy the products which have stunning looks with respect to their competitive products. Design for Aesthetics includes appearance, style, colour, form/shape, visuals and so on.

3. Design for Manufacturability & Assembly (DFMA)

- ✓ DFMA stands for two terms; *DFM – Design for Manufacturability* which means for ease of manufacturing of parts/components of final product. *DFA – Design for Assembly* which means manufactured parts can be easily assembled to form a final product. DFMA approach helps to design and manufacture/construct the product easily and economically. Designer must design components/parts that can be easily manufactured with available resources at minimum cost of production and can be easily assembled by assembly personnel. The intentions behind implementing DFMA practice in product development is to minimize manufacturing and assembly cost, improve efficiency,

[1] Definition by IEEE.

eliminate waste of material and time. Iteration on involved raw materials may be performed to check available alternatives – as materials play a major role in production cost. Basic guidelines may be followed as below:

- Check for alternative and compatible raw materials (Refer/ revise to LNM)
- Minimize the number of parts (Refer/ revise to PDC)
- Develop a modular design
- Design parts to be multi-functional
- Design parts for multiple-use
- Design for ease of fabrication/ production/ assemble
- Minimize assembly paths
- Avoid separate fasteners (i.e. monolithic units)
- Eliminate adjustments as possible (i.e. movement in parts addressing multiple use – it's a trade-off)
- Design for minimum handling
- Avoid use of additional tools when possible
- Minimize subassemblies (i.e. joining and removing some of the parts)
- Use standard parts when possible (refer/ revise to LNM)
- Simplify operations
- Design for efficient and adequate testing (refer/ revise to LNM)
- Use repeatable & understood processes
- Analyze failures
- Rigorously assess value (i.e. cost of production against minimizing cost of human efforts being done at present – Refer to AEIOU observation framework)

4. Design for Cost, Environment

- ✓ *Design for cost* means designing for lowest possible life cycle cost. It involves – assumed product design cost (manufacturing), delivery cost (to the end-user) as well as cost of operation and maintenance.
- ✓ *Design for environment* strategy describes best practices of designing a product/process to minimize health and environmental ill-impacts. Four main concepts of Design for Environment includes: (a) Design for Environmental aspects during Processing and Manufacturing; (b) Design for Environmental aspects in Packaging; (c) Design for Disposal or Reuse (i.e. after end of product/ process life-cycle as involved in one's case); (d) Design for Energy Efficiency (i.e. energy consumption during the product/ process usable life)

5. Modelling and Analysis using Software:

- ✓ *Branch Specific software can be used for simulation/analysis purpose to further refine the design before investing more time, money and resources.*

6. Prototyping and Proofing of Concepts:

- ✓ *Prototypes, Models and Proof of concepts*
  - *Prototypes* [1]*:* Prototypes are the first full scale and usually a functional form of design and in this sense, it is a working models of designed parts/artefacts. They are tested in the same environments in which they are expected to perform as final products.
  - *Models* [1]*:* A model is "a miniature representation of something". They may be a paper model or computer model or physical model. Models are usually a smaller and made of different material than are of original products, and they are tested in laboratory or controlled environment to validate their expected behaviour.
  - *Proof of Concepts* [1]*:* A proof of concept, in this context, refers to a model of some part of a design that is used specifically to test whether a particular concept will actually work as proposed. Proof of concept test will validate the idea or concept in controlled environment.
- ✓ *Building series of Prototypes to further refine the project*
- ✓ *How much it will cost?*

7. Engineering Economics of Design:

- ✓ *Cost Estimation*
- ✓ *Labour, Material and overhead cost*
- ✓ *The time value of money*

8. Design for Use, Reuse and Sustainability

- ✓ *Design for USE –* How long this design will work?
  - Reliability
  - Maintainability
- ✓ *Design for Reuse*
- ✓ *Design for Sustainability*

[1] Engineering Design – A project Based Introduction by Clive L. Dym, Patrick Little, Elizabeth J. Orwin – Wiley publications

9. Test the prototype

- ✓ *Test your design in real operational environment and then iterate if required.*

10. Ethics in Design

- ✓ *Codes of Ethics*
- ✓ *Ethics: Understanding Obligations*
- ✓ *Ethics: on engineering practice and the welfare of the public*
- ✓ *Ethics: Always a part of engineering practice*

Optional Areas:

GTU Innovation Council will help in below areas for the students whose projects are innovative & extraordinary and who really want to develop their projects further. Visit http://www.gtuinnovationcouncil.ac.in/ for more info.

- Design Support
- Intellectual Property Right
- Business Model Canvas
- Student Start-up
- Incubation and Co-working space

Submissions by the end of 6th semester shall be:

A. Process Report comprising:
   a. Introduction (Describe your project in detail including domain – type, place, why and how team selected this domain and why this domain is important in relation to Design Thinking/Human-Centered process etc.)
   b. Canvases and framework from 5th semester based on different phase of Design Thinking
   c. Feedback analysis with the user and Summary on validation process and refinement in the rough prototype shall be clearly included in the report
   d. Detail design calculations/data
   e. CAD/Software modelling details
   f. Testing of final model if available
   g. Any other important aspects you feel should be included

B. Iterative versions of the prototype models with all necessary details
C. Individual Log Book (duly signed by faculty guide)

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 – 2B (2160001) (6th Semester)

BE - III 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 6th semester examinations, the work of the students in Design Engineering-2B 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 6th semester will be conducted internally by the College/ Institute.)

EVALUATION SCHEME:

Sr. No.	Particular	Sub-Head Weightage
1.	✓ Design calculation (it may include size & shape specifications, tolerances, material requirement, standards/safety rules/govt. policies, sketches, detail & assembly drawings, list of components with specifications etc.) These all aspects are case sensitive so one can add/remove some aspects from the list. ✓ For CE, IT, other process related branches, one may also use Flow chart/Block Diagrams/Algorithms/Programming etc. ✓ Measuring Instruments/techniques - knowledge and use ✓ Comparison of existing materials, methods, tools and equipment for your project **Detail Design:** Considerations for- **Design for Performance, Safety and Reliability** ✓ Different aspects of design for performance, safety and reliability introduced/ considered for defined problem **Design for Ergonomics and Aesthetics** ✓ Consideration of Ergonomics and Aesthetics aspects to raise the value of products **Design for Manufacturability & Assembly (DFMA)** ✓ Reference, different considerations and guidelines followed for DFMA during the work **Design for Cost, Environment** ✓ Cost and Environment consideration as they play major role in Product design **Design for Use, Reuse and Sustainability**	25
2.	Simulation & Analysis (CAD/Software modelling), Mathematical model	15

3.	**Prototyping & Testing:** ✓ Versions of Prototypes with all possible modification and iterations to further refine the solutions (15 marks out of 25 - for students who have made iterative versions for prototype with refinement; if students only present final prototype without any version/s or modification/s then this 15 marks will not be counted for such students) **Note:** Report should carry all details/modification for the versions of prototype with images, it is not required to have different physical models for the different versions ✓ Testing/user feedback results (10 marks out of 25 - if the details and testing/user feedback results are there) ✓ Video of Prototypes (YouTube link)	25
4.	**Report & Log book** (Compilation of work, complete Log book, Future action plan, Question and Answer, Communication Skill)	15
		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.

Note: In final year, students will use their learning of Design Thinking from these four modules of DE-1A, 1B, 2A, 2B to complete their IDP/UDP projects. There would not be separate Design Engineering subject in final year. On successfully completion of these four modules and repeating Design Thinking process again and again, students would be able to use it effectively and can solve any problem with creativity.