# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Bachelor of Engineering**
**Level: UG**
**Branch: Mechanical/Manufacturing and Production**
**Subject Code: BE05000581**
**Subject Name: Product Design and Value Engineering**

| | |
|---|---|
| w. e. f. Academic Year: | 2024-25 |
| Semester: | 5 |
| Category of the Course: | Professional Elective Course - 2 |

| | |
|---|---|
| **Prerequisite:** | Nil |
| **Rationale:** | The product development through engineering aspects always remains challenges to Engineers. The aim of present course is to develop in the students' skills for evaluating, articulating, refining, and pitching a new product or service offering, either as a start-up business or a new initiative within an existing firm. |

**Course Outcome:**

After Completion of the Course, Student will able to:

| No | Course Outcomes | Marks% weightage |
|---|---|---|
| 1 | Integrate customer-oriented approaches in the conceptualization and design of products. | 25 |
| 2 | Analyze functional requirements and develop appropriate product configurations to meet design objectives | 15 |
| 3 | Evaluate product requirements through development processes and select optimal materials based on performance, cost, and sustainability criteria. | 25 |
| 4 | Evaluate product designs through virtual prototyping based on functionality, feasibility, and performance criteria. | 15 |
| 5 | Apply value engineering principles to analyze and improve product design and development for enhanced functionality and cost effectiveness | 20 |

**Teaching and Examination Scheme:**

| Teaching / Learning Scheme (in Hours per semester) | | | | | Total Credits | Assessment Pattern and Marks | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Theory | | Tutorial / Practical | | | |
| L | T | P | PBL | Total no of hours per semester | | ESE (E) | PA / CA (M) | PA/CA (I) | PBL (I) | ESE (V) | |
| 45 | 0 | 30 | 15 | 90 | 3 | 70 | 30 | 20 | 30 | 50 | 200 |

***Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

**Content:**

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| Unit No. | Content | No. of Hours |
|---|---|---|
| 1. | **Identifying Customer Needs:** Customer Satisfaction, Voice of customer, Customer Populations Types of customer needs, Customer need models. Gathering Customer needs: Need Gathering Methods, Conducting Interviews: Like Dislike Method, Articulated-Use Method, Product feel and Industrial Design, Organizing and Prioritizing Needs: Grouping Interpreted needs, Affinity Diagram, Determining need Importance, Customer use patterns | 06 |
| 2. | **Product Design:** Introduction, Product life cycles, Characteristics of Successful Product development, Design and development of Products, Types of Design and Redesigns, Engineering Designs, Duration and cost of product development, the challenges of Product development. | 06 |
| 3. | **Product Configuration and Design for Function:** Design for function techniques, Function analysis, and function family tree. Engineering Ethics and Issues of society related to design of products, Design for safety, Design Evaluation: Design for manufacturing methodology, Design for assembly methodology, Additional Assembly evaluation methods. Product evaluation: Product design for disassembly, Evaluation of Product for disassembly aspects in products, Design for Product maintenance. Product specifications. | 08 |
| 4. | **Product Development Processes and Product Planning:** A Generic development process, concept development, the front end process, adopting the generic product development process, Product Planning Process, The challenges of Product development. | 07 |
| 5. | **Product Analysis and Material Selection:** Tools and charts used for product analysis like bill of materials, Gozinto chart, performance characteristics of materials, material selection process, sources of information on material properties, economics of materials, evaluation methods for material selection. | **06** |
| 6. | **Product Architecture and virtual Product Prototyping:** Product Architectures type, Product Modularity and types, Modular design and methods. Advance functional methods: Function dependency, Module heuristics and application. Introduction to virtual reality, Design using virtual prototyping, Application of digital tools, Introduction to Additive manufacturing | **06** |
| 7. | **Value Engineering:** Definition, applications, Value Engineering Function: Approach of Function, Evaluation of Function, Determining Function, and Classifying Function, Evaluation of costs, Evaluation of Worth, Determining Worth, Evaluation of Value, Value Engineering tools and techniques. | **06** |
| | **Total** | **45** |

**Suggested Specification Table with Marks (Theory):**

| Distribution of Theory Marks | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| **15** | **20** | **30** | **20** | **10** | **5** |

*(Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)*

**The syllabus of Product Design and Value Engineering directly contributes to**

| | |
|---|---|
| **SDG 1** | **No Poverty** |
| **SDG 3** | **Good health and well-being** |
| **SDG 4** | **Quality Education** |
| **SDG 6** | **Clean water and Sanitation** |
| **SDG 7** | **Clean water and Sanitation** |
| **SDG 8** | **Decent work and Economic growth** |
| **SDG 9** | **Industry Innovation and Infrastructure** |
| **SDG 11** | **Sustainable Cities** |
| **SDG 12** | **Environmental committee** |
| **SDG 15** | **Life on Land** |
| **SDG 17** | **Partnerships** |

**Reference Books:**

1. Product Design, by Kevin Otto, Kristin wood, Pearson Education Inc.
2. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill
3. Product Development, by Chitale & Gupta, Tata McGraw Hill
4. The Mechanical Process Design, by David Ullman, McGraw hill Inc
5. Engineering Design Process, by Yousef Haik, T M M Shahin, Cengage Learning
6. Product design & process Engineering by Niebel & deeper, McGraw hill
7. Value Management by Heller, Addison Wasley
8. Value engineering A how to Manual S. S. Iyer, New age International Publishers
9. Value Engineering: A Systematic Approach by Arthur E. Mudge - Mc GrawHill
10. New Product Development Timjones. Butterworth Heinmann, Oxford.
11. Value engineering A how to Manual S. S. Iyer, New age International Publishers
12. Value Engineering: A Systematic Approach by Arthur E. Mudge - Mc GrawHill
13. Assembly automation and product design – by Geoffrey Boothroyd, CRC Taylor & Francis
14. Product Design for Engineers, By Devdas Shetty, Cengage Learning

**Standards and Act:**

1. BS 7000 Series – Design Management Systems
2. ISO 12100 – Safety of machinery (Risk assessment)
3. Boothroyd-Dewhurst DFMA Guidelines (widely used industry methodology)
4. ISO 14001 – Environmental Management Systems
5. ISO 14006 – Eco-design
6. ISO 14040 / 14044 – Life Cycle Assessment (LCA)
7. ISO 6385 – Ergonomic principles in design
8. ISO 9241 – Human-system interaction
9. ISO 9001, BS 7000 Product design

10. The Society of American Value Engineers (SAVE International): Value engineering (VE) and the value methodology (VM)
11. ASTM E1699 – Standard Guide for Value Engineering (VE)

**List of Experiments:**

1. To study Product life cycles, characteristics, design and the challenges of development of products.
2. Study of Engineering Ethics and Issues of society related to design of products.
3. Exercise on Concept Development (Case study of different Product)
4. Concept development analysis for design for Assembly and Design for manufacturing
5. Exercise on material selection for Product
6. Exercise on Customer need (Survey for Product feature and functions)
7. Exercise on Product Architecture and Virtual Prototyping
8. Case study on Value Analysis and Value Engineering
9. Exercise on Evaluation of Worth of Product
10. Exercise on Determining functions and Classifying functions of Product.

**Major Equipment: Nil**

**List of open source software:**

1. FreeCAD, SolveSpace, BRL-CAD
2. Blender, OpenSCAD
3. CalculiX + OpenFOAM

**List of learning website:**

1. http://nptel.ac.in/courses/

**List of suggested activities for Problem-based Learning (PBL):**

| Sr. No. | PBL category | Name of the activity | No. of hours | Evaluation Criteria |
|---|---|---|---|---|
| 1. | Complex Problem-Solving targeting relevant SDGs / Mini Project | Mini Project | 15h (need to be changed as per total PBL hours) | Based on the novelty of project, technical understanding, report quality and presentation |
| 2. | Case Study Analysis / Seminar | Seminar | 15h (need to be changed as per total PBL hours) | Based on the quality of report and presentation, technical understanding |
| 3. | Micro project | Micro project | 8h (need to be changed as per total PBL hours) | Based on the novelty of project, technical |

| | | | | |
|---|---|---|---|---|
| | | | | understanding, quality of report and demonstration |
| 4. | Industry/Research laboratory visit | Industry/Research laboratory visit | Visit = 5h,<br>Report preparation = 5h<br>Total = 10h | Based on report submitted. Report should contain observations and calculations based on industry/ lab data. |
| 5. | Video Based Learning | Technical video-based learning related to the subject | Duration of video = 5h<br>Report preparation = 5h<br>Total = 10h | Report /presentation based on the video learning outcomes. |
| 6. | Assignment / Technical Writing / Research Writing | Assignment writing. Numerical based assignment is preferable. | 5 assignments of 4 h each<br>Total = 20h | Based on the correctness of submitted assignment |
| 7. | Group Discussion / Quiz / Simulation | Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software | 5 small coding-based assignment of 2h each<br>Total = 10h | Based on the coding solution submitted. |
| 8. | Video Based Learning | Self-learning online course | Minimum duration of the course should be 10h | Examination based assessment at the end of course. Based on the certificate produced. |
| 9. | Complex Problem-Solving targeting relevant SDGs / Mini Project | Identification and solution of Complex problem | Maximum 2 problems. Study of the problem and solution finding,<br>Total = 10h | Based on the depth of the solution submitted. |
| 10. | Video Based Learning | Videos on Industrial safety/Disaster Management aspects based on subject | Duration of video = 5h<br>Report preparation = 5h<br>Total = 10h | Based on quiz/report submitted |
| 11. | Research Paper Review / Analysis | Technical paper reading and summarization of research papers based on relevant subject | 5 research papers = 20h | Summarize research paper and evaluation critical parameters |
| 12. | Poster / Chart / PowerPoint presentation | Poster/chart/power point preparation on technical topics | Duration = 6h | Based on poster/chart preparation and presentation skills |
| 13. | Industry/Research | Industrial exposure for | Duration = 15h for | Based on evaluation |

| | | | | |
|---|---|---|---|---|
| | laboratory visit | 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue | industrial exposure<br><br>Problem identification and tentative solution = 10h<br>Total = 20h | of critical problems and solutions |
| 14. | Group Discussion / Quiz / Simulation | Group Discussion on emerging/trending technical topics based on subject | Duration = 1h – 3h per topic | Based on performance in group discussion, technical depth, knowledge etc. |
| 15. | Case Study Analysis / Seminar | Real world case studies-based learning | Duration of data collection/study = 5h<br>Report preparation = 5h<br>Total = 10h | Based on in-depth study, technical depth, data collected, fact finding, etc. |
| 16. | Group Discussion / Quiz / Simulation | Application/Software development | Duration = 10h | Depending on the complexity of the Application/Software |
| 17. | Assignment / Technical Writing / Research Writing | Research paper publication | Duration = 10h | Based on submission of proof of publication |
| 18. | Micro project | Upgradation/Reverse engineering studies of existing equipment of the laboratory | Duration 10h | Based on the performance of the equipment |
| 19. | Industry/Research laboratory visit | Expert lecture/session | Duration 3h<br>For attending the lecture/session– 2h and for report writing 1h | Based on the proof of attendance<br>and report submitted |
| 20. | Video Based Learning | Annotated Video Explanation of Concept/Problem | 10h (Preparation + Recording + Submission) | Based on accuracy of explanation, clarity, and presentation style. |
| 21. | Assignment / Technical Writing / Research Writing | Patent Search and Innovation Gap Identification | 10h (Search + Report) | Based on number of relevant patents analyzed and identification of innovation scope. |
| 22. | Assignment / Technical Writing / Research Writing | Preparation of a report on Indian Standard(s) | 10h (study of Indian Standard(s) + report | Based on report quality and understanding of the relevant Indian Standard(s). |

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Product Design and Value Engineering compulsorily incorporates Micro Project and 5 marks as PBL activities for PEC.**

   These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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