18ES150	ENGINEERING EXPLORATION

Category	L	T	P	Credit
ES	1	2	-	3

Preamble

The course Engineering Exploration provides an introduction to the engineering field. It is designed to help the student to learn about engineering and how it affects our everyday lives. On the successful completion of the course, students will be to explain how engineering is different from science and technology and how science, mathematics and technology are an integral part of engineering design.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO1. Explain technological & engineering development, change and impacts of engineering	Understand
CO2. Draw a product in enough detail that others can accurately build it and write specification sheet for a given product	Apply
CO3. Complete initial steps (Define a problem, list criteria and constraints, brainstorm potential solutions and document the ideas) in engineering design process	Apply
CO4. Draw sketches to a design problem and provide a trade-off matrix	Apply
CO5. Communicate possible solutions through drawings and prepare project report	Apply
CO6. Use reverse engineering to suggest improvements in a tool design	Apply
CO7. Apply the concept of engineering fundamentals in Civil, Mechanical, Electrical and Computer Engineering	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	M	L	-	-	-	-	-	-	-	-	-	-
C02	S	M	L	-	-	-	-	-	-	-	-	-
C03	S	M	L	-	-	-	-	-	-	-	-	-
C04	S	M	L	-	-	-	-	-	-	-	-	-
C05	S	M	L	-	-	-	-	-	-	-	-	-
C06	S	M	L	-	-	-	-	-	-	-	-	-
C07	S	M	L	-	-	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

S.No	Bloom's category	Continuous Assessment Tests			End Semester Examinations
		1	2	3	
1	Remember	20	20	20	20
2	Understand	20	20	20	20
3	Apply	60	60	60	60
4	Analyze	0	0	0	0

5	Evaluate	0	0	0	0
6	Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the role of Engineer?
2. How do you believe the growth of engineering has impacted the product that we have today?
3. Select an engineering product, list the specifications and constraints that must be considered when designing the product. Make a list of tradeoff.

Course Outcome 2 (CO2):

1. List the steps of a design problem.
2. Identify the problem you see in the product you used in your daily life.
3. Determine the design constraint and criteria for a problem.
4. Create an isometric drawing of a design.

Course Outcome 3 (CO3):

1. List the five factors when considering development problem.
2. Imagine you have noticed the car you are riding is making a squeaking noise from the engine compartment. Define the problem with your vehicle. Classify the potential problem.
3. Imagine you are hired by your local city to develop a new public transportation.
    a. Define the problem.
    b. List the criteria and constraint.
    c. List the potential solution.

Course Outcome 4 (CO4):

1. Imagine you are an engineer who is designing a portable sitting device; you need to design a chair that will be portable that will fit in the trunk of the car which hold 100 kg individual and will be easily produced. Create sketches using a four step process to this design problem.
2. Imagine you are an engineer who develops method to automatically sort books at college library. Develop possible sketches and list potential solution and give the tradeoff matrix.
3. How can your research improve the design?

Course Outcome 5 (CO5):

1. What details are able to show with the perspective drawing?
2. What is the difference between mockup and prototype?
3. List five different question engineers must ask about function of the design.

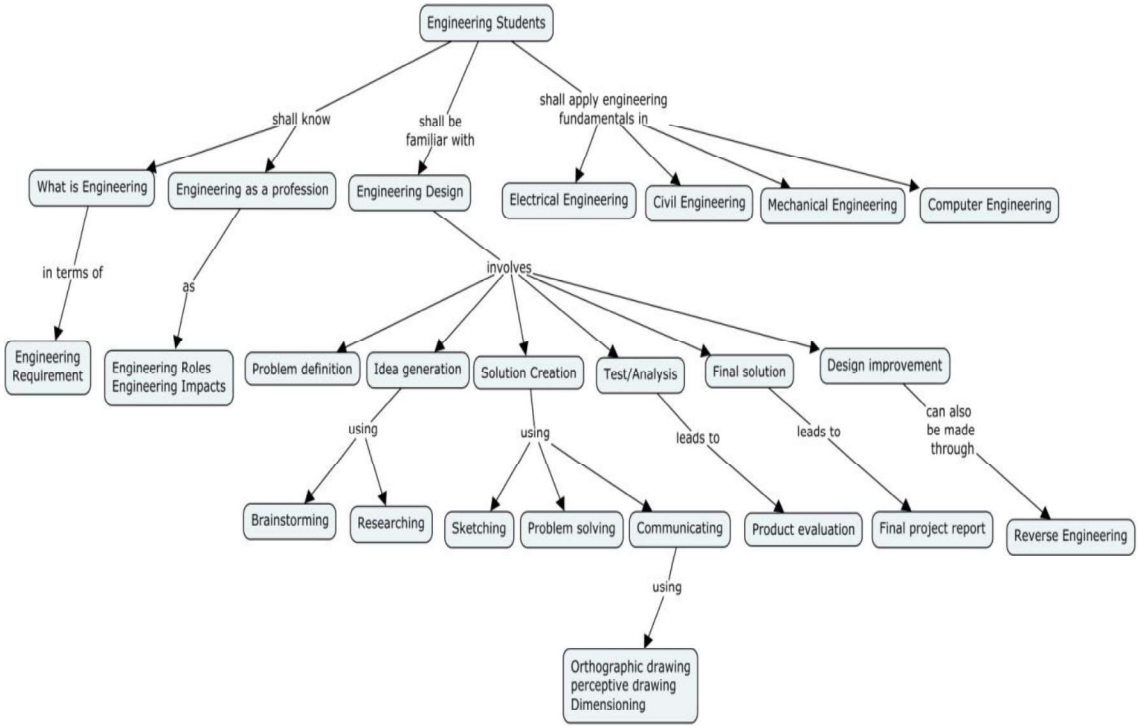
Course Outcome 6 (CO6):

1. Select a product to analyze with respect to function, fit, aesthetics, safety and environment impact. Write a summary on evaluation of the product. If you would like make changes to the design list the changes.
2. What design components should be reconsidered in reverse engineering processes? Why?
3. What are the benefits of reverse engineering?

Course Outcome 7 (CO7):

1. Explain ohms law and list the related formulas.
2. What role do you think the range selection plays in the accuracy of the measurements?
3. Why it is important for a civil engineer to study structural forces?
4. Describe the differences between fluids used in hydraulics and pneumatics.

Concept Map



Syllabus

What is Engineering: Engineering Requirement, Knowledge within Engineering disciplines, Engineering advancements **Engineering Design:** Problem definition, idea generation through brainstorming and researching, solution creation through evaluating and communicating, text/analysis, final solution and design improvement. **Defining problems and Brainstorming:** Researching design, sketching problem solving **Communicating solution**: Dimensioning orthographic drawing, perspective drawing **Modeling and Testing final output:** Product evaluation, reverse engineering, final project report. **Civil Engineering:** Structural forces structural analysis, bridge design components, structural design **Mechanical Engineering:** Types of motion, mechanical power system, mechanical power formula, mechanical design. **Electrical Engineering:** Reading analog multimeter, measuring current, voltage and resistance, electricity from chemicals, solar cells, magnets, Ohms law and watts law, circuit identification and circuit calculation, resistor color code, continuity **Computer Engineering:** Logic gates, algorithms, computer architecture, binary code

Reference Books

1. Ryan A.Brown, Joshua W.Brown and Michael Berkihiser: "Engineering Fundamentals: Design, Principles, and Careers", Goodheart-Willcox Publisher, Second Edition, 2014.
2. Saeed Moaveni ,"Engineering Fundamentals: An Introduction to Engineering", Cengage learning, Fourth Edition, 2011.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**What is Engineering**	
1.1	Engineering Requirement	1
1.2	Knowledge within Engineering disciplines,	1
1.3	Engineering advancements	1
2	**Engineering Design**	
2.1	Problem definition,	1
2.2	idea generation through brainstorming and researching	1
2.3	solution creation through evaluating and communicating,	1
2.4	text/analysis	1
2.5	final solution and design improvement	1
3	**Defining problems and Brainstorming:**	
3.1	Researching design	1
3.2	sketching problem solving	2
4	**Communicating solution**	
4.1	Dimensioning orthographic drawing	1
4.2	perspective drawing	1
5	**Modeling and Testing final output**	
5.1	Product evaluation	1
5.2	reverse engineering	1
5.3	final project report	1
6	**Civil Engineering**	
6.1	Structural forces structural analysis	2
6.2	bridge design components	2
6.3	structural design	1
7	**Mechanical Engineering**	
7.1	Types of motion	2
7.2	mechanical power system	1
7.3	mechanical power formula	1
7.4	mechanical design	1
8	**Electrical Engineering:**	
8.1	Reading analog multimeter, measuring current, voltage and resistance	1
8.2	electricity from chemicals, solar cells, magnets,	1
8.3	Ohms law and watts law, circuit identification and circuit calculation	1
8.4	resistor color code, continuity	2

No.	Topic	No. of Lectures
9	**Computer Engineering**	
9.1	Logic gates, algorithms,	1
9.2	computer architecture,	2
9.3	binary code	2
	Total	36

Course Designers:

1. Dr.S.J. Thiruvengadam sjtece@tce.edu
2. Dr. S.Baskar sbeee@tce.edu

18ES290	LATERAL THINKING

Category	L	T	P	Credit
ES	0	0	2	1

Preamble

The purpose of thinking is to collect information and to make the best possible use of it. Vertical thinking is concerned with proving or developing concept patterns. Lateral thinking is concerned with restructuring such patterns (insight) and provoking new ones (creativity). Lateral and vertical thinking are complementary. Skill in both is necessary. Although the emphasis in education has always been exclusively on vertical thinking, the need for lateral thinking arises from the limitations of the behaviour of mind as a self-maximizing memory system. Lateral thinking can be learned, practised and used. It is possible to acquire skill in it just as it is possible to acquire skill in mathematics. The course provides formal opportunities to practise lateral thinking and also an explanation of the processes involved.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO #	Course Outcome Statement	Weightage in %
CO1	Explain the concept of lateral thinking, distinguish it from vertical thinking.	10
CO2	Use lateral thinking for problem solving	10
CO3	Generate Alternatives, challenge assumptions and suspend judgment and Practice lateral thinking in design process	20
CO4	Apply the concept of factorization and reversal method for restructuring	20
CO5	Organize brainstorming sessions	10
CO6	Use PO for innovation	10
CO7	Aware of limitation of established patterns and practice lateral thinking in small projects	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	2.3.1, 3.2.6
CO2	TPS3	Apply	Value	-	2.4.1, 2.4.2, 2.4.3
CO3	TPS3	Apply	Value	-	2.4.1, 2.4.2, 2.4.3, 2.4.5, 2.4.6
CO4	TPS3	Apply	Value	-	2.3.1, 2.4.2, 2.4.3
CO5	TPS4	Analyse	Organize	-	3.1.1, 3.1.2, 3.2.1, 3.2.2
CO6	TPS3	Apply	Value	-	2.1.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.6
CO7	TPS5	Evaluate	Characterize	-	2.3.4, 4.5.1, 4.6.1

Mapping with Programme Outcomes and Programme Specific Outcomes

CO #	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	-	-	-	-	-	-	-	-	L
CO2	S	M	L	-	-	-	-	-	-	-	-	L
CO3	S	M	L	-	-	-	-	S	L	L	-	L
CO4	S	M	L	-	-	-	-	S	L	L	-	L
CO5	S	S	M	L	-	-	-	S	S	S	-	L
CO6	S	M	L	-	-	-	-					L
CO7	S	S	S	M	-	S	-	-	S	S	-	S

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Continuous Assessment

Worksheets	:	20 Marks
Case Studies	:	30 Marks

Terminal Examination

Ability Test	:	50 Marks
Case Study (Best) Presentation and Viva Voce	:	50 Marks

Syllabus

The way the mind works, Difference between lateral and vertical thinking, Attitudes towards lateral thinking, Basic nature of lateral thinking, The use of lateral thinking Techniques, The generation of alternatives, Challenging assumptions, Innovation, Suspended judgment, Design, Dominant ideas and crucial factors, Fractionation, The reversal method, Brainstorming, Analogies, Choice of entry point and attention area, Random stimulation, Concepts/divisions/polarization, The new word PO, Blocked by openness, Description/problem solving/design

Learning Resources

1. Edward de Bono, “Lateral Thinking: Creativity Step by Step”, Happer Collins Publisher, 1990.
2. Edward de Bono, “Six Thinking Hats”, Little Brown and Company Publisher, 1985.
3. Edward de Bono’s Thinking Course, Video Lecture, Weblink: https://www.yputube.com/watch?v=AUq_AL2LNEw

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	The way the mind works	1	CO1
1.1	Difference between lateral and vertical thinking	1	CO1
1.2	Attitudes towards lateral thinking	1	CO2
2.	Basic nature of lateral thinking	1	CO2
2.1	The use of lateral thinking techniques	1	CO2
2.2	The generation of alternatives	1	CO3
2.3	Challenging assumptions	1	CO3
2.4	Innovation	1	CO3
2.5	Suspended judgment	1	CO3
3.	Design	1	CO3
3.1	Dominant ideas and crucial factors	1	CO3
3.2	Fractionation	1	CO4
4.	The reversal method	1	CO4
4.1	Brainstorming	1	CO5
4.2	Analogies	1	CO5
4.3	Choice of entry point and attention area	1	CO5
4.4	Random stimulation	1	CO5
4.5	Concepts/divisions/polarization	1	CO5
4.6	The new word PO	2	CO6
5.	Blocked by openness	2	CO7
5.1	Description/problem solving/design	2	CO7

Course Designers:

S J. Thiruvengadam sjtece@tce.edu

18ES390	DESIGN THINKING	Category	L	T	P	Credit
		ES	1	-	2	2

Preamble

Design has been defined as a "systematic, intelligent process in which designers generate, evaluate, and specify concepts for devices, systems, or processes whose form and function achieve clients' objectives or users' needs while satisfying a specified set of constraints". Human-centered design is defined as a process and a set of techniques used to create new solutions for the world. Solutions include products, services, environments, organizations, and modes of interaction. The reason this process is called "human-centered" is because it starts with the people we are designing for. This course facilitates the development of students' professional skills through their team engagement in developing conceptual design for a local community problem.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Identify a specific social need to be addressed	20
CO2	Identify stakeholder's requirements for the societal project	20
CO3	Develop measurable criteria in which design concepts can be evaluated	10
CO4	Develop prototypes of multiple concepts using user's feedback	30
CO5	Select the best design solution among the potential solutions with its functional decomposition	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.1, 3.1.2, 3.2.3, 3.2.6, 4.1.2
CO2	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.2, 2.5.1, 2.5.2, 3.1.2, 3.2.3, 3.2.6, 4.1.2
CO3	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.3, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.3.1
CO4	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.4, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.4.1
CO5	TPS5	Evaluate	Organise	Adaptation	1.1, 1.2, 2.1.5, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.4.1

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	-	-	M	M	M	L	M	M	S
CO2	S	M	L	-	-	M	M	M	L	M	M	S
CO3	S	M	L	-	-	M	M	M	L	M	M	S
CO4	S	M	L	-	M	M	M	M	L	M	M	S
CO5	S	S	M	L	M	M	M	M	L	M	M	S

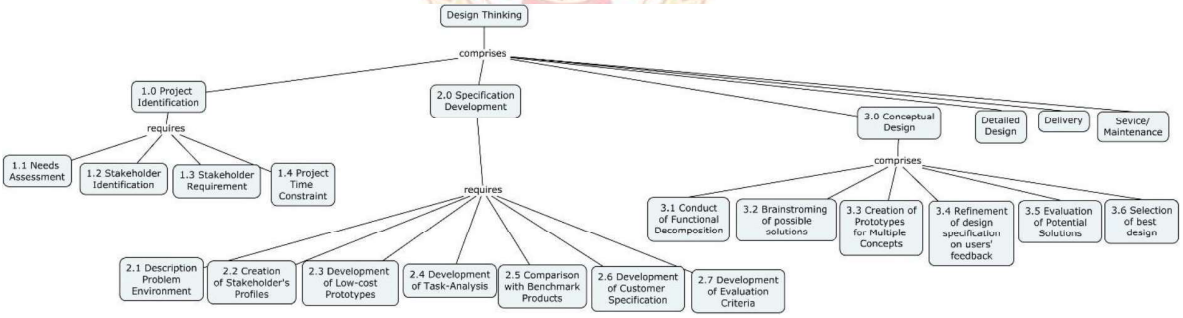
S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Phases	Deliverables	Marks	Course Outcomes
Continuous Assessment			
Review 1 – Problem Identification	Technical Report	10	CO1 and CO2
Review 2 – Specification Development	Technical Report	20	CO3
Review 3 -Conceptual Design	Technical Report	20	CO4 and CO5
End-Semester Examination			
Demonstration	Prototype	60	CO1, CO2, CO3, CO4 and CO5
Poster Presentation	Poster	40	

- Reports are to be submitted at each review. The report and presentation will be evaluated based on Rubrics
- Demonstration and Poster presentation will be evaluated by two faculty members nominated by their respective Head of the Department.

Concept Map



Syllabus

1.0 Project Identification: Needs Assessment, Stakeholder Identification, Stakeholder Requirement Project Time Constraint.
2.0 Specification Development: Description Problem Environment, Creation of Stakeholder's Profiles Development of Low-cost Prototypes, Development of Task-Analysis, Comparison with Benchmark Products, Development of Customer Specification, Development of Evaluation Criteria,
3.0 Conceptual Design: Conduct of Functional Decomposition, Brainstroming of possible solutions, Creation of Prototypes for Multiple Concepts, Refinement of Design Specification on users' feedback, Evaluation of Potential Solutions, Selection of best design.

Learning Resources

1. Learning Material prepared by TCE faculty members
2. https://www.ideo.com/
3. https://engineering.purdue.edu/EPICS

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours		Course Outcome
		In-Class	Hands-on	
1.	**Project Identification**: Introduction to Human-Centered Design	1	-	CO1
1.1	Needs Assessment	1	2	CO1
1.2	Identification of Stakeholders	1	2	CO2
1.3	Identification of Stakeholder Requirements		2	CO2
1.4	Project Time Constraint	1	2	CO2
2.	**Specification Development**			
2.1	Description Problem Environment	1	2	CO3
2.2	Creation of Stakeholder's Profiles		2	CO3
2.3	Development of Low-cost Prototypes	1	2	CO3
2.4	Development of Task-Analysis	1	2	CO3
2.5	Comparison with Benchmark Products	1	2	CO3
2.6	Development of Customer Specification		2	CO3
2.7	Development of Evaluation Criteria	1	2	CO3
3.	**Conceptual Design**			
3.1	Conduct of Functional Decomposition	1	2	CO4
3.2	Brainstroming of possible solutions	1	2	CO5
3.3	Creation of Prototypes for Multiple Concepts	1	2	CO5
3.4	Refinement of design Specification on users' feedback		2	CO6
3.5	Evaluation of Potential Solutions	1	2	CO6
3.6	Selection of best design		2	CO6
	Total	12	34	

Course Designers:

1. Dr.S.J.Thiruvengadam sjtece@tce.edu
2. Dr.S.Saravana Perumaal sspmech@tce.edu

18ES590	SYSTEM THINKING

Category	L	T	P	Credit
ES	1	-	2	3

Preamble

Systems thinking is the integrated paradigm for systems science and system approaches to practice. It is concerned with understanding or intervening in problem situations, based on the principles and concepts of the system model. It can help to provide a common language and an intellectual foundation and make practical system concepts, principles, patterns and tools accessible to systems engineering. System thinking considers the similarities between systems from different domains in terms of a set of common systems concepts, principles, and patterns. The scope of systems thinking is a starting point for dealing with real-world situations using a set of related systems concept. The system thinking is viewed as both a set of founding ideas for the development of systems theories and practices and also as a pervasive way of thinking need by those developing and applying them. This systems approach is a way of tackling real-world problems and making use of the concepts, principle, patterns of systems thinking to enable the systems to be engineered and used.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Explain the concepts of systems thinking, System engineering and Systems Life Cycle	10
CO2	Identify system elements, interactions, boundary and environment for the given system descriptions	10
CO3	Develop a functional architecture with appropriate primary function(s) and sub-functions of the identified system	15
CO4	Develop a physical architecture with appropriate sub-systems and components of the identified system	15
CO5	Prepare a system requirement specification review documents for the various stages of acquisition phase of the identified system	20
CO6	Develop a system model with logical and physical architecture using system modelling tool like SysML	30

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	-	1.1, 2.3.1, 2.3.2
CO2	TPS3	Apply	Value	-	1.1, 2.1.1, 2.3.1,2.3.2, 2.3.3, 2.3.4, 2.4.4, 4.3.1,
CO3	TPS3	Apply	Value	Mechanism	1.1, 2.1.1, 2.3.1,2.3.2, 2.3.3, 2.3.4, 2.4.4, 3.1.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 4.3.1, 4.3.2, 4.3.3, 4.4.5, 4.5.1
CO4	TPS3	Apply	Value	Mechanism	1.1, 2.1.1, 2.3.1,2.3.2, 2.3.3, 2.3.4, 2.4.4, 3.1.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 4.3.1, 4.3.2, 4.3.3, 4.4.5, 4.5.1
CO5	TPS3	Apply	Value	Mechanism	1.1, 2.1.1, 2.3.1,2.3.2, 2.3.3,

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
					2.3.4, 2.4.4, 3.1.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 4.3.1, 4.3.2, 4.3.3, 4.4.5, 4.5.1
CO6	TPS3	Apply	Value	Mechanism	1.1, 2.1.1, 2.3.1,2.3.2, 2.3.3, 2.3.4, 2.4.4, 3.1.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 4.3.1, 4.3.2, 4.3.3, 4.4.5, 4.5.1

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	-	-	-	-	-	-	-	-	-
CO2	S	M	L	-	-	L	L	L	L	L	-	M
CO3	S	M	L	-	-	M	M	M	L	M	M	S
CO4	S	M	L	-	-	M	M	M	L	M	M	S
CO5	S	M	L	-	-	M	M	M	L	M	M	S
CO6	S	M	L	-	S	M	M	M	L	M	M	S

S- Strong; M-Medium; L-Low

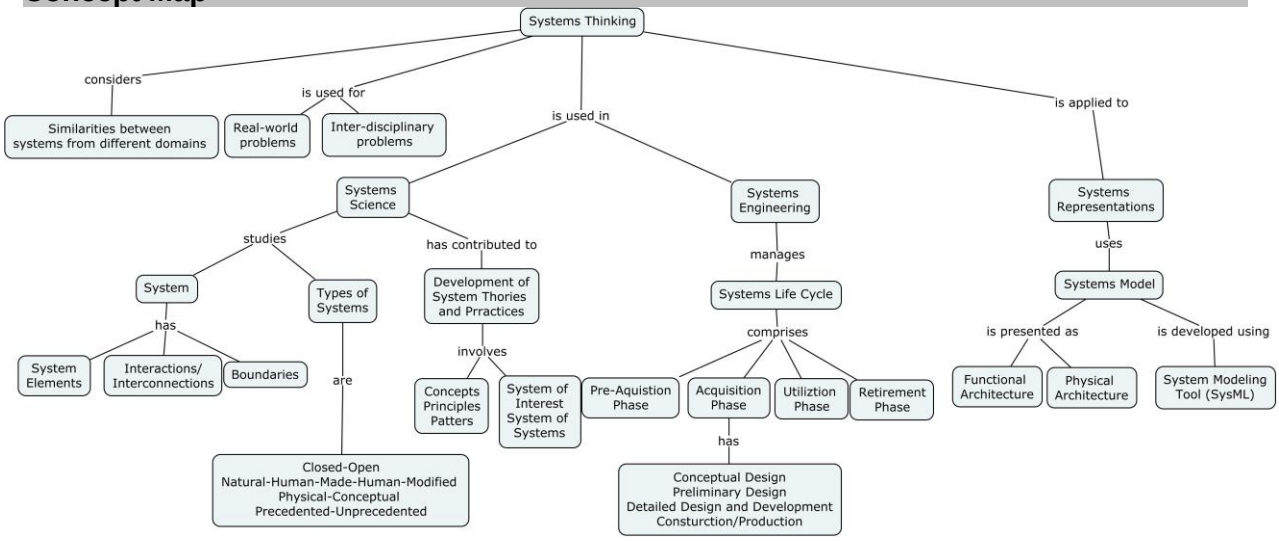
Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Test -2
Remember	20
Understand	40
Apply	40
Analyse	-
Evaluate	-
Create	-

Phases	Deliverables	Marks	Course Outcomes
Continuous Assessment			
Continuous Assessment Test-1		10	CO1 and CO2
Review 1 – Functional & Physical Architecture and System Requirement Specification	Technical Report	25	CO3, CO4 and CO5
Review 2 – Systems Modeling	Technical Report	15	CO6
End-Semester Examination			
Demonstration	Virtual Prototype with simulation	60	CO1, CO2, CO3, CO4 CO5 and CO6
Poster Presentation	Poster	40	

- Reports are to be submitted at each review. The report and presentation will be evaluated based on Rubrics.
- Demonstration of Virtual Prototype with simulation and Poster presentation will be evaluated by two faculty members nominated by their respective Head of the Department.

Concept Map



Syllabus

1.0 Systems Fundamentals: System - Definition, System Elements, Interactions, System Boundary, - Types of Systems: Closed-Open, Natural-Human-Made-Human-Modified, Physical-Conceptual and Precedented-Unprecedented. Systems science - Systems approaches. Systems Thinking: Concepts, principles and pattens. System of Interest - Systems of System. Systems Engineering: Product, Service, Enterprise. System Life Cycle: Pre-acquisition phase, Acquisition Phase, Utilization Phase and Retirement Phase.

2.0 Acquisition Phase: Conceptual Design: Business needs and requirements, Stakeholder needs and requirements, System Requirement Specification, Functional Base Line, System Requirement Review – Functional Architecture. Preliminary Design: Configuration items, Allocated Baseline, Preliminary Design Review – Physical Architecture. Detailed Design and Development: System Modeling, Product Base Line, Critical Design Review. Construction/Production: Formal Qualification Review, Acceptance Test and Evaluation.

3.0 Systems Modeling: System Model - Types of models – System Modeling Concepts – Modeling Standards. System Architecture: Logical Architecture Model – Physical Architecture Model. Systems Life Cycle Process Model: Vee model.

Learning Resources

1. A Guide to Guide to the Systems Engineering Body of Knowledge (SEBoK), version 2.2, INCOSE Systems Engineering Research Center and IEEE Computer Society, Released 31 October 2019 – https://www.sebokwiki.org/w/images/sebokwiki-farm!w/8/8b/SEBoK_v2.1.pdf
2. Systems Engineering Handbook, A Guide for Systems Life Cycle Processes and Activities, 4th Edition, INCOSE-TP-2003-002-04, 2015.
3. R. Ian Faulconbridge, Michael Ryan, “Systems Engineering Practice”, Argos Argos Press, 2014.
4. Jon Holt and Simon Perry, “SysML for Systems Engineering”, The Institution of Engineering and Technology, London, United Kingdom, 2008.
5. Sanford Friedenthal, Alan Moore and Rick Steiner, “A Practical Guide To SysML: The Systems Modeling Language, Third edition, Morgan Kaufmann, an imprint of Elsevier, 2015
6. Coursera course on Introduction to Systems Engineering - R. Ian Faulconbridge, Michael Ryan of The University of New South Wales, Sydney.
7. NPTEL Course: Systems Engineering Theory and Practice – IIT Kanpur – Prof. Deepu Philip (Last offered in 2019) - https://nptel.ac.in/courses/110/104/110104074/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours		Course Outcome
		In-Class	Hands-on	
1.	**Systems Fundamentals:** System - Definition, System Elements, Interactions, System Boundary	1	-	CO1
1.1	Types of Systems: Closed-Open, Natural-Human-Made-Human-Modified, Physical-Conceptual and Precedented-Unprecedented.	1	2	CO1
1.2	Systems science - Systems approaches.	1	-	CO1
1.3	Systems Thinking: Concepts, principles and pattens.	1	-	CO1
1.4	System of Interest - Systems of System. Systems Engineering: Product, Service, Enterprise System Life Cycle: Pre-acquisition phase, Acquisition Phase, Utilization Phase and Retirement Phase.	2	2	CO2
2.	**Acquisition Phase**			
2.1	Conceptual Design: Business needs and requirements, Stakeholder needs and requirements, System Requirement Specification, Functional Base Line, System Requirement Review – Functional Architecture.	1	4	CO3
2.2	Preliminary Design: Configuration items, Allocated Baseline, Preliminary Design Review – Physical Architecture.	1	4	CO3
2.3	Detailed Design and Development: System Modeling, Product Base Line, Critical Design Review.	1	4	CO4
2.4	Construction/Production: Formal Qualification Review, Acceptance Test and Evaluation.	1	4	CO5
3.	**Systems Modeling**			
3.1	System Model - Types of models – System Modeling Concepts – Modeling Standards.	1	2	CO6
3.2	System Architecture: Logical Architecture Model – Physical Architecture Model.	1	4	CO6
3.3	Systems Life Cycle Process Model: Vee model.	1	2	CO6
	Total	14	28	

Course Designers:

1. Dr.S.J.Thiruvengadam sjtece@tce.edu
2. Dr.S.Saravana Perumaal sspmech@tce.edu
3. Dr.C.Jeyamala jeyamala@tce.edu

18ES690	ENGINEERING DESIGN PROJECT

Category	L	T	P	Credit
Project	1	0	4	3

Preamble

An engineer must understand the economic, social, political, sustainability and environmental contexts in which the need arises. Engineering solutions are always created in response to some societal/industrial need. Understanding the societal/industrial need is central to success in engineering design. Therefore, the engineering students have been assigned on the problem identification phase of engineering design. Now, they have an opportunity to reflect and realise the knowledge that have been gained through the courses such as 18ES150 Engineering Exploration, 18ES290 Lateral Thinking, 18ES390 Design Thinking, 18XX490 Project Management and 18ES590 System Thinking. This course will enable the students to integrate CDIO Skill-based courses and their domain-specific courses. More specifically, by employing the broad knowledge they gain from experiences in foundation elective, general elective and audit courses, students are better equipped to provide engineering solution societal and/or industrial needs.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	Course Outcome Statement	Weightage in %
CO1	Execute different phases of engineering design project including functional composition and design specification in a team.	20
CO2	Evaluate the alternate engineering design approaches as per the performance criteria with design verification and validation.	20
CO3	Evaluate a design with the use of test verification matrix / Design Failure Mode Effect Analysis (DFMEA)/ Usability testing	15
CO4	Explain the significance of Intellectual Property rights and the procedure for searching and filing a patent.	15
CO5	Exhibit team work with appropriate conflict management strategies.	10
CO6	Prepare appropriate design documents and deliver effective technical presentations	10

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.1, 3.1.2, 3.2.3, 3.2.6, 4.1.2
CO2	TPS5	Evaluate	Organise	Adaptation	1.1, 1.2, 2.1.2, 2.5.1, 2.5.2, 3.1.2, 3.2.3, 3.2.6, 4.1.2
CO3	TPS5	Evaluate	Organise	Adaptation	1.1, 1.2, 2.1.3, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.3.1
CO4	TPS2	Understand	Respond	Guided Response	1.1, 1.2, 2.1.4, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.4.1
CO5	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.5, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.4.1
CO6	TPS3	Apply	Value	Mechanism	1.1, 1.2, 2.1.4, 3.1.2, 3.2.3, 3.2.6, 4.1.2, 4.4.1

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	-	-	M	M	M	S	S	S	S
CO2	S	S	S	M	-	M	M	M	S	S	S	S
CO3	S	S	S	M	S	M	M	S	S	S	S	S
CO4	M	L	-	-	-	M	M	-	-	-	-	S
CO5	S	M	L	-	-	M	M	S	S	S	M	S
CO6	S	M	L	-	-	-	-	S	S	S	-	S

S- Strong; M-Medium; L-Low

Assessment Pattern:

Phases	Deliverables	Marks	Course Outcomes
Continuous Assessment			
Review 1 – Engineering Design Project Selection, functional decomposition and Specification	Technical Report	10	CO1, C06
Review 2 – Evaluation of Design Approaches	Technical Report	20	CO2, CO5, CO6
Review 3 – Design Verification and validation	Technical Report	20	CO3, CO4, CO6
End-Semester Examination			
Demonstration	Prototype	60	CO1, CO2, CO3, CO4 CO5, CO6
Design Portfolio Presentation	Portfolio Document	40	

- Reports are to be submitted at each review. The report and presentation will be evaluated based on customized Rubrics for periodic reviews.
- Demonstration and Design Portfolio presentation will be evaluated by two faculty members nominated by their respective Head of the Department.

Syllabus

Project Selection – Search Phase, Preliminary Design Review (PDR) and Critical Design Review (CDR), Project Specification, Proposal Report, Proposal Presentation

Engineering Design Process - The NASA Design Approach, Design Verification and Validation ,Design Verification Plan – DFMEA, test verification matrix, Usability testing, DRIDS-V Design Approach and Plan

Intellectual Property Rights – Trademarks, Copyrights and Patents, Types of patents, Searching patents, Filing Patents

Team formation and Communication – Types of teams, Team Conflict Management – common causes, cultural styles and conflict, Project Team Evaluation, Conducting Meetings and Making Presentations

Learning Resources

- Harvey F. Hoffman, “The Engineering Capstone Course: Fundamentals for Students and Engineers”, Springer, 2014
- https://sharepoint.ecn.purdue.edu/epics/teams/Public%20Documents/EPICS_Design_Process.pdf?_ga=2.252800138.2089889711.1612784342-1089955741.1612784342

Course Contents and Lecture Schedule

Module No	Topic	No. of Lectures	Course Outcome
1	**Project Selection**		
	Search Phase, Preliminary Design Review (PDR) and Critical Design Review (CDR), Project Specification,	2	CO1, CO6

	Proposal Report, Proposal Presentation		
2	**Engineering Design Process**		
2.1	The NASA Design Approach	1	CO2
2.2	Design Verification and Validation	1	CO2
2.3	Design Verification Plan – DFMEA, test verification matrix, Usability testing,	2	CO3
2.4	DRIDS-V Design Approach and Plan	1	CO3
3	**Intellectual Property Rights**		
3.1	Trademarks, Copyrights and Patents,	1	CO4
3.2	Types of patents, Searching patents,.	1	CO4
3.3	Filing Patents	1	CO4
4	**Team formation and Communication**		
4.1	Types of teams, Team Conflict Management – common causes, cultural styles and conflict,	1	CO5
4.2	Project Team Evaluation, Conducting Meetings and Making Presentations	1	CO5, CO6
	Total	**12**	

Course Designers:

- Dr.S.J. Thiruvengadam sjtece@tce.edu
- Dr. S.Saravana Perumaal sspmech@tce.edu
- Dr.C.Jeyamala jeyamala@tce.edu

18ES790	CAPSTONE DESIGN PROJECT (COMMON TO B.E./B.TECH PROGRAMMES)

Category	L	T	P	Credit
Project	0	0	6	3

Preamble

Capstone Design Project is a culminating course where students work in teams to design, build, and test prototypes with real world applications. The Capstone Design course provides students an opportunity to work with real-world, open-ended, interdisciplinary challenges proposed by industrial and research project sponsors. They learn and apply the engineering design process: defining functional requirements, conceptualization, analysis, identifying risks and countermeasures, selection, and physical prototyping. Student teams design and build working, physical prototypes to validate their solutions. The course reemphasizes teamwork, project management, research and development.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcome Statement
CO1	Apply prior knowledge, independent research, published information, patents, and original ideas in addressing complex engineering problems and generating solutions.
CO2	Make design decisions based on product design requirements, product lifecycle considerations, resource availability, and associated risks
CO3	Develop design solutions in addressing performance requirements while satisfying relevant societal/industrial and professional constraints.
CO4	Demonstrate effective use of contemporary tools for engineering analysis, fabrication, testing, and design communication.
CO5	Plan, monitor, and manage project schedule, resources, and work assignments to ensure timely and within-budget completion.
CO6	Test and defend performance of a design product with respect to at least one primary design requirement.
CO7	Perform professionally—exhibiting integrity, accepting responsibility, taking initiative, and providing leadership necessary to ensure project success.
CO8	Use formal and informal communications with team, advisor, and clients to document and facilitate progress

* *Weightage needs to be assigned based on the customized domain-specific rubrics*

CO Mapping with CDIO Curriculum Framework

CO#	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.1, 1.2,1.3, 2.1, 2.2, 2.4, 3.1, 3.2, 4.1, 4.2, 4.3, 4.4, 4.5
CO2	TPS5	Evaluate	Organise	Adaptation	4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 4.2.1, 4.2.2, 4.2.3, 4.2.4
CO3	TPS3	Apply	Value	Mechanism	4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.5
CO4	TPS4	Analyse	Organise	Complex Overt Response	4.5.1, 4.5.2, 4.5.3, 4.5.4, 4.5.5
CO5	TPS4	Analyse	Organise	Complex Overt Response	4.3.1, 4.3.2, 4.3.3, 4.3.4
CO6	TPS4	Analyse	Organise	Complex Overt Response	4.5.1, 4.5.2, 4.5.3, 4.5.4, 4.5.5
CO7	TPS3	Apply	Value	Mechanism	2.5.1, 2.5.2

CO8	TPS3	Apply	Value	Mechanism	3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	-	-	M	M	S	S	M	M	S
CO2	S	S	M	L	S	M	M	M	S	M	M	S
CO3	S	M	L	-	-	M	M	M	S	M	M	S
CO4	S	S	M	L	M	M	M	M	S	M	M	S
CO5	S	S	M	L	M	M	M	M	S	M	S	S
CO6	S	S	M	L	M	M	M	M	S	M	M	S
CO7	S	M	L	-	-	M	M	S	S	S	M	S
CO8	S	M	L	-	-	M	M	S	S	S	M	S

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Phases	Deliverables	Marks	Course Outcomes
Continuous Assessment			
Comprehensive Test on disciplinary knowledge*	MCQ format	20	CO1
Review 1 – Capstone Project Selection, functional decomposition and Technical Specification	Technical Report & Presentation	25	CO1, CO2, CO7, CO8
Review 2 – Evaluation of Design Approaches, Project planning and modern tool usage	Technical Report & Presentation	30	CO3, CO4, CO5, CO7, CO8
Review 3 – Evaluation of Testing and Validation, Documentation	Technical Report & Presentation	25	CO5, CO6, CO7, CO8
End-Semester Examination			
Demonstration of the product	Presentation & Viva -voce	60	CO1, CO2, CO3, CO4 CO5, CO6, CO7, CO8
Poster Presentation	Poster	40	

- Reports are to be submitted at each review. The report and presentation will be evaluated based on customized domain-specific rubrics for periodic reviews.
- Demonstration and Poster presentation will be evaluated by two faculty members nominated by their respective Head of the Department.

***** The content for comprehensive test on disciplinary knowledge shall be decided by the committee at department level.

Course Designers:

- Dr.S.J. Thiruvengadam sjtece@tce.edu
- Dr.S.Saravana Perumaal sspmech@tce.edu
- Dr. C.Jeyamala jeyamala@tce.edu