# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**
**Subject Code: 3161013**
**Semester – VI**
**Subject Name: Systems Engineering**

**Type of course:** Programme Elective Course

**Prerequisite:** Knowledge of Control Theory, microprocessor/microcontroller hardware, programming concept in C, MATLAB : System Level Software.

**Rationale:** Systems Engineering plays crucial role in today's industry, where system level design, planning and implementation is generally achieved by interdisciplinary mode involving various branches of engineering to solve real life problems. It involves the project policies standards, human factor engineering in production lines.
Systems engineering is a discipline that utilizes an inter-disciplinary problem-solving approach across the entire technical effort irrespective of whether the systems or the systems of systems are for military, industrial, commercial or civil applications. This course will provide an overview of both theory and practice of the systems engineering discipline along with systems engineering design approach. The aim of the course is also to equip students with capability to develop system solutions that optimally fulfill customer objectives with available resources. Focus will be on creating now-how on solving open-ended problems, utilizing creativity, problem formulation, generation of need statements, requirements analysis, alternative solutions generation and examination, concurrent engineering design, enforcing various realistic aspects such as safety, reliability, manufacturability, operations, aesthetics, ethics, and sustainability.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 2 | 0 | 2 | 3 | 70 | 30 | 30 | 20 | 150 |

**Content:**

| Sr. No. | Content | Total Hrs |
|---|---|---|
| **1** | Fundaments of Systems Engineering, Discipline specific Engineering Standards: Systems Engineering: History and Examples, System Engineering as Profession, Power of System Engineering, Systems Engineering view Point, Perspectives, Domains, fields, approaches, activities and products, System Engineering Management(SEM), Program, /Project Life Cycle, Lifecycle Integration, Engineering standards | 5 |
| **2** | Complex System Structure: Building blocks, hierarchy, interfaces , environment, interactions, life cycle, evolutionary characteristics, Systems Engg method , Systems testing throughout development | 3 |
| **3** | Systems development Management: Work breakdown structure (WBS), Systems Engineering Management Plan (SEMP), Systems risk management, organizing for systems engg Need analysis – originating, operations, functional, and feasibility Need validation, systems opperations requirement System requirements development, performance requirements | 4 |

| | | |
|---|---|---|
| **4** | Engineering Concept Stage:<br>Concept exploration, validating requirements, Concept definition – selection and validation, functional analysis and allocation Systems architecture, system modeling languages, Model-Based Systems Engg (MBSE) Decision making, modeling for decisions Simulation, Trade-of analysis | **4** |
| **5** | Engineering development Stage:<br>Program risk reduction, prototype development for risk mitigation, Development testing, risk reduction, Revision of functional analysis and design, Overview of probability data analysis, Hypothesis testing | **3** |
| **6** | Engineering design Stage:<br>Implementing system building blocks, component design, Design validation, Change management Concepts of reliability, redundancy, Concepts of maintainability, availability, predictability, User interface design and GUI | **3** |
| **7** | Integration, testing and evaluation of Total system:<br>Test planning and preparation, system integration Developmental and operational test and evaluation Engineering for production, transition from development to production, Production operations Installation, maintenance and upgrading Installation testing In-service support Upgrades and modernization | **6** |

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

| **Distribution of Theory Marks** | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| **5** | **15** | **25** | **10** | **10** | **5** |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Reference Books:**

1. *NASA Systems Engineering Handbook, NASA/SP-2007–6105 Rev 1*. Military Bookshop,
2. INCOSE,. *Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*. 4th ed. Wiley, 2015. p. 304. ISBN: 9781118999400.
3. ISO/IEC/IEEE 15288:2015, Systems and Software Engineering—System Life Cycle Processes.

**Course Outcomes:**

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|

| | | |
|---|---|---|
| CO-1 | Describe the most important Systems Engineering standards and best practices as well as newly emerging approaches | |
| CO-2 | Structure the key steps in the systems engineering process starting with stakeholder analysis and ending with transitioning systems to operations | |
| CO-3 | Analyze the important role of humans as beneficiaries, designers, operators and maintainers of aerospace and other systems | |
| CO-4 | Characterize the limitations of the way that current systems engineering is practiced in terms of dealing with complexity, lifecycle uncertainty and other factors | |
| CO-5 | Apply some of the fundamental methods and tools of systems engineering to a simple cyber-electro-mechanical system as a stepping stone to more complex and real world projects | |

**List of Experiments:**

**(General guidelines.. Institute may change list of experiments based on laboratory set up available)**

1. Study of Project Management Software Platform/Tools
2. Study of Project Life Cycle Software Platform/ Tools
3. Study of Need Analysis Software Platform/ Tools
4. Study of Requirement Analysis Software Platform/ Tools
5. Study of Model Based System Engineering Software Platform/Tools ( UML/ SysML, MATLAB, Simulink, LABVIEW etc.)
6. Study of Design Synthesis Software Platform/Tools
7. Design of cyber-electro-mechanical system
8. System Design of Unmanned Aerial Vehicle (UAV) System
9. System Design of Battery Operated Electric Vehicle
10. System Design of Automated Robotic arm
11. System Design of Underwater Vehicle
12. System Design of Nano Satellite for Local Communication
13. System Design of Smart Meter for Air Quality Monitoring /Control
14. System Design of Smart Meter for Water Quality/Water Management Monitoring /Control
15. System Design of Smart Meter for Electricity Distribution/Management Monitoring /Control