DEFENCE INSTITUTE OF ADVANCEDTECHNOLOGY

(Deemed to be University)
Girinagar, Pune – 411025 (Maharashtra)

www.diat.ac.in

INFORMATION BULLETIN

Admission to
M. Tech. in Industrial Systems Engineering
(Specialization: Model Based Systems Engineering)
For Working Professionals
2025-2026

CONTENTS

1. About DIAT

Amidst the lush, green Sahyadri Hills and overlooking the picturesque Khadakwasla Lake lies the Defence Institute of Advanced Technology (DIAT). Established on 1st May 1952 as the Institute of Armament Studies, it was originally located on the sprawling campus of the College of Military Engineering, Dapodi, Pune. In 1967, the institute was renamed the Institute of Armament Technology and relocated to its present location at Girinagar, Pune. Since then, the institute, under the aegis of the Department of Defence Research and Development, Ministry of Defence, Government of India, has grown in strength and stature. It was recognized as a Deemed-to-be University on 1st April 2006. The institute has also acquired ISO 9001:2000 certification from DNV, Norway. Having been conferred the status of a Category "A" Deemed-to-be University by the Ministry of Human Resource Development, Government of India, the institute is now on its path to achieving NBA and NAAC 'A' Grade accreditations.

The Institute, a premier autonomous educational entity equipped with modern laboratories and well-qualified faculty members, is engaged in postgraduate education and research leading to M.Tech. and Ph.D. degrees.

Continuous efforts are made to maintain high standards of quality training in the critical area of modern Defence Technologies, thereby enhancing the technical capabilities of DRDO scientists, service officers, officers from defence industries, and fresh engineering graduates. The Institute also contributes to preparing skilled manpower for industries involved in the Government of India's "Make in India" campaign.

At DIAT, to meet the needs of the Armed Forces, DRDO, Defence Quality Assurance, Defence Ordnance Factories, Directorate of Aeronautical Quality Assurance, and other public sector undertakings, many specialized and customized postgraduate courses are conducted. In addition to the Ph.D. and M.Tech. programmes, the Institute also offers specific, limited-duration courses of 1 to 1.5 years, along with a variety of specialized short-term courses.

DIAT opened its doors to the general public in 2006 and has since been admitting students under the open category with scholarships for its Ph.D. and M.Tech. programmes. To strengthen ongoing research initiatives and enhance the quality of teaching and training, the Institute has introduced a scheme for appointing "Visiting Professors/Scientists."

The Institute is steadily progressing toward a quantum leap in the field of technical education and research, with a focus on the specific needs of the defence sector.

2. Location

Location of DIAT by Lat, Long is (18.424463, 73.758395) and GPS coordinates are 18° 25' 28.0668" N and 73° 45' 30.222" E.

Traveling from Mumbai to Pune takes about three hours by road or train. Private cabs such as Ola, Uber, and other services are frequently available from the airport and railway station.

Trains such as the Duronto, Intercity, and Deccan Queen run frequently from Mumbai Railway Station to Pune Railway Station.

Several trains, including the Duronto, Nizamuddin Express, Goa Express, and Mysore Express, run frequently from New Delhi Railway Station to Pune Railway Station. The journey takes approximately one day.

Many direct flights, such as those operated by SpiceJet, Air India, and IndiGo, are available frequently from New Delhi Airport to Pune Airport. The flight duration is about two hours.

3. Information Center and Library

Information Centre and Library (IC&L) is the knowledge hub of the Defence Institute of Advanced Technology (DU), Pune. It reflects the institute's commitment to providing the best possible library and information services to its academic community, including faculty members, scientists, students, and staff. The IC&L is a significant resource for information related to defence, science and technology, and allied subjects in this region of the world. The library houses a vast collection of both printed and digital resources. It offers a wide range of services, including reference and consultation, membership, circulation, document delivery, resource sharing, information alerts, bibliographic services, and digital library services. The IC&L continues its mission of facilitating new knowledge through the procurement, retrieval, preservation, organization, and dissemination of diverse resources. The library's collection—comprising books, journals, e-journals, databases, theses, reports, standards, and other reading materials—is its greatest asset. The library subscribes to 350 print and online journals and databases such as ScienceDirect, IEL, ASME, ACM, ProQuest (TRC, ABI/Inform), Scopus, SpringerLink, J-Gate, and e-books. The total collection includes 57,242 books, 4,772 e-books, 21,875 back volumes, 2,000 reports, and 1,762 dissertations and theses.

A compact storage system has been installed in the new library building to preserve older materials, including back volumes dating before the 1960s. To provide integrated access to its resources, the library uses LibSys-10, a web-centric library management software. IC&L has implemented RFID technology through LibSys-10 for managing its collections and services. RFID significantly reduces the time needed for circulation operations, as it allows information to be read from tags much faster than from barcodes. It also enables automated data collection without requiring line-of-sight or item-by-item scanning, reducing human effort and error.

The library has also developed the DIAT (DU) Digital Repository, an information system designed to ingest, store, manage, preserve, and provide access to digital content. The institutional digital repository supports scholarly communication and provides open access to articles, dissertations, research data, and more. It consists of formally organized digital content generated by faculty, staff, and students of the institute.

This repository plays a crucial role in capturing and managing the university's intellectual assets as part of its broader information strategy. The library uses DSpace, an open-source repository software package, to build and maintain this repository. DSpace meets DIAT's specific needs as a digital archive system, focused on long-term storage, access, and preservation of digital content.

4. Eligibility

1. Degree: B.E. / B. Tech. in any stream of Engineering / M.Sc. of a recognised Institute/University.

2. Experience: Two years professional experience in Systems Development. The candidate shall be currently employed. Candidate has to provide certificate from the employer to confirm his nature of work) and candidate has to provide NOC from their respective employer.

5. Admission

Working professionals who fulfils the eligibility criteria will undergo Written Test & Interview or only Interview based on the number of applications received.

Minimum students' enrolment required to run this program will be 12.

6. Selection Process

Admission to M. Tech. in Industrial Systems Engineering (Specialization: Model Based Systems Engineering) will be based on the performance in the written test and interview or only interview depending upon the number of applications received. Interview will be conducted by a panel of experts through online/offline mode. The merit list will be valid only for the academic year 2025-2026.

7. Fee Structure

One Time Fee		**Total**
Admission Fee (Non-Refundable	Rs. 6000/-	Rs. 26,000/-
Caution Deposit (Refundable)	Rs. 20,000/-	
Per Semester Fee		Total
Tuition Fee	Rs. 1,06,000/-	Rs. 1,25,000/- per semester per student
Library Fee	Rs. 2,000/-	
Miscellaneous	Rs. 17,000/-	

8. Tentative Schedule of Admissions 2025-26

- Announcement of inviting Applications: 08/05/2025
- Last date to receive applications: 25/07/2025
- Announcement of candidates called for Written Test(www.diat.ac.in): 28/07/2025
- Written Test & Interview or Interview at DIAT: 04/08/2025
- Announcement of Merit list (www.diat.ac.in): 04/08/2025
- Counseling cum Admission: 04 /08/2025

9. Instructions to Apply

The application fee for GEN, EWS, and OBC categories is INR 600/-, and for SC, ST, and PWD categories, it is INR 200/-. The application fee must be paid online through State Bank Collect. To make the payment, click on the **Online Payment Gateway** link available on the institute's homepage: www.diat.ac.in. **Do not use mobile applications** to make the payment.

The scan copy of application form with necessary documents in 1 single pdf format to be uploaded in Google Form (https://forms.gle/SKo6UpSQPvaDPhDd7) and also to be sent through Email at mtech_admissions@diat.ac.in.

10. List of documents to be uploaded with application

- Copy of SSC/Class X marks card/certificate in support of Date of Birth.
- Copy of Intermediate/ (10+2) / Class XII marks card/certificate
- Copies of Provisional Certificate / Degree Certificates and Marks Cards of the qualifying examinations
- Copy of the valid caste certificate (in case of SC/ST/OBC/EWS candidates)
- Photograph on application form
- Fee payment receipt with transaction number
- NOC from the respective employer
- Certificate from the employer to confirm his nature of work experience.

11. Department Specific Qualifications, Specializations and other details

Sr. No.	Offering Department	Programme (M.Tech.)	Specialization	Years	Minimum Qualification and Work Experience Required
1	Department of Aerospace Engineering	Industrial Systems Engineering	Model Based Systems Engineering	2.5 Years (5 Semesters)	**55% of marks or 6.0 CGPA (on a 10-point scale) in** B.E. / B. Tech. in any stream of Engineering / M.Sc. of a recognized Institute/University. Experience: Two years professional experience in Systems Development. The candidate shall be currently employed. Candidate has to provide certificate from the employer to confirm his nature of work) and candidate has to provide NOC from their respective employer.

About the Program:

M. Tech. in Industrial Systems Engineering (Specialization in Model Based Systems Engineering) focuses on Systems Thinking, Systems Architecture, Systems Design, Modelling, Verification, Validation, AI/ML, Design Optimization etc. This program also puts emphasis on domains like Aerospace Systems/Automotive Systems /Medical Systems/ Embedded Software Systems Engineering.

Mode of Conduct: Hybrid Mode

Faculties Involved: Professionals from Industries, Research Laboratories and Academia

Classes:

- Classes and tutorials will be conducted through hybrid mode.
- Classes will be conducted on Friday Evening & Saturdays.
- All students have to be present at DIAT for one week at the beginning and two weeks at the end of 1st and 2nd semesters for lab classes / hands on training / tutorials / end semester exams. Students have to present at DIAT for two weeks at the end of 3rd to 5th semester to complete their thesis work report / thesis followed by presentation / end semester exams.

Examination/Evaluation:

Theory Courses:

- Two formative assessments during the semester with 20 marks each. (Online or Offline Mode)
- Assignments/Quizzes shall carry 10 marks.
- End Semester Examination shall carry 50 marks. Students have to appear for the End Semester exams at DIAT.

Dissertation Work:

- Students have to carry out their Dissertation work at their respective organizations.
- Students have to choose one Guide/Supervisor from their organization and one from DIAT. The thesis topics shall be mutually agreed upon. Both the Supervisors/Guides will have to support and monitor the progress.
- Students have to submit Dissertation progress report in the 3rd and 4th semesters and Thesis in the 5th / Final Semester.
- At the end of the 3rd, 4th and 5th semesters, students have to appear for End Semester Examinations / Evaluation of submitted Report / Thesis, presentation on the completed work and a viva voce.

Note: DIAT reserves the right to decide the number of seats to be filled under this category. By mere fulfilment of eligibility criteria does not guarantee the candidates to be shortlisted for written test / interview.

12. Program Structure & Syllabus

Semester-1

#	Course Code	Course Name	Credits
1	ISE 601	Introduction to Systems Engineering	3
2	ISE 602	Requirements Engineering	3
3	MOOC /SWAYAM NPTEL / PGC 603	Research Methodology	3
4	ISE 641	*Systems Engineering Lab - 1	2
		CREDITS FOR FIRST SEMESTER	11

Semester-2

#	Course Code	Course Name	Credits
1	ISE 603	System Architecture, Design & Tradeoff Analysis	3
2	ISE 604	Multi-Disciplinary Analysis & Optimization	3
3	MOOC /SWAYAM NPTEL / PGC 604	AI/ML	3
4	ISE 642	*Systems Engineering Lab - 2	2
		CREDITS FOR SECOND SEMESTER	11

Semester-3

#	Course Code	Course Name	Credits
1	ISE 605	Model Based Systems Engineering	3
2	ISE 606	System Verification & Validation	3
3		Professional Elective-1	3
4	ISE 651	M. Tech. Dissertation Phase I	10
		CREDITS FOR THIRD SEMESTER	19

Semester-4

#	Course Code	Course Name	Credits
1		Professional Elective-2	3
2		Professional Elective-3	3
3	MOOC/SWAYAM NPTEL	Professional Elective-4	3
	ISE 652	M. Tech. Dissertation Phase II	10
		CREDITS FOR FOURTH SEMESTER	19

Semester-5

#	Course Code	Course Name	Credits
1	ISE 653	M. Tech. Dissertation Phase III	20
		CREDITS FOR FIFTH SEMESTER	20

List of Professional Electives

#	Course Code	Course Name	C
1	ISE 607	Human Factors in Systems Engineering	3
2	ISE 608	System Safety & Reliability	3
3	ISE 609	Systems Life Cycle Cost Analysis & Risk Management	3
4	ISE 610	AI-ML for Systems Engineering	3
5		SWAYAM-NPTEL - MOOC	3
Electives of Specific Domain			
7	ISE 611	Spacecraft Systems Engineering	3
8	ISE 612	Aircraft Systems Engineering	3
9	ISE 613	Automotive Systems Engineering	3
10	ISE 614	Medical Systems Engineering	3
11	ISE 615	Software Systems Engineering	3

For Course: 1 credit is 1 lecture hour per week
For Laboratory: 1 credit is 2 hours laboratory work per week
Course Work: 40 Credits
Dissertation/Thesis: 40 Credits
Total Credits: 80

Note:

- *Systems Engineering Lab 1 & 2 will be conducted offline at DIAT, one week during the beginning of the semester and one week at the end of the semester.
- Students have to take minimum 1 or maximum 2 electives from the list of “Electives of Specific Domain”
- Students may opt MOOC/SWAYAM NPTEL course for Professional Elective - 4 in the fourth semester.

Syllabus

Course Code & Title
ISE 601 - Introduction to Systems Engineering
Course Context
Systems Engineering is an interdisciplinary approach that facilitates the successful realization of complex systems. As a critical discipline and practice, it has been instrumental in the development of many advanced and integrated systems across various domains. At its core, Systems Engineering involves a holistic view of a problem—considering all facets and variables, and effectively integrating both technical and social dimensions. Systems Engineers assume a variety of roles throughout a system's lifecycle, including Requirements Owner, Systems Architect, Systems Analyst, Systems Integrator, and Integrated Product Team (IPT) Coordinator. They serve as the *technical conscience* of a project, ensuring coherence, integrity, and alignment of the system with its intended purpose. In essence, Systems Engineers are the glue that binds the diverse elements of a system, enabling it to function as a unified and effective whole.
Course Objectives
1. Introduce systems engineering practice (theory) that pertain to creation of multi-disciplinary solutions to complex systems. 2. Build an appreciation and provide insights into key systems engineering practices. 3. Provide an overview of various development lifecycle activities pertaining to systems engineering of complex systems.
Course Content
Unit I: Fundamentals of Systems: Definition & Concepts of System, Systems Engineering, Systems Thinking, Structure of Complex Systems. **Unit II: System Development Life Cycle Stages:** Requirement Definition, Conceptual Design, Preliminary Design, Architecture Definition, Detailed Design and Development, System Analysis, Interface, Management, System Integration, System Verification, System Transition, System Validation, System Operation, System Maintenance, System Disposal. **Unit III: Systems Engineering Management:** Technical reviews management. Development, Acceptance & Operational Test & Evaluation, Test & Evaluation Master Plan, Decision Management, Technical Risk Management, Configuration Management, Quality Assurance, **Unit IV: Systems Engineering Development Approaches:** Waterfall, V, Spiral models. Lean and agile Systems Engineering. **Unit V: Specialty Areas in Systems Engineering:** Interoperability, Logistics, Safety, Reliability, Maintainability, Security, Usability. **Unit VI: Modeling & Simulation:** Introduction to System Modeling & Simulation.
Course Outcome
CO1: Describe the system development process CO2: Define the different concepts in systems engineering CO3: Apply the concepts to build a system of interest CO4: Design an architecture of a system of interest CO5: Simulate a system of interest and analyze
Text Books
1. “Systems Engineering Principles and Practice” by Kossiakoff, Alexander and William N. Sweet, Wiley, 2011 2. “Systems Engineering Practice, Canberra: Argos Press” by Faulconbridge, R.I. and Ryan, M. J., Revised Edition 2018.
Reference Books / Materials
1. “INCOSE Systems Engineering Handbook”, Ver. 4, Wiley. 2. “System Engineering Body of Knowledge”, www.sebokwiki.org. 3. “NASA Systems Engineering Handbook”, Rev1, December 2007. 4. “ISO/IEC/IEEE 15288 - Systems and software engineering — System life cycle processes”, 2023. 5. “Systems Engineering And Analysis” by Benjamin S. Blanchard and Wolter J. Fabrycky, 6th edition 2023, Prentice Hall International Series in Industrial and Systems Engineering. 6. System Engineering Analysis, Design, and Development: Concepts, Principles, and Practices, 2nd Edition Charles S. Wasson

Course Code & Title
ISE 602 – Requirements Engineering
Course Context
The complete and accurate definition of system requirements is a primary focus of the early systems engineering effort. The life cycle of a system begins with a mission statement. Subsequently, this is translated into a large number of statements of requirement that form the basis for the logical (functional) design and subsequently the physical architecture. The requirements flow down and transitions must be managed by a rigorous process that guarantees that all relevant requirements are included. It also needs to be ensured that all irrelevant requirements excluded. The establishment of correct and sufficient requirements is fundamental to the engineering of complex multidisciplinary systems
Course Objectives
1. Understand the processes and management practices associated with the requirements engineering discipline. 2. Understand the need for the requirements engineering discipline. 3. Understand the strengths and weaknesses of accepted requirements engineering methodologies and processes. 4. Develop major requirements engineering plans and artefacts. 5. Understand the role and contribution of requirements engineering in project and business contexts. 6. Develop appropriate requirements engineering artefacts for an example project.
Course Content
Unit I: Requirements Engineering Processes: Requirements Engineering Processes, Representation and Organization of Requirements, Implementation and Applications of Traceability, Capabilities of Commercial Requirements, Requirements Engineering in Problem/Solution Domain, Functional Breakdown, Concept of Operations, Types of Requirements. **Unit II: Characteristics of Good Requirements:** Requirements attributes, EARS Notation: Ubiquitous Requirements, Event-Driven Requirements, State-Driven Requirements, Optional Feature Requirements, Complex Requirements. **Unit III: Requirements in Problem Domain & Solution Domain** Stakeholder Needs & Requirements, Requirements Elicitation, CONOPS, Operational Scenarios & Use cases, Requirements hierarchy & flow down, Requirements specification tree, Interface requirements, **Unit IV: Tools for Managing Requirements:** DOORS (Dynamic Object-Oriented Requirements System): Requirements Capture & Management, Traceability, Collaboration, Customization & Scripting, Integration with Other Tools, Version Control & Change Management. MathWorks Tools.
Course Outcome
CO1: Define the principles of requirements capture and authoring CO2: Describe the process of requirements capture and management CO3: Apply the good requirements principles to a system of interest CO4: Examine and review the requirements for a system of interest CO5: Categories the requirements into various types CO6: Evaluate the design tradeoff during functional breakdown for a system of interest
Text Books
1. “Requirements Engineering” by Jeremy Dick, Elizabeth Hull and Ken Jackson, 4th edition, 2017
Reference Books / Materials
1. “Requirements Engineering: Fundamentals, Principles & Techniques”, Klaus Pohl, 2nd edition, Springer, 2025 2. “INCOSE Needs & Requirements Manual”, INCOSE Requirements Working Group, TP-2021-002-01, Wiley, 2024 3. “Requirements Practice”, by Ryan, M. J., Canberra: Argos Press, 2017 4. “INCOSE - Guide for Writing Requirements” - V3, updated 2019 5. “System Engineering Analysis, Design, and Development: Concepts, Principles, and Practices”, 2nd Edition Charles S. Wasson, 2015.

Course Code & Title

ISE 603 - System Architecture, Design & Tradeoff Analysis

Course Context

The purpose of System Architecture and Design is to enable the creation of a global solution based on principles, concepts and properties logically related and consistent with each other. The solution architecture and design have features, properties and characteristics satisfying the set of requirements, and implementable through technologies. An effective architecture is as design agnostic as possible to allow for maximum flexibility in design space. This course covers principles and methods for technical System Architecture. The background, history and some frameworks of system architecture are provided, and using the architecture framework consists of all views, operational view, systems view and technical view, some examples are explained. It presents a synthetic view including: the resolution of ambiguity to identify system goals and boundaries; the creative process of mapping form to function; and the analysis of complexity and methods of decomposition and re-integration. Industrial speakers and faculty present examples from various industries. Heuristic and formal methods are presented. Also, some of the recent advances in System Architecture are provided.

Course Objectives

1. Understand system architecture and design processes
2. Define various frameworks, methodologies and approaches for system architecture
3. Able to identify and arrive at the architecture of systems, critique them, and learn from them
4. Create architectures for new or improved systems
5. Execute the role of a system architect
6. Produce deliverables of the architect needed to define the architecture of a system

Course Content

Unit I: Architecture Fundamentals:
Architecture Definition, Architecture Viewpoints, Concept Analysis, Models & Views of Architecture, Functional, Behavioral, Data, Performance, Case Studies

Unit II: Architecture Evaluation and Analysis:
Structure & Behavior, Evaluating Candidate Architectures, System/Subsystem Analysis, Tradeoff Analysis, Architecture Frameworks & Standards

Unit III: Design Principles, Methodologies & Progression:
Structured & object oriented design approaches, Design Heuristics & principles, Reuse/ modularity, Design Progression, Architecture Domains, Software, IT, Manufacturing, Social

Unit IV: Design For X:
Design for Reliability, Design for Manufacturability, Design for sustainability, Design of Experiments & sensitivity analysis Robustness Design, Tradeoff Analysis.

Unit V: Intellectual Property Considerations:
Patents & Intellectual Property

Course Outcome

CO1: Identify the different views
CO2: Describe the process of developing architecture
CO3: Sketch the different architectures for the system of interest
CO4: Calculate the parameters of interest from the system architecture
CO5: Develop a complete architecture for the system of interest.
CO6: Analyze and obtain an optimal architecture for a system of interest.

Text Books

1. "The Art of Systems Architecting", Mark W Maier & E. Rechtin, 4th edition, CRC Press, 2025

Reference Books / Materials

1. "System Architecture: Strategy, Product Development for Complex Systems", Edward Crawley, Bruce Cameron, Daniel Selva, 2nd edition, Pearson, 2023 ".
2. "Systems and software engineering — Architecture description", ISO/IEC/IEEE 42010:2011
3. "IEEE Standard for Application and Management of the Systems Engineering Process" - 1220-2005
4. System Engineering Analysis, Design, and Development: Concepts, Principles, and Practices, 2nd Edition Charles S. Wasson, 2015.

Course Code & Title
ISE 604 - Multi-Disciplinary Analysis & Optimization
Course Context
The goal of multidisciplinary analysis & optimization (MDAO) is to find a solution to a multi-disciplinary problem within an optimization framework. The objective of the course is to learn methodologies for formulating and performing multi-disciplinary analysis, how to build surrogate models and uncertainty models and do system level optimization using decomposition strategies.
Course Objectives
1. Understand Multi-disciplinary Analysis and Challenges for Optimization 2. Learn about various Decomposition strategies for MDAO 3. Need for Surrogate Modeling and Variable Fidelity Analysis 4. Learn about various Optimization techniques and how to compute coupled derivatives and how to handle multiple objectives 5. How to handle uncertainty in the design process
Course Content
Unit I: Introduction Definition of Multi-disciplinary Analysis and Design Optimization (MDAO), Why MDAO?, Building blocks for MDAO, Challenges in Implementation, Parameterization of System, Variable Fidelity Analysis, Organizational Complexities **Unit II: Types of MDAO Architectures** Concept of coupled Design Variables, Monolithic MDAO Architectures, Distributed MDAO Architectures **Unit III: Surrogate Modeling and Design Space Visualization** Response Surface Methodology and DoE, Design and Analysis of Computer Experiments, Kriging, Deep Neural Networks, Design Space Visualization. **Unit IV: Gradient Based Optimization and Computation of Derivatives** Constrained Problem Formulation, understanding n dimensional space, Optimality conditions, Penalty Methods, Sequential Quadratic Programming, Gradients and Jacobians, Overview of methods for computing derivatives, Symbolic Differentiation, Finite Differences, Complex Step, Algorithmic Differentiation, Adjoint Methods, Coupled derivatives computation **Unit V: Multi-Objective Optimization** Multiple Objectives, Pareto Optimality, Solution Methods **Unit VI: Optimization Under Uncertainty** Robust Design, Reliable Design, Building Uncertainty Models when Data is scarce **Unit VII: Frameworks for MDAO** Frameworks in Industry, Setting up MDAO problem in frameworks, Case Study
Course Outcome
CO1: Explain the principles of multi-disciplinary analysis and optimization and their applications in engineering and design. CO2: Apply mathematical optimization techniques and computational algorithms for solving multi-disciplinary problems. CO3: Implement and evaluate various optimization techniques, such as gradient-based methods, evolutionary algorithms, and surrogate modeling. CO4: Be able to understand and translate the system requirements into a formal Optimization Problem using an appropriate multi-disciplinary analysis with high fidelity and solve the same
Text Books
1. "Engineering Design Optimization" by Joaquim R.R.A. Martins, Andrew Ning, Cambridge University Press, 2021 2. "A Summary of Industry MDO Applications and Needs," Giesing, J. P., Barthelemy, Jean-Francois M., AIAA Paper 98-4737 (1998).
Reference Books / Materials
1. "Response Surface Methodology: Process and Product Optimization using Designed Experiments" by Myers RH, Montogomery DC, Anderson-Cook CM, 4th Edition, John Wiley & Sons. 2. "Design & Analysis of Computer Experiments", by Jerome Sacks, William J Welch, Toby J Mitchell, Henry p. Wynn Statistical Science 4(4) 409-423 Nov 1989. 3. "Efficient Global Optimization of Expensive Black-Box Functions" by Donald R. Jones, Matthias Schonlau, William J Welch, Journal of Global Optimization 13, 455-492, 1998 4. "Algorithms for Optimization" by Mykel J Kochenderfer, Tim A Wheeler, The MIT Press -9780262039420- EPUB publication

Course Code & Title
ISE 605 - Model Based Systems Engineering
Course Context
Model-based systems engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases. MBSE Formalizes the practice of systems development using models. It results in quality/productivity improvements & lower risk. Data-centric specifications enable automation and optimization, allowing SEs to focus on value added tasks and ensure a balanced approach is taken. Unprecedented levels of systems understanding can be achieved through integrated analytics, tied to a model-centric technical baseline.
Course Objectives
1. Appreciate the need and advantages of model-based approaches 2. Familiarity with SysML notation 3. Familiarity with various modeling approaches and methodologies 4. Develop various types of models pertaining to requirements, architecture and design of complex systems
Course Content
Unit I: Introduction to MBSE: Introduction to MBSE, MBSE Concepts, MBSE Ontology **Unit II: Modeling Techniques and Languages:** Introduction to Object Process Modeling (OPM), Object Process Language (OPL), Overview of SysML Block Definition Diagrams, Internal Block Diagrams, Use Case Diagrams, Activity Diagrams, Sequence Diagrams, State Machine Diagrams, Parametric Diagrams, Requirements Diagrams, Package Diagrams **Unit III: Modeling Approaches:** Operational Analysis Modeling, Functional Analysis Modeling, Logical Architecture Modeling, Physical Architecture Modeling **Unit IV: Architecture Frameworks:** Architecture Frameworks in MBSE **Unit V: Practical Applications and Case Studies:** Case Studies of MBSE, MBSE Deployment **Unit VI: Advanced Concepts:** Introduction to Digital Twins
Course Outcome
CO1: Describe the different modelling paradigms and diagrams CO2: Apply the different modelling paradigms to the system of interest CO3: Develop the model for the system of interest CO4: Analyze the behavior of the models. CO5: Evaluate the different design tradeoff from the models for the system of interest
Text Books
1. “SysML Distilled: A Brief Guide to the Systems Modeling Language”. Lenny Delligatti. Addison-Wesley Professional; 1 edition-2013 2. “Model-based systems engineering with OPM and SysML” by Dov Dori, Springer
Reference Books / Materials
1. “SysML for Systems Engineering – A model-based approach” by Jon Holt and Simon Perry, IET. 2013 2. “Model-based System and Architecture Engineering with the Arcadia Method (Implementation of Model Based System Engineering)”, by Jean-Luc Voirin, ISTE Press - Elsevier. 2017 3. “Handbook of Model-Based Systems Engineering”, Editors: Azad M. Madni, Norman Augustine, Michael Sievers, Springer 2023

Course Code & Title
ISE 606 - System Verification & Validation
Course Context
System verification & validation is critical to the success of engineered systems. It needs to be verified that the system design satisfies the system requirements. It needs to be validated that the system requirements meet the stakeholders needs. The aim is to test and evaluate the system progressively as it passes through the various development phases to avoid costly and time-consuming modifications to the system design late in the life cycle. Progressive test and evaluation is both a risk mitigation measure and project performance measure that provides a high degree of confidence early in the system life cycle that the design is tracking to perform as required. A thorough evaluation of a system involves validating the system against the original customer requirements. Obviously, this full validation cannot be completed until the entire system has been designed, developed and constructed, and then operated in the intended operational environment by operational personnel.
Course Objectives
1. Articulate importance and key aspects of verification/validation in Systems Engineering and Project Management as applied to system design and capability acquisition lifecycles 2. Appreciate validation methods, verification methods and categories, configuration baselines and functional and physical configuration 3. Compare the types of verification/ validation and their contemporary issues 4. Develop hierarchical and traceable verification/ validation measures for systems - measures of effectiveness/performance (MOEs/MOPs) 5. Understand and formal methods of verification
Course Content
Unit I: Fundamentals of System Verification and Validation: System Verification, System Validation, Various Approaches to System Validation and Verification, Inspection, Testing, Analysis, Demonstration **Unit II: Test Case Generation:** Generation of Test Cases Using the Markov Chain Model, Writing Verification/Validation Plans **Unit III: Formal Methods:** Introduction to Formal Methods, Formal Approaches to System Validation/Verification **Unit IV: Specialty Areas:** Focus on Specialty Areas (e.g., EMI/EMC) DO 160 **Unit V: Test Automation:** Test Automation Models, Computation Automation, Timed Automation, Simulation **Unit VI: Model Checking Verification:** Model Checking Verification Techniques **Unit VII: Standards for Safety-Critical Systems:** Verification and Validation Activities Prescribed in Standards, DO-178C, DO-254, APR 4754
Course Outcome
CO1: Describe the various standards used in the verification process CO2: Define the test methods for the system of interest CO3: Design test cases for the system of interest CO4: Evaluate the complexity of systems and identify the test effort CO5: Develop a test plan for the system of interest.
Text Books
1. "Verification, Validation and Testing of Engineered Systems," by Engel, Avner, John Wiley & Sons, 2010 2. "Understanding Formal Methods" by Jean-Francois Monin, , Springer, 2003
Reference Books
1. "Understanding Formal Methods", by Jean-Francois Monin, , Springer, 2003 2. "Industrial Use of Formal Methods: Formal Verification" by Jean-Louis Boulanger (Editor), Wiley, 2012 3. "Evolving Toolbox for Complex Project Management" by Eds. Alex Gorod, Leonie Hallo, Vernon Ireland, Indra Gunawan (2019), CRC Press, Taylor & Francis Group, Auerbach, ISBN 9780429197079 4. "Test and Evaluation of Aircraft Avionics and Weapon Systems" by McShea, R. E (2010)., 2nd Ed., Institution of Engineering and Technology, ISBN 978-1-61353-176-1 5. RTCA DO 160, DO 178 standards 6. Model-Based Testing of Reactive Systems, Editors: Manfred Broy, Bengt Jonsson, Joost-Pieter Katoen, Martin Leucker, Alexander Pretschner, Springer, 2005

Course Code & Title

ISE 607 - Human Factors in Systems Engineering

Course Context

This course serves students in advanced students in human factors and human systems integration. The course enables students to understand the roles and risks of human factors in the design, operation, and modernization of complex systems. Behavioral and cognitive limitations of human operators and maintainers in complex systems play key roles in the overall performance, safety, and cost of operations. It is important that system architects, designers, engineers, and managers fully appreciation the information reception, information processing, and skilled performance issues involved. Emphasis is placed on methods, models, and techniques, including psychophysics, cognitive evaluations, field assessments, and surveys.

Course Objectives

1. Understand human factors and implications on system design
2. Understand human machine interactions
3. Apply various analysis techniques pertaining to human factors to be addressed in system design

Course Content

Unit I: Introduction to Human Factors:
Human Factors Fundamentals, Role of Standards in Human Factors

Unit II: Cognitive and Perceptual Processes:
Sensation and Perception, Selection and Control of Action, Information Processing, Mental Workload

Unit III: Design Principles and Ergonomics:
Cross-Cultural Design, Anthropometry, Biomechanics, Task Analysis and Design, Situational Awareness

Unit IV: Workplace and Environmental Design:
Workplace Design Principles, Sound and Noise Factors, Occupational Health and Safety, Human Error and Reliability, Maintainability

Unit V: Modeling Human Performance:
Persona Development, Modeling Human Performance in Complex Systems, Virtual Environments, Neuro ergonomics

Unit VI: Human-Computer Interaction (HCI):
Human-Computer Interaction Principles, Usability Testing, Website Design Evaluation, Smarter Products and Technology Integration

Unit VII: Design Approaches:
Cross-Cultural Issues in Design, Universal Design Principles, Empathy and Affinity in Design, User-Centered Design of Consumer Products

Unit VIII: Practical Applications and Case Studies:
Case Studies in Human Factors and Design, Group Projects on Human Factors Applications

Course Outcome

CO1: Describe the role of standards and fundamentals of human factors in systems engineering
CO2: Describe the various design principles
CO3: Apply the humans factor engineering in the system of interest
CO4: Analyze a design and optimize for a system of interest

Text Books

1. "Handbook Of Human Factors And Ergonomic", by Gavriel Salvendy (Ed)., John Wiley & Sons, 2012.

Reference Books

1. "Engineering Psychology & Human Performance" by Wickens, Hollands, Parasuraman, & Banbury, 4th Ed., 2012.
2. "Human Factors & Ergonomics in Consumer Product design" by Waldemar Karwowski, Marcelo M Soares, Neville A Stanton, Crc press, 2011.

Course Code & Title
ISE 608 - System Safety & Reliability
Course Context
System safety analysis builds upon the fundamentals of good systems thinking, analyzing each requirement from macro to micro level behavior and eliminate or control safety risk potential. Safety risk potential pertains to any damage to the system, harm to the humans involved or damage to environment. Various analysis includes system safety analysis, functional hazard analysis and Fault Tree analysis. System reliability analysis is required to prevent or to reduce the likelihood or frequency of system failures. Analyzing the reliability of designs and addressing causes of failures is critical.
Course Objectives
1. Understand the fundamentals of reliability and safety management of safety critical systems. 2. Understand the use of core techniques and be able to apply these techniques to the analysis and design of safety critical systems. 3. Plan a reliability and safety management program for the acquisition or modification of a complex system. 4. Develop and critically review key reliability and safety program artefacts including management plans, analyses and arguments.
Course Content
Unit I: Introduction to System Safety: Introduction to System Safety, System Safety Planning, Safety Process Overview. **Unit II: Hazard Identification and Analysis:** Hazard Identification Techniques, Safety-Guided Design Principles, Hazard Risk Assessment, Risk Reduction Strategies, Hazard Control Measures. **Unit III: STPA (System-Theoretic Process Analysis):** Hazards and Losses, Hierarchical Control Structure, Unsafe Control Actions, Analysis. **Unit IV: Safety Management Practices:** Safety Reviews and Audits, Hazard Tracking Mechanisms, Analysing Accidents and Incidents, Anomaly Reporting and Safety Practices, Building a Safety Culture **Unit V: Safety Standards and Guidelines:** Overview of ARP 4761, Safety Frameworks and Compliance. **Unit VI: Reliability Theory:** Introduction to Reliability Theory, Reliability Failure Models. **Unit VII: Quantitative System Analysis:** Quantitative Analysis Techniques, FMECA (Failure Mode, Effects, and Criticality Analysis), FTA (Fault Tree Analysis), RBD (Reliability Block Diagram), Markov Processes in Reliability Analysis, Reliability of Safety Systems **Unit VIII: Advanced Reliability Analysis:** Life Data Analysis Techniques, Bayesian Reliability Analysis
Course Outcome
CO1: Describe the different methods of safety analysis CO2: Compute the FTA, RBD for a system of interest CO3: Apply the principles of STPA for a system of interest CO4: Analyze the architecture alternatives for system safety CO5: Estimate the probability of failures for system of interest.
Text Books
1. “Reliability of Safety-Critical Systems: Theory and Application”, Marvin Rausand, Wiley 2014
Reference Books / Materials
1. “System Safety Skeptic” by Terry L Hardy., AuthorHouse 2010 2. “Engineering a Safer World: Systems Thinking Applied to Safety” by Nancy G. Leveson, MIT Press, 2012. 3. “Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment is an Aerospace Recommended Practice from SAE”, ARP4761. 4. “System Reliability Theory: Models, Statistical Methods & Applications”, Marvin Rausand and Arnljot Hoyland,., John Wiley & Sons, 2004 5. STPA handbook

Course Code & Title
ISE 609 - Systems Life Cycle Cost Analysis & Risk Management
Course Context
Understanding the system scope of work and related cost is fundamental knowledge required to start any activity. Inadequate cost estimation and poor risk management are the leading causes of failure in development of engineered systems. This course covers different methods used to identify and measure the cost elements as the first step to build a cost estimate. The course also addresses methods to identify, analyze, treat and monitor risks. Numerous standards and guidelines As part of this course, there is an opportunity to apply the learnings in a case project using the concepts learned in class.
Course Objectives
1. Articulate basic concepts of cost estimation, different types of costs and their differences, 2. Proficiency in different methods used to estimate costs, how to gather information, compile and use a cost estimate, how to work with others, critique an estimate and provide insight on how to prepare one, 3. Familiarity with use of statistics and modeling techniques to improve the estimate. 4. Understand how to quantify risks, including risk levels , and assessing their impact on life cycle costs, schedule and performance
Course Content
Unit I: Introduction to Cost Estimation: Basic Concepts of Cost Estimation, Different Types of Costs and Their Differences, Importance of Credible, Supportable, Usable, Accurate, Achievable, Competitive, Complete, and Realistic Cost Estimates. **Unit II: Cost Estimation Methods and Techniques:** Methods Used to Estimate Costs, How to Gather Information, Compile, and Use a Cost Estimate, Working with Others: Critiquing an Estimate and Providing Insights, Use of Statistics and Modeling Techniques to Improve Estimates. **Unit III: Project Management and Cost Estimation:** Basic Project Management Techniques and Their Relationship to Cost Estimation, Cost Distribution Over the Life of a Project, Project Phases and Associated Costs and Risks, **Unit IV: Decision-Making Tools for Cost Reduction:** Basic Decision-Making Tools as Aids to Cost Reduction, Cost Analysis and Risk Management **Unit V: Risk Quantification and Analysis:** Quantifying Risks, Including Risk Levels, Assessing Impact on Life Cycle Costs, Schedule, and Performance, Basic Principles of Probability & Uncertainty and Their Implications in Risk Analysis, Correlation Among Risks **Unit VI: Data Gathering and Statistical Techniques:** Data Gathering Techniques for Cost Components and Risk Levels, Data Analysis and Statistical Techniques for Estimating Costs **Unit VII: Using Risk Analysis for Decision Making:** Using Risk Analysis to Support Decision Making
Course Outcome
CO1: Describe the concepts of risk management and cost estimation CO2: Describe the statistical techniques of risk management CO3: Apply the concepts to the system of interest CO4: Develop a project plan to develop the system of interest. CO5: Develop a risk management plan for the system of interest
Text Books
1. “Cost Estimating”, by Steward, Rodney D., Second Edition, John Wiley and Sons 2. “Probability Methods for Cost Uncertainty Analysis: A Systems Engineering Perspective”, by Garvey, Paul R, Marcel Dekker, Inc. 2000
Reference Books / Materials
1. “Foundations of Risk Analysis: A knowledge and Decision –Oriented Perspective” by Aven, Terji., John Wiley and Sons, Inc. 2008 2. “Hazop and Hazan: Identifying and Assessing Process Industry Hazards”, by Trevor A Kletz

Course Code & Title
ISE 610 - AI-ML for Systems Engineering
Course Context
This course explores the integration of Artificial Intelligence (AI) and Machine Learning (ML) in systems engineering. It focuses on the application of AI and ML algorithms in system development, the use of open-source models and large language models (LLMs), and the process of developing AI systems for engineering applications. The course also covers AI tools used for system design, development, and certification, providing students with hands-on experience in utilizing these technologies within systems engineering frameworks
Course Objectives
1. Familiarize with fundamentals of AI & ML for Systems Engineering 2. Understanding different AI/ML algorithms and models 3. Learning AI tools and Techniques for System Developments 4. Understanding AI Ethics, Risk and Challenges
Course Content
Unit I: Fundamentals of AI and ML in Systems Engineering • Introduction to AI and Systems Engineering • Basic Concepts in Machine Learning • Mathematical Foundations for ML **Unit II: AI/ML Learning Algorithms and Models** • Supervised Learning Algorithms • Unsupervised Learning Algorithms • Deep Learning Models • Reinforcement Learning **Unit III: Open Source Models and Large Language Models (LLMs)** • Introduction to Open Source AI Models • Working with Large Language Models (LLMs) • Model Deployment **Unit IV: AI Tools and Techniques for System Development** • AI Tools in Systems Engineering • Developing AI Solutions for Systems Engineering • Lifecycle and Certification of AI Systems **Unit V: System Engineering for AI** • AI System Design Process • AI Ethics, Risks, and Challenges • Project and Case Studies
Course Outcome
CO1: Understand the fundamentals of AI and Machine Learning and how they can be applied to systems engineering problems. CO2: Implement key AI/ML algorithms and models, and integrate them into engineering systems using open-source tools. CO3: Design AI-based solutions for complex engineering systems, applying system engineering principles to AI system development. CO4: Apply AI tools in system development, focusing on the development process, lifecycle, and certification of AI-based systems. CO5: Evaluate the ethical, regulatory, and technical considerations of deploying AI systems in real-world engineering environments.
Text Books
1. "Systems Engineering and Artificial Intelligence" by William F. Lawless, Ranjeev Mittu, Donald A. Sofge, Thomas Shortell, Thomas A. McDermott, , Springer
Reference Books / Materials
1. "Artificial Intelligence: A Modern Approach" by Russell/Norvig, 2. "Co-Intelligence: Living and Working with AI" by Ethan Mollick,

Course Code & Title

ISE 611 - Spacecraft Systems Engineering

Course Context

This course typically covers the design, development, and operation of spacecraft, including satellites, probes, and crewed vehicles. It integrates multiple engineering disciplines to ensure the successful performance of a spacecraft in its intended mission.

Course Objectives

1. Understand the fundamental concepts of spacecraft design and engineering.
2. Study the space environment, including vacuum, radiation, micrometeoroids, and thermal effects.
3. Learn about key spacecraft subsystems
4. Study orbit Dynamics and mission analysis, space craft propulsion, space craft power systems, communication

Course Content

Unit I: Spacecraft Systems Engineering

Introduction to Spacecraft Systems Engineering; Anatomy of a Spacecraft; Types of Spacecraft

Unit II: Space Environment and Its Effects on Spacecraft Design

Launch Environment; Solar Influence on Space Environments; Radiation and Plasma Environments; Space Particulate Environment; Materials Selection and Effects

Unit III: Orbit Dynamics and Mission Analysis

Orbit Selection; Keplerian Dynamics; Orbital Perturbations

Unit IV: Spacecraft Propulsion

Launch Vehicles and Propulsion; Electric Propulsion; Secondary Propulsion Systems; Propellant Management

Unit V: Spacecraft Power and Communications

Spacecraft Power Systems; Thermal Control Systems; Communication Systems; On-board Data Handling

Course Outcome

CO1: Understand the Space Environment: Demonstrate knowledge of the space environment, including solar radiation, high-energy and low-energy plasma, space debris, and the effects of these environments on spacecraft design and materials.

CO2: Apply Orbital Mechanics: Utilize Keplerian dynamics, co-planar and non-planar orbital transfers, and perturbation analysis to perform orbital maneuvers for various mission types.

CO3: Design Spacecraft Propulsion Systems: Identify and evaluate the appropriate propulsion system (chemical, electric, or secondary) based on mission requirements and spacecraft needs.

CO4: Analyze Spacecraft Power Systems: Design spacecraft power systems, including solar arrays, batteries, RTGs, and fuel cells, while considering power distribution, regulation, and environmental factors.

CO5: Develop Thermal and Communications Systems: Understand and design thermal control systems for spacecraft and develop communication strategies, including TT&C and payload data transmission.

CO6: Perform Mission Analysis and Design: Apply spacecraft systems engineering principles to design and analyze space missions, considering cost, risk, and programmatics, and integrate spacecraft subsystems effectively.

Text Books

1. “Spacecraft Systems Engineering” by Fortescue, Swinerd & Stark (Editors) (2011). (4th Edition). John Wiley & Sons.

Reference Books / Materials

1. “Space Vehicle Design”, Second Edition (AIAA Education) by Michael D. Griffin, James R. French
2. “Elements of Spacecraft Design” (AIAA Education) by Charles D. Brown
3. “Spacecraft Systems Engineering” 3rd Edition by Peter Fortescue (Editor), John Stark (Editor), Graham Swinerd (Editor)
4. “Space Mission Engineering: The New SMAD” (Space Technology Library, Vol. 28) Edited by James R. Wertz, David F. Everett, and Jeffrey J. Puschell
5. “Basics of Spaceflight” by Dave Doody, Jet Propulsion Laboratory
6. “The Space Environment and Its Effects on Space Systems” (AIAA Education Series) by Vincent L. Piscane
7. “Space Modeling and Simulation: Roles and Applications Throughout The System Life Cycle” by Larry B. Rainey
8. “The Space Environment: Implications for Spacecraft Design” by Alan C. Tribble

Course Code & Title
ISE 612 - Aircraft Systems Engineering
Course Context
This course typically covers the design, integration, and operation of various aircraft systems. It is a multidisciplinary subject that combines aerospace engineering, mechanical engineering, electrical engineering, and control systems.
Course Objectives
Understanding 1. Aircraft Systems & Subsystems 2. Systems Engineering Approach 3. Flight Control & Avionics 4. Propulsion & Power Systems 5. Safety, Reliability & Maintenance
Course Content
Unit I: Introduction to Aircraft Systems Engineering Overview of Aircraft Systems Engineering; Key Aircraft Subsystems; Systems Engineering Process **Unit II: Aircraft Flight Control Systems** Introduction to Flight Control; Control System Design; Human-Machine Interface (HMI); Autopilot and Flight Management Systems (FMS) **Unit III: Aircraft Propulsion and Power Generation Systems** Aircraft Propulsion Systems; Power Generation and Distribution; Fuel Systems **Unit IV: Avionics and Onboard Communication Systems** Avionics Systems; Communication and Data Networks; Flight Data Monitoring and Control **Unit V: Aircraft Systems Integration, Testing, and Validation** Systems Integration; Testing of Aircraft Systems; Safety, Reliability, and Redundancy
Course Outcome
CO1: Apply Systems Engineering Principles: Demonstrate the ability to apply systems engineering principles to design, integrate, and test aircraft flight control systems and other subsystems. CO2: Design Flight Control Systems: Design and optimize aircraft flight control systems, considering stability, control, and human-machine interface. CO3: Understand Propulsion and Power Generation: Understand the components and principles of aircraft propulsion systems, power generation, and their integration into the overall aircraft systems architecture. CO4: Analyze Avionics and Communication Systems: Gain knowledge of avionics systems, onboard communication, and flight data monitoring, and their critical role in the operation of an aircraft. CO5: Perform Aircraft Systems Integration and Testing: Understand the importance of system integration and testing in the development of aircraft systems and the methods used to ensure performance, safety, and reliability.
Text Books
1. “Aircraft Design: A Systems Engineering Approach” by Mohammad H. Sadraey,
Reference Books / Materials
1. “Aircraft Systems Mechanical, electrical, and avionics subsystems integration” by Ian Moir, Allan Seabridge, 2. “Systems Engineering for Aerospace A Practical Approach” by Richard Sheng,

Course Code & Title
ISE 613 - Automotive Systems Engineering
Course Context
This course typically covers the design, development, and integration of complex automotive systems, focusing on modern vehicle technologies. It blends mechanical, electrical, and software engineering principles to address real-world automotive challenges.
Course Objectives
1. Understand the principles of automotive systems and their interdependencies. 2. Study the architecture and design of major vehicle components (engine, transmission, braking, steering, suspension, etc.). 3. Analyze interactions between mechanical, electrical, and software components. 4. Understand the vehicle safety, testing and validation, quality assurance & certification.
Course Content
Unit I: Introduction to Automotive Systems Engineering Overview of Automotive Systems Engineering; Systems Engineering Process in Automotive Design; Automotive Industry Standards **Unit II: Powertrain Systems and Integration** Powertrain Fundamentals; Transmission Systems; Hybrid and Electric Vehicle Powertrains; Powertrain Control Systems **Unit III: Chassis and Suspension Systems** Chassis Systems; Suspension Systems; Steering Systems; Braking Systems **Unit IV: Vehicle Electronics and Control Systems** Electrical and Electronics Systems; Control Systems and ECUs; Advanced Driver Assistance Systems (ADAS); Vehicle-to-Everything (V2X) Communication **Unit V: Automotive Safety, Testing, and Quality Assurance** Vehicle Safety Systems; Testing and Validation of Automotive Systems; Quality Assurance in Automotive Design; Vehicle Certification and Regulatory Compliance
Course Outcome
CO1: Apply Systems Engineering Principles to Automotive Design: Understand and apply the systems engineering approach to the design, integration, and validation of automotive systems, ensuring effective problem-solving and decision-making throughout the vehicle lifecycle. CO2: Design and Integrate Powertrain Systems: Gain a comprehensive understanding of automotive powertrain systems, including internal combustion engines, electric propulsion, hybrid architectures, and transmission systems, and their integration into the vehicle. CO3: Analyze and Optimize Chassis and Suspension Systems: Demonstrate knowledge of vehicle chassis design, suspension dynamics, and steering systems, and apply this knowledge to enhance vehicle performance, safety, and comfort. CO4: Design and Implement Advanced Control and Electrical Systems: Understand and develop the electronic and control systems used in modern vehicles, including ECUs, sensors, actuators, and ADAS technologies, as well as their integration with vehicle subsystems. CO5: Ensure Automotive Safety and Regulatory Compliance: Assess and implement vehicle safety features, including crashworthiness and active safety systems, and understand the testing, validation, and regulatory processes required to meet automotive industry standards.
Text Books
1. “Automotive Systems Engineering” by Markus Maurer (Editor), Hermann Winner,
Reference Books / Materials
1. “Automotive Technology: A Systems Approach” by Jack Erjavec 2. “Automotive Systems and Software Engineering: State of the Art and Future Trends” by Yanja Dajsuren (Editor), Mark Van 3. “Automotive Systems Principles and Practice” by Den Brand (Editor) G.K. Awari, V.S. Kumbhar, R.B. Tirpude,

Course Code & Title
ISE 614 - Medical Systems Engineering
Course Context
Health Care Systems Engineering (HCSE) integrates engineering principles with healthcare practices to optimize processes, enhance patient care, and improve operational efficiency within healthcare systems. This multidisciplinary field combines aspects of industrial engineering, systems analysis, and healthcare management to address complex challenges in the medical sector.
Course Objectives
1. Systems Thinking in Healthcare 2. Modeling and Simulation 3. Quality Improvement and Process Engineering 4. Healthcare Operations and Resource Management
Course Content
Unit I: Introduction to Healthcare Systems and Delivery Understanding Healthcare Systems; Systems Thinking in Healthcare; Healthcare Reform and Engineering Solutions **Unit II: Quantitative Models and Healthcare Operations** Statistical and Quantitative Models in Healthcare; Process Management and Optimization; Resource Allocation and Scheduling **Unit III: Medical Automation Systems** Principles of Medical Process Automation; System Design and Integration for Automation; Emerging Technologies in Medical Automation **Unit IV: Telemedicine and Remote Patient Monitoring** Telemedicine Technologies; Automated Patient Monitoring; Challenges and Opportunities in Remote Healthcare **Unit V: Healthcare Systems Design, Integration, and Quality Control** Healthcare Systems Design and Integration; Quality Control and Assurance in Healthcare; Healthcare System Evaluation and Performance Measurement
Course Outcome
CO1: Apply Systems Engineering Principles to Healthcare: Understand and apply systems engineering principles and processes to improve the design, delivery, and management of healthcare services. CO2: Use Quantitative Models for Healthcare Optimization: Utilize statistical and quantitative models to optimize healthcare operations, including resource allocation, scheduling, and process management. CO3: Design and Implement Medical Automation Systems: Design, integrate, and optimize medical automation systems, with a focus on improving efficiency, reducing costs, and minimizing errors in medical processes. CO4: Leverage Telemedicine and Remote Monitoring: Understand the technologies and methodologies behind telemedicine and remote patient monitoring, and apply them to modern healthcare delivery systems. CO5: Evaluate and Improve Healthcare System Performance: Implement quality control, continuous improvement strategies, and performance evaluation methods to enhance healthcare system efficiency, safety, and overall patient care outcomes.
Text Books
1. **“Healthcare Systems Engineering”,** by Paul M. Griffin, H B Nembhard, C J DeFlitch, N D Bastian, H Kang and D A Munoz
Reference Books / Materials
1. **“Health Care Operations Management: A Systems Perspective” ,** by James R. Langabeer and Jeffrey Helton 2. “Systems Engineering Approach to Medical Automation”, by Robin Felder, Majd Alwan and Mingjun Zhang

Course Code & Title
ISE 615 - Software Systems Engineering
Course Context
Software Systems Engineering is a specialized field within systems engineering that focuses on the development of complex, software-intensive systems. It encompasses the analysis, design, development, testing, and maintenance of software, ensuring that these systems meet specific user needs while adhering to constraints such as quality, time, and budget.
Course Objectives
1. Understanding Software Development Phases 2. Applying Software Process Models 3. Gaining Knowledge in Software Engineering Methodologies 4. Emphasizing Quality Assurance 5. Developing Teamwork and Communication Skills 6. Preparing for Professional Practice
Course Content
Unit I: Foundations of Systems and Software Engineering Introduction to Systems Engineering and Software Engineering; Characteristics of Systems and Software-Enabled Systems; Distinctions between Physical Systems Engineers (PhSEs) and Software Systems Engineers (SwSEs); Overview of System Life Cycles and Engineering Disciplines **Unit II: Development Approaches and Process Models** Traditional System Development Models (Linear, Vee, Incremental); Iterative Software Development Models; Integrated Incremental-Iterative System Development Model (I3); Aligning Systems and Software Development Processes **Unit III: Requirements and Architecture Definition** Business and Mission Analysis for Software-Enabled Systems; Stakeholder Identification and Requirements Elicitation; System Capabilities and Technical Feasibility Assessment; Model-Based System Architecture and Design Strategies **Unit IV: Implementation, Verification, and Validation** System Implementation and Integration Strategies; Verification and Validation Techniques for Software and System Components; Managing Quality Attributes in Software-Enabled Systems; Case Studies: Real-World System Development Scenarios **Unit V: Technical Management and Leadership** Planning and Estimating Technical Work; Risk Assessment and Control in Systems Engineering; Organizing and Leading Systems and Software Teams; Metrics, Measurement, and Continuous Process Improvement
Course Outcome
CO1: Understand and apply fundamental principles of systems engineering and software engineering to software-enabled systems. CO2: Analyze and resolve challenges that arise from differences in systems and software engineering methodologies. CO3: Develop system capabilities using integrated incremental and iterative development approaches. CO4: Utilize model-based system architectures to design and manage complex software-enabled systems. CO5: Apply project management techniques to plan, estimate, and control technical work in system development.
Text Books
1. “Systems Engineering of Software-Enabled Systems “ by Richard E. Fairley
Reference Books / Materials
1. "Software Engineering: A Practitioner's Approach" by Roger S. Pressman and Bruce R. Maxim 2. "Software Engineering: Theory and Practice" by Shari Lawrence Pfleeger and Joanne M. Atlee 3. "System Engineering Management" by Benjamin S. Blanchard and John E. Blyler 4. "The Art of Software Testing" by Glenford J. Myers

Course Code & Title
ISE 641 - Systems Engineering Lab - 1
Course Context
This course introduces students to MATLAB as a powerful computational tool for modeling, analysis, and simulation within the field of systems engineering.
Course Objectives
The course emphasizes the application of MATLAB to systems engineering problems.
Course Content
Basic Matlab Commands – Arrays manipulation, matrices, polynomials, curve fits Advanced Matlab – optimization, excel interface Basic Simulink – Second order system, simulation, logic gates, discrete system elements Systems Composer – Model examples Requirements Toolbox Verification and Validation Toolbox
Course Outcome
CO1: Model and analyze complex systems using MATLAB and Simulink. CO2: Implement numerical methods and optimization relevant to systems engineering. CO3: Define system behaviors using system composer and attach requirements to them. CO4: Fundamentals of verification and validation using tools

Course Code & Title
ISE 642 - Systems Engineering Lab - 2
Course Objectives
• Systematic Requirements Engineering • Functional decomposition into objects and processes • Model-Based Architecture Design and interfaces • Capture of temporal behaviours
Course Content
Capella – Basic of modelling • Architecture diagrams • Dataflows diagrams • Functional chains diagrams • Sequence diagrams • Tree diagrams • Mode and States diagrams • Classes and Interfaces diagrams OPCAT • Object Process Methodology modelling • Objects, Process, States • Relationships
Course Outcome
CO1: Ability to create and manage system models using its graphical tools. CO2: Structuring systems using Operational Analysis, System Analysis, Logical Architecture, and Physical Architecture layers. CO3: Creating clear, scalable, and maintainable models for complex systems. CO4: Linking requirements to system models for improved verification and validation.