भारतीय सूचना प्रौद्योगिकी संस्थान रांची

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY RANCHI

An Institute of National Importance under
Ministry of Education, Government of India

EXECUTIVE M.TECH. PROGRAMME IN

CSE (Design Thinking & Innovation)

COURSE STRUCTURE & SYLLABI

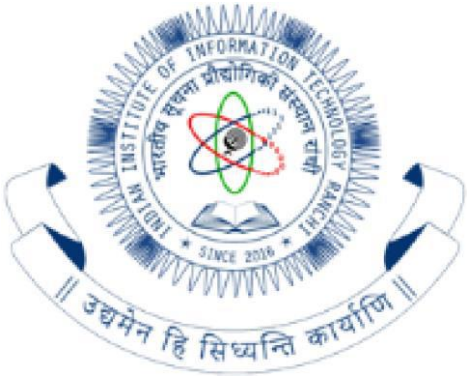
Effective from 2022-23 Admitted Batch

Course Structure and Syllabi

For

Executive M.Tech. in
CSE
(Design Thinking & Innovation)

Effective from 2022-23



भारतीय सूचना प्रौद्योगिकी संस्थान राँची

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, RANCHI

(An Institution of National importance under act of Parliament)

(Ranchi - 834010), Jharkhand

Indian Institute of Information Technology, Ranchi

Curriculum for

M. Tech in Computer Science & Engineering with specialization in Design Thinking

Breakup of the credits semester wise

Credits required for M.Tech Course: 68-76

Semester/ Projects	Credits
I	14
II	15=29
III	15=44
IV	14=58
V	16=74
Total	74

1st Semester						
Course Code	Course Name	Teaching Hours / Week				Credit Points
		L	T	P	Total	C
DT-5001	Design Thinking: Concepts and Tools	3	0	0	3	3
DT-5003	Advanced Data Structure and Algorithms	3	0	0	3	3
HD-50XX	Elective I	3	1	0	4	4
DT-5101	Design Thinking Tools – Lab (Storytelling)	0	0	3	3	2
DT-5103	Advanced Data Structure and Algorithms Lab (Python)	0	0	3	3	2
TOTAL						**14**

2nd Semester						
Course Code	Course Name	Teaching Hours / Week				Credit Points
		L	T	P	Total	C
DT-5002	Requirement Engineering	3	0	0	3	3
DT-5004	Object Oriented Modelling and Design	3	0	0	3	3
DT-5006	Creativity and A.I.	3	0	0	3	3
HD-50XX	Elective II	3	1	0	4	4
DT-5104	Object Oriented modelling and Design Lab	0	0	3	3	2
TOTAL						**15**

3rd Semester						
Course Code	**Course Name**	**Teaching Hours / Week**				**Credit Points**
		L	**T**	**P**	**Total**	**C**
DT-6001	UX and UI Design	3	0	0	3	3
DT-6003	Business Model Innovation	3	1	0	4	3
DT-6005	Human-Centered Design for Inclusive Innovation	3	0	0	3	3
HD-60XX	Elective III	3	1	0	4	4
DT-6101	UX and UI Design Lab	0	0	3	3	2
TOTAL						**15**

4th Semester						
Course Code	**Course Name**	**Teaching Hours / Week**				**Credit Points**
		L	**T**	**P**	**Total**	**C**
PR-6102	Project & Dissertation	-	-	-	-	12
PR-6104	Comprehensive Viva	-	-	-	-	02
TOTAL						**14**

5th Semester						
Course Code	**Course Name**	**Teaching Hours / Week**				**Credit Points**
		L	**T**	**P**	**Total**	**C**
PR-7101	Project & Dissertation	-	-	-	-	16
TOTAL						**16**

Legend:

L - Number of lecture hours per week
T - Number of tutorial hours per week
P - Number of practical hours per week
C - Number of credits for the course

List of Electives (CSE)

Elective I (for first semester)

1. **HD-5001:** Web services and E-Commerce
2. **HD-5003:** Real Time Data Analysis
3. **HD-5005:** Software and System Engineering

Elective II (for second semester)

1. **HD-5002:** Software Defect & Quality Prediction Techniques
2. **HD-5004:** Optimization Techniques
3. **HD-5006:** Cloud Computing

Elective III (for third semester)

1. **HD-6001:** Deep and Reinforcement Learning Techniques
2. **HD-6003:** Stochastic Processes and Queuing Theory
3. **HD-6005:** Information Theory and Coding
4. **HD-6007:** Pattern Recognition

DT-5001	Design Thinking: Concepts and Tools	L	T	P	Credit
		3	0	0	3

Preamble

This course will enable students to understand the concepts of Design Thinking and important tools associated with application of Design Thinking. Focus will be given to areas of mindset transformation for human centered approach first.

Prerequisite

None

Course Outcomes

- Understand the Design Mind and how to change one's view of approaching a problem situation
- Gain techniques to better understand the social, emotional, and physical needs of your customers.
- Apply methods that will help you turn your customer needs into human-centered solutions.
- Use ideation techniques to quickly generate, develop, and test new ideas.
- De-risk your new ideas by gaining feedback through rapid prototypes.
- Showcase your new skills through tangible, mini projects and activities in application of different tools

Syllabus

Unit 1 : **Designing the Self (Design The Thinking)**

Power of Visualization, Impediments in achieving visualized state, Methods to overcome, 13 Musical Notes, 5 Minds

Unit 2: Design Appreciation

What is Design, Elements of a Good Design, Approaches to Design (D1, D2, D3), 3 Laws of Design Thinking, Case study discussion

Unit 3 : Introduction to the Process (Part 1)

Feel Stage and Define Stage, Persona tool, Journey Mapping, Cartographic Perspective, Stakeholder Mapping, Understanding the Users' Needs, Root Cause Analysis, Redefining the Problem Statement

Unit 4: Introduction to the Process (Part 2)

Divergence Stage, Convergence Stage, Brainstorming, Mind Mapping, Metaphor, Random Association Technique, 10-100-1000gm tool, Q-B-L Filter, Prototyping Techniques, Design Thinking application for product development

Unit 5: Introduction to the Process (Part 3)

Communication Stage, Branding, Packaging, Storyboarding, Storytelling, Tools for effective storytelling, Case studies

References

1. UnMukt: Science and Art of Design Thinking., by Arun Jain., 2019
2. Designing for growth: A design thinking tool kit for managers, by Jeanne Liedtka and Tim Ogilvie., 2011, ISBN 978-0-231-15838-1
3. The design thinking playbook: Mindful digital transformation of teams, products, services, businesses and ecosystems, by Michael Lewrick, Patrick Link, Larry Leifer., 2018, ISBN 978-1-119-46747-2
4. Presumptive design: Design provocations for innovation, by Leo Frishberg and Charles Lambdin., 2016, ISBN: 978-0-12-803086-8
5. Systems thinking: Managing chaos and complexity: A platform for designing business architecture.", "Chapter Seven: Design Thinking", by Jamshid Gharajedaghi, 2011, ISBN 978-0-12-385915-0

DT-5003	Advanced Data Structure and Algorithms	L	T	P	Credit
		3	0	0	3

Preamble

This course aims at providing a systematic study of the methods of structuring and manipulating data in computing.

Course Outcomes

- Basic ability to analyze algorithms and to determine algorithm correctness and time efficiency class.
- Master a variety of advanced abstract data type (ADT) and data structures and their implementations.
- Master different algorithm design techniques (brute-force, divide and conquer, greedy, etc
- Ability to apply and implement learned algorithm design techniques and data structures to solve problems.

Syllabus

UNIT 1:

Divide and Conquer: Max-subarray problem, Strassen's matrix multiplication, Multiplying two polynomials (FFT).

Greedy Algorithms: Interval scheduling problem, minimum spanning tree algorithms with correctness proof. Union-find data structure.

UNIT 2:

Dynamic Programming: Rod cutting problem, matrix chain multiplication problem, longest common subsequence problem.

Number Theoretic Algorithms: Elementary number theoretic notions, Euclid's algorithm for GCD computation, Miller-Rabin primality test.

UNIT 3:

NP: Complexity class NP, NP completeness, reductions. Introduction to approximation algorithms: Combinatorial approximation algorithms for Min vertex cover, max-cut, and steiner tree problem.

UNIT 4:

Introduction to randomized algorithms: Randomized quicksort, randomized algorithm for finding mincut, big O notation and solving recurrence relations, sorting algorithms, binary search tree, red black tree.

Reference Books

1. Algorithm Design, Jon Kleinberg and Eva Tardos, Pearson, ISBN-13: 978-0321295354,ISBN-10:0321295358.
   http://www.cs.princeton.edu/~wayne/kleinberg-tardos/
2. A.V. Aho, J.E. Hopcroft, and J.D. Ullman, Data Structures and Algorithms, Addison Wesley, Reading Massachusetts, USA, 1983.

DT-5006	Creativity and A. I.	L	T	P	Credit
		3	0	0	3

Preamble

This course focuses on creativity and better understand A.I., examining the interplay between creativity, organizational processes and systems, and successful innovation. Throughout the course, tools and techniques for fostering individual and group creativity, management practices that foster (or inhibit) innovation, methods for developing and evaluating ideas for new products, services, and the business models to execute these ideas, and principles and practices for leading innovation is explored. Using a variety of readings, case examples, discussions, experiential exercises, and a challenging team project, students explore and apply the principles of creativity and artificial intelligence in the industries.

Prerequisite

None

Course Outcomes

- Characterize and implement various design research methodologies.
- Conduct design research for artistic works, organizational strategies, and economic policies.
- Explain the theories and techniques behind the latest works in artificial creativity.

Syllabus

UNIT 1:

Artificial Creativity, can machine be creative?, observational research, business application, Poetical science of A.I. , From Ada to Turing, Turing Test for creativity

UNIT 2:

Symbolic Approach to A.I., Subsymbolic approach to A.I., Teachable machine, Creativity through computation, Machine atelier, LoFi Prototype.

UNIT 3:

Natural Creativity, Visual Thinking by DALL·E, Crafting your own research, Artbreeder, Stakeholder Mapping, Creativity framework, creative process, Magic Sketchpad, Cultural Probes, Neuroaesthetics.

UNIT 4:

Creative Flow, Creative Systems and Machines, Machine Composer, Creative by design, Bring Life to Space with A.I., Expanded Notions of Artifacts, Creative Collaboration, Exploration, Creative organizations, From Creative to Innovative.

UNIT 5:

Innovation Eight, Innovation Ten, Creative Economy, Scale and Tolerance, Unintended Consequences, Creative Intervention, Creative Artifacts and Challenges, Biased Creatives.

Reference Books

1. AI for Creativity, 1st Edition, By Niklas Hageback, Copyright Year 2022, ISBN 9781032047751, CRC Press.
2. Artificial Intelligence and Creativity: An Interdisciplinary Approach, Springer; 1994th edition

DT-5002	Requirement Engineering	L	T	P	Credit
		3	0	0	3

Preamble

The course will discuss concepts for systematically establishing, defining and managing the requirements for a large, complex, changing and software-intensive systems, from technical, organizational and management perspectives. The course will consider the past, present and future paradigms and methodologies in requirements engineering.

Prerequisite

None

Course Outcomes

- Understand the need for requirements for large-scale systems.
- Understand requirements engineering processes.
- Understand models of requirements, functional requirements, and non-functional requirements.
- Understand object-oriented and goal-oriented requirements engineering.

Syllabus

UNIT1:

Understanding the use of critical tools to explore unstated needs of the customers. Use Persona tool to understand the customer and capture insights, stakeholder mapping to understand all those who are associated with the issue, identify patterns and anti-patterns, contextually understand the application of the first law of Design Thinking.

UNIT2:

Leverage Circle Time as an effective tool to explore the needs of End Users, understand how user uses a product / service through Journey Map tool and identify friction points

UNIT 3:

Introduction to requirements engineering, Requirement Engineering processes, Spiral Model, Role Actor Diagram, Maturity Model, Requirement Engineering in Agile Models, Requirement Engineering in V Model.

UNIT 4:

Requirements models, Why-What-How model, 4-Variable model, Reference model, Goal-Service-Constraint model, 4-World model, Requirement analysis, modelling and specification, Carving solution space, prioritizing requirements.

UNIT 5:

Requirements Elicitation, Properties of Requirements, Ethnomethodology, Domain Analysis, Problem Frames, Data/Information Elicitation Techniques, Scenario Analysis, Types of Scenarios

UNIT 6:

Enterprise Modelling, Business Modelling, Enterprise Requirements, Structured Analysis, Goal-Oriented Requirement Engineering.

Reference Books

1. Requirements Engineering: Processes and Techniques, G. Kotonya and I. Sommerville, John Wiley Sons
2. Requirements Engineering: Processes and Techniques, G. Kotonya and I. Sommerville, John Wiley Sons
3. Requirements Engineering: Social and Technical Issues, J. Goguen, and M. Jirotka (Eds.), Academic Press, 1994.
4. y: A platform for designing business architecture.", "Chapter Seven: Design Thinking", by Jamshid Gharajedaghi, 2011, ISBN 978-0-12-385915-0

DT-6001	UX and UI Design	L	T	P	Credit
		3	0	0	3

Preamble

Every digital interface/interaction (e.g., web and mobile application, car dashboard, smart appliance) was designed to solve a problem or to make our lives better, easier, more successful. UI/UX is the communication layer between the computer software and the user. This hands-on, projects-based course, explores the principles and practice of user interface and user experience design for digital platforms.

Prerequisite

None

Course Outcomes

- Understand how UX & Design Thinking form the core of every successful project.
- Learn the crucial interviewing skills necessary to ensure you're building the right application for the right people.
- Understand the importance of UX & Design Thinking for application design projects.
- Learn a new way to break down larger problem sets into chunks that more clearly identify the problems.

Syllabus

UNIT1: Use the Journey Map as tool to understand the patterns and anti-patterns of a product usage to enhance UX, understand 'Less is More' and 'Last 2%=200%' to create addictive UI/UX, the importance of questioning assumptions

UNIT2: Develop the art of Asking Right Questions as a tool to understand how users experience the product / service, understand the cartographic view of the entire product and how the user navigates

UNIT 3: User Experience (UX), Concepts of UX, Trends in UX, User Interaction (UI), Mental Model, Cognitive Model in UX, Emerging Technologies in UX, UX Design and its usage, Elements of UX Design, Persona in UX Design, 6 stages used to design in UX, Heuristic Evaluation.

UNIT 4: Heuristic Evaluation, Case studies, User Research, Benefits of User Research, Elements used in User Research, Process in User Research, User Interview, Modern Day User Research Methods.

UNIT 5: UX Design Process, Visual Design Principles, Interaction Design, Wire Framing & Storyboarding, Screen Design and Layouts, Information Design and Data Visualization, Information Architecture, Elements and Widgets, Various Prototyping Tools.

UNIT 6: UX Improvement process, Understanding the usability test findings, Applying the usability test feedback in, Improving the design, UX Deliverables and its process, UX projects based on Android/IOS.

Reference Books

1 Norman, D. (2013). The design of everyday things: Revised and expanded edition. Basic books.

2 Gothelf, J. (2013). Lean UX: Applying lean principles to improve user experience. " O'Reilly Media, Inc.".

3 Mullet, K., & Sano, D. (1996). Designing visual interfaces. Acm Sigchi Bulletin, 28(2), 82-83.

DT-5004	Object Oriented Modelling and Design	L	T	P	Credit
		3	0	0	3

Preamble

Object Oriented Approach is innovative and modern approach of designing the system by focusing primarily on Data elements of the application domain. It differs from the functional/traditional approach by providing features like data hiding, encapsulation and better reuse. Modelling is not a separate phase but it is involved in every phase of software engineering. Modelling is all about making models/prototypes of the system/situations needed to do better analysis, design, coding and testing

Prerequisite

None

Course Outcomes

- The Knowledge of the basic concepts of Object-oriented modelling and Design.
- Will be able to use the Object-Oriented notations and process that extends from analysis through design to implementations.
- Will be able to use the Object-Oriented notations and process that extends from analysis through design to implementations.
- Capable to model the requirements with use cases and describe the dynamic behaviour and structure of the design.
- Easily create a modular design with components and relate the logical design to the physical environment.
- The student will be able to use the concept of design patterns and apply it where suitable.

Syllabus

UNIT 1:

Object Basics, Object state and properties, behaviour, methods, messages. Object Oriented System Development life cycle, Benefits of object-oriented methodology, Rumbaugh OMT, The Booch methodology, Jacobson's OOSE methodologies, Unified Process., Introduction to UML, Important views & diagram to be modelled for system by UML.

UNIT 2:

Factional View (models): Use Case Diagram, Activity Diagram, Static structural view (models), Class Modelling and Design approaches, Behavioral (Dynamic structural view): State diagram, Interaction diagram, Sequence diagram.

UNIT 3:

Collaboration diagram, Approaches for developing dynamic systems, Architectural view: Logical architecture, Hardware architecture, Process architecture, Implementation architecture, Reuse libraries, framework components and patterns.

UNIT 4:

Reuse of classes, reuse of components, reuse of frameworks, black box framework, white box frame, reuse of patterns: architectural and design pattern.

Reference Books

1 Designing Flexible Object Oriented systems with UML - Charles Ritcher
2 Object Oriented Analysis & Design, Sat/.inger. Jackson, Burd Thomson
3 Object oriented Modeling and Design with UML - James Rumbaugh. Micheal Blaha (second edition)
4 The Unified Modeling Language User Guide - Grady Booch, James Rumbaugh, Ivar Jacobson.
5 Object Oriented Modeling and Design - James Rumbaugh
6 Object-Oriented Analysis and Design: using UML Mike O'Docherty Wiley Publication

DT-6005	Human Centered Design for Inclusive Innovation	L	T	P	Credit
		3	0	0	3

Preamble

This course introduces the principles and practices of human-centered design (also sometimes called "design thinking") which are essential for developing innovative and inclusive products, services, processes and policies.

Prerequisite

None

Course Outcomes

- Acquire tools for seeing the world as your users & stakeholders see it, with particular attention to marginalized or silent voices.
- Identify latent human needs, looking beyond obvious patterns in quantitative and qualitative data to understand underlying drivers and motivations.
- Learn how to involve users & stakeholders in all stages of design—from ideating to prototyping and testing—& bring a learning mindset to the process.

Syllabus

UNIT 1

Empathy, Questioning Assumptions, Contextual introduction to Persona, Understanding User Needs.

UNIT 2:

Introduction to human-centered design, Case example - Redesigning the patient experience, Fit between gender analytics and human-centered design, Case example - Attracting, developing and retaining women.

UNIT 3:

Introduction to empathy-based research, Importance of understanding users and stakeholders, Empathy-based research methods, Considerations when conducting empathy-based research.

UNIT 4:

Introduction to reframing, Considerations when conducting empathy-based research, Case Example: Reframing the wait for elevators, How to reframe problems, Open sorting: finding new patterns, Closed sorting: need finding, Closed sorting: using a journey map, Generating fresh insights

UNIT 5:

Introduction to ideation, prototyping and testing, Ideation, Prototyping, Testing, What comes after testing? Implementation.

Reference Books

1 Luma Institute. (2012). Innovating for people: Handbook of human-centered design methods. Luma Institute, LLC.
2 Boy, G. A. (Ed.). (2017). The handbook of human-machine interaction: a human-centered design approach. CRC Press.
3 Goodwin, K. (2011). Designing for the digital age: How to create human-centered products and services. John Wiley & Sons.

DT-6003	Business Model Innovation	L	T	P	Credit
		3	0	0	3

Preamble

The core of Business Model Design lies in skills and leadership of the entrepreneurial manager. It requires a disciplined approach to seeking opportunities, as well as gathering and aligning resources to achieve important goals. In this course, students will strengthen two important skills: intuition and visual thinking, while applying quantitative methods learned in other courses, such as Finance, Economics and Financial Intelligence.

Prerequisite

None

Course Outcomes

- Organize complexity through: visual thinking mapping and system design.
- Organize complexity through: visual thinking mapping and system design.
- Identify key business patterns through the BMC
- Distinguish the elements of a business model
- Identify storytelling as a component of the Design and Innovation of the Business Model.

Syllabus

UNIT 1:

BELIEF Framework, Customer versus Product Development, Understanding User Needs, Listening-Dialogue-Observation, Idea Generation using brainstorming, Metaphor and 'Yes, and…' techniques.

UNIT 2:

What is a Business Model?, White Spaces in Your Business Model, Business model portfolio, Methodologies to Develop Your Business Model, Gassman's Methodology, Essential element for the development of new business models.

UNIT 3:

Different types of Business Models, Visual thinking in your business model. What is innovation?, Learning methods and outcomes, 3 components of a business model, Business model vs. strategy, Other business model frameworks.

UNIT 4:

Value proposition - Introduction and client, VP: price and perceived value, VP: detailed examples of game changing VP, Value Proposition: The value curve, Value Proposition: The value curve in practice, Value Architecture: The value chain, Value Architecture: The extended value chain, Value Architecture: Distinctive resources and competencies, Profit equation overview, Profit equation details.

UNIT 5:

Introduction to the 14 directions, Direction 1: Reduce client price, Direction 2: Reduce clients' hassle, Direction 3: Look for non-clients, Direction 4: Introduce more functionality or more

emotion, Direction 5: Search other segments or industries, Direction 6: Introduce a third party, Direction 7: Modify the revenue stream, Direction 8: Introduce technology, Direction 9: Modify one or several steps in the value chain.

UNIT 6:

Direction 10: Eliminate or add a step in the value chain, Direction 11: Leverage strategic resources, Direction 12: Associate with competitors, Direction 13: Identify supplementers, Direction 14: Find new resources, Applying the Odyssey 3.14 approach, Trends in business models.

Reference Books

1 Casanova, L. (2009). Global latinas: Latin America's emerging multinationals. Londres, UK: Palgrave Macmillan.

2 Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. Communications of the association for Information Systems, 16(1), 1.

HD-5001	Web Services and E-Commerce	L	T	P	Credit
		3	1	0	4

Preamble

The Internet and the World Wide Web, simply referred to as the Web, are revolutionizing the way people, businesses and government transact business via electronic commerce. This course will examine the major trends in web technologies and electronic commerce (e-commerce), including the Internet, security, architectures, policy and social issues.

Prerequisite

None

Course Outcomes

- Identify the major management challenges for building and using information systems and learn how to find appropriate solutions to those challenges.
- Evaluate the role of the major types of information systems in a business environment and their relationship to each other
- Develop the modern Web applications using the client and server-side technologies and the web design fundamentals.
- Develop the modern web pages using the HTML and CSS features with different layouts as per need of applications.

Syllabus

Unit 1:

Introduction to XHTML and Javascript, XML Elements and Attributes, XML Document Structure and Syntax, XML Namespaces, XML Data Validation, XML 1.1 new features, XML Namespaces, XML parsers for data validation, Document Type Definitions, W3C XML Schemas.

Unit 2:

Parsing XML with Document Object Model (DOM), Parsing XML and with Simple API for XML(SAX), XSLT concepts and transformations, Storing and Binding data in HTML, Navigation from record to record, Extracting data from DSO, Binding XML data into HTML tables, Reading XML and Extracting data from it, Creating a DOM Document Object, Getting a Document's Document Element, Searching for XML Elements by name, Extracting Data from XML attributes, Xquery and its usage.

Unit 3:

Design of Information system, Architecture of an Information system, Understanding Middleware, RPC and related Middleware, TP Monitors, object Brokers, Message Oriented Middleware, Web Service concept, SOAP, WSDL, UDDI, Creating and Deploying, Accessing and Building .NET Web Services, Authentication and Security for Web Services; Major components of e-Commerce, e-Commerce framework, Media Convergence.

Unit 4:

Anatomy of e-Commerce application, Types of e-Commerce: Inter-organizational, Intra organizational, C2B, Communication Security goals; E commerce privacy policy, Network security policy, Firewall security policy, Requirements of transaction security, E commerce

encryption, Digital Money Security Payment Transaction, Electronic Security basics, Limitation of e-Commerce, Security measures.

Reference Books

1 Web Services Security and E-business, by Radhamani, G., Rao, G. S.V. Radha Krishna, Idea Group Inc (IGI), 31-Oct-2006.

HD-5003	Real Time Data Analysis	L	T	P	Credit
		3	1	0	4

Preamble

This course discusses the issues related to the design and analysis of systems with real-time constraints. The students will get an insight of different features of real time OS and will study different uniprocessor and multiprocessor scheduling mechanism.

Prerequisite

None

Course Outcomes

- Gain Knowledge about Schedulability analysis.
- Learn about the Real-time programming environments.
- Attain knowledge about real time communication and databases.
- Develop real time systems.

Syllabus

Unit 1:

Introduction to real time computing: Concepts; Example of real-time applications – Structure of a real time system – Characterization of real time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance metrics - Prediction of Execution Time : Source code analysis, Micro-architecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems

Unit 2:

Real time OS: Threads and Tasks – Structure of Microkernel – Time services – Scheduling Mechanisms Communication and Synchronization – Event Notification and Software interrupt Task assignment and Scheduling

Unit 3:

Task allocation algorithms: Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms Fault tolerant scheduling

Unit 4:

Real Time Communication: Network topologies and architecture issues – protocols – contention based, token based, polled bus, deadline-based protocol, Fault tolerant routing. RTP and RTCP.

Unit 5:

Real time Databases Transaction priorities – Concurrency control issues – Disk scheduling algorithms – Two phase approach to improve predictability

Reference Books

1 C.M. Krishna, Kang G. Shin – " Real Time Systems", International Edition, McGrawHill Companies, Inc., New York, 1997.

2 Jane W.S. Liu, "Real-Time Systems", Pearson Education India, 2000

3 Philip A. Laplante and Seppo J. Ovaska, "Real-Time Systems Design and Analysis:Tools for the Practitioner'' IV Edition IEEE Press, Wiley, 2013.

4 Sanjoy Baruah, Marko Bertogna, Giorgio Buttazzo, "Multiprocessor Scheduling for Real-Time Systems ", Springer International Publishing, 2015.

DT-5005	Software and System Engineering	L	T	P	Credit
		3	1	0	4

Preamble

This course aims at discussing various System design methodologies, the impact of cohesion and coupling measures on the goodness of the software design. The student will learn the importance of practicing different coding standards, guidelines along with reliability metrics and management techniques & standards

Prerequisite

None

Course Outcomes

- Choose a proper life cycle model for different real life industrial applications, design software using function-oriented approach (DFDs) and object-oriented approach (UML diagrams).
- Understand the concepts of computer aided software engineering (CASE) and use different CASE tools in the development, maintenance and reuse of software systems.
- Know the emerging concepts like SOA etc., their functioning and their applications in real life problems.

Syllabus

UNIT 1:

Importance of System Engineering Paradigms for Software Systems; Life Cycle Models-Project scheduling and tracking, System Configuration Management.

UNIT 2:

Requirement Analysis – Functional Modelling of Software Systems, Requirements Analysis and Specifications, Analysis Modeling, Design Concepts and Principles, Function-oriented design, Architectural design, User Interface Design, Component Level Design. UML Modelling

UNIT 3:

Quality Assurance of Software Systems Testing Techniques for Software Systems: Black box and White box Testing, Regression testing, Reliability Modelling of Software Systems, Quality Assurance and Maintenance

UNIT 4:

Measurement of Software Systems**,** Metrics for Measurement of Software Systems, Direct Measurement, Indirect Measurement: Product, Metrics: Product metrics Process Metrics, Project Metrics

UNIT 5:

Software Configuration Management, Change Requirements, Version control, Change management, scheduling, estimating, etc. Manual and Automatic Test Data Generation for Software Systems/Embedded Systems.

Reference Books

1 R. S. Pressman, Software Engineering A Practitioner's Approach, McGraw Hill Publications , 2006
2 R. Mall, Fundamentals of Software Engineering, Prentice Hall of India , 2014
3 I. Sommerville, Software Engineering, Pearson Education, Asia , 2006
4 P. Jalote, An Integrated Approach to Software Engineering, Narosa , 2006

HD-6005	Information Theory and Coding	L	T	P	Credit
		3	1	0	4

Preamble

This course aims to introduce the concept of information. It helps the students in understanding the limits of error free representation of information signals and the transmission of such signals over a noisy channel. It also gives an idea on different coding techniques for reliable data transmission.

Prerequisite

None

Course Outcomes

- Apply the knowledge of Shannon's source coding theorem and Channel coding theorem for designing an efficient and error free communication link.
- Analyze various coding schemes.
- Design an optimum decoder for various coding schemes used.

Syllabus

Unit 1:

Introduction: Introduction to information theory & error control coding, Information measure, Entropy, Differential Entropy, Conditional Entropy, Relative Entropy, Information rate, Mutual Information, Channel Capacity.

Unit 2:

Source Coding: Shannon's Source Coding Theorem, Prefix Coding, Huffman Coding, Shannon-Fano Coding, Arithmetic Coding, Lempel-Ziv Algorithm, Rate Distortion Theory.

Unit 3:

Channel Capacity & Coding: Channel Coding Theorem, Markov Sources, Discrete Channel with discrete Noise, BSC, BEC, Capacity of a Gaussian Channel, channel capacity for MIMO system, Bandwidth-S/N Trade-off.

Unit 4:

Block Codes: Galios Fields, Hamming Weight and Hamming Distance, Linear Block Codes, Encoding and decoding of Linear Block-codes, Parity Check Matrix, and Bounds for block codes, Hamming Codes, Syndrome Decoding.

Unit 5:

Cyclic Codes: Introduction to cyclic code, Method for generating Cyclic Codes, Matrix description of Cyclic codes, Cyclic Redundancy Check (CRC) codes, Circuit implementation of cyclic codes, Burst error correction, BCH codes.

Unit 6:

Convolutional Codes: Introduction to Convolutional Codes, Polynomial description of Convolutional Codes, Generating function, Matrix description of Convolutional Codes, Viterbi Decoding of Convolutional code, Introduction to Turbo Code.

Unit 7:

Coding for Secure Communications: Introduction to Cryptography, Overview of Encryption Techniques, Secret-Key Cryptography, Data Encryption, Standard (DES), Public-Key Cryptography, RSA algorithm, Digital signature, One- way Hashing.

Reference Books

1 "Information Theory, Coding & Cryptography", by Ranjan Bose, TMH, Second Edition.
2 "Communication Systems", by S. Haykin, 4th Edition, Wiley-Publication.
3 "Elements of Information Theory" by Thomas M. Cover, J. A. Thomas, Wiley-Inter science Publication.
4 "Error Correction Coding Mathematical Methods and Algorithms" by Todd K. Moon, Wiley India Edition.
5 "Error Correction Coding Mathematical Methods and Algorithms" by Todd K. Moon, Wiley India Edition.

HD-6007	Pattern Recognition	L	T	P	Credit
		3	1	0	4

DT-6011

This course will enable the students in learning a human-centered approach to innovation – anchored in empathizing with customers, rapid prototyping, and generating creative ideas – that will transform the way you develop products, services, processes and strategy.

Prerequisite

None

Course Outcomes

- Gain techniques to better understand the social, emotional, and physical needs of your customers.
- Apply methods that will help you turn your customer needs into human-centered solutions.
- Use ideation techniques to quickly generate, develop, and test new ideas.
- De-risk your new ideas by gaining feedback through rapid prototypes.
- Showcase your new skills through tangible, real-world project challenges, like an insights report or prototypes of products and services.

Syllabus

Unit 1:

Basics of Probability, Random Processes and Linear Algebra (recap): Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra.

Unit 2:

Linear Algebra: Inner product, outer product, inverses, eigen values, eigen vectors, singular values, singular vectors. Bayes Decision Theory : Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features.

Unit 3:

Parameter Estimation Methods : Maximum-Likelihood estimation :Gaussian case. Maximum a Posteriori estimation. Bayesian estimation: Gaussian case. Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation, Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation. Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs. Nonparametric techniques for density estimation. Parzen-window method. K-Nearest Neighbour method.

Unit 4:

Dimensionality reduction: Principal component analysis - it relationship to eigen analysis. Fisher discriminant analysis - Generalised eigen analysis. Eigen vectors/Singular vectors as

dictionaries. Factor Analysis, Total variability space - a dictionary learning methods. Non negative matrix factorisation - a dictionary learning method. Linear discriminant functions: Gradient descent procedures, Perceptron, Support vector machines - a brief introduction.

Unit 5:

Artificial neural networks: Multilayer perceptron - feedforwark neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks. Non-metric methods for pattern classification: non-numeric data or nominal data. Decision trees: Classification and Regression Trees (CART).

Reference Books

1 R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001

2 S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

3 S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

HD-5002	Software Defect & Quality Prediction Techniques	L	T	P	Credit
		3	1	0	4

Preamble

This course discusses various ways of measuring software defects. The students will learn about different types of software metrics and software defect prediction models along with software quality prediction models.

Prerequisite

None

Course Outcomes

- Will be helpful in Quantifying Software Quality and Better analysis of Software Internal Parameters.
- Early Prediction of Software Reliability, Maintainability and Testability will be helpful in developing Better Quality Software

Syllabus

Unit 1:

Fundamentals of Measurements and Experimentation Software Measurements, Software Metrics, Representational Theory of Measurements, Goal Based Framework for Software Measurements, Software Metrics and Data Collection, Analyzing Software-Measurements Data.

Unit 2:

Software Defect Prediction, Software Testing, Software Defects, Bugs and Failures, Defect Prediction Based on Bugs, Defect Prediction Based on Metrics and other parameters.

Unit 3:

Time Series Analysis of Software Defects, Basics of Time Series Analysis, Stationary and Non-Stationary Models of Time Series, Linear and Non-Linear Time Series Models for Software Defect Prediction, Advantages of Time Series Analysis over Other Prediction Models.

Unit 4:

Software Reliability Prediction, Software Reliability, Software Reliability Prediction Models, Software Reliability Prediction Based on Fault Data.

Unit 5:

Research Project on Software Quality Prediction, Software Maintainability Prediction, Software Testability Prediction, Prediction of NonFunctional Requirements of Software, Quality Assurance and CMMI Models.

Reference Books

1 R. S. Pressman, Software Engineering: A Practitioner's Approach, McGraw Hill Publications , 2006
2 R. S. Pressman, Software Engineering: A Practitioner's Approach, McGraw Hill Publications , 2006
3 I. Sommerville, Software Engineering, Pearson Education , 2006
4 I. Sommerville, Software Engineering, Pearson Education , 2006

HD-5004	Optimization Techniques	L	T	P	Credit
		3	1	0	4

Preamble

This course will discuss different operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function). The students will learn about the formulation of mathematical models for quantitative analysis of managerial problems in industry.

Prerequisite

None

Course Outcomes

- Recall the theoretical foundations of various issues related to linear programming modeling to formulate real-world problems as a LP model
- Explain the theoretical workings of the graphical, simplex and analytical methods for making effective decision on variables so as to optimize the objective function.
- Identify appropriate optimization method to solve complex problems involved in various industries.
- Demonstrate the optimized material distribution schedule using transportation model to minimize total distribution cost.
- Find the appropriate algorithm for allocation of resources to optimize the process of assignment.
- Explain the theoretical workings of sequencing techniques for effective scheduling of jobs on machines.
- Apply the knowledge of game theory concepts to articulate real-world competitive situations to identify strategic decisions to counter the consequences.

Syllabus

UNIT 1:

Introduction to Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques: Single variable Optimization, Multi variable Optimization with and without constraints, Multivariable Optimization with equality constraints - solution by method of Lagrange multipliers, Multivariable Optimization with inequality constraints - Kuhn – Tucker conditions.

UNIT 2:

Various definitions, statements of basic theorems and properties, Advantages, Limitations and Application areas of Linear Programming, Graphical method of Linear Programming problem.

Simplex Method: Phase I and Phase II of the Simplex Method, The Revised Simplex method, Primal and Dual Simplex Method, Big – M method.

UNIT 3:

Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems. (Including assignment and travelling salesman problems) (No degeneracy problems)

Queuing Models: Essential features of queuing systems, operating characteristics of queuing system, probability distribution in queuing systems, classification of queuing models, solution of queuing M/M/1 : /FCFS, M/M/1 : N/FCFS, M/M/C : /FCFS, M/M/C : N/FCFS.

UNIT 4:

Dynamic Programming: Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Integer Programming: Pure and mixed integer programming problems, Solution of Integer programming problems – Gomory's all integer cutting plane method and mixed integer method, branch and bound method, Zero-one programming.

UNIT 5:

Simulation Modeling: Introduction, Definition and types, Limitations, Various phases of modeling, Monte Carlo method, Applications, advantages and limitations of simulation

Inventory Models: Role of demand in the development of inventory models, objectives, inventory costs, quantity discount, Economic Order Quantity (EOQ), EOQ when stock replenishment is not instantaneous, Economic lot size when shortages are allowed, economic lot size with different rate of demand in different cycles (Instantaneous replenishment). (No Dynamic EOQ Models)

Reference Books

1 J. K. Sharma, "Operations Research", Macmillan, 5th Edition, 2012
2 R. Pannerselvan, "Operations Research", 2nd Edition, PHI Publications, 2006.
3 R. Pannerselvan, "Operations Research", 2nd Edition, PHI Publications, 2006.
4 Maurice Saseini, Arhur Yaspan, Lawrence Friedman, "Operations Research: Methods & Problems", 1 st Edition, 1959.

HD-5006	Cloud Computing	L	T	P	Credit
		3	1	0	4

Preamble

This course will enable the students to deliver an application built in the cloud with the concept of application-based building blocks for processing of data. It helps in acquiring the concept of cloud computing and to have knowledge on the various issues in cloud computing.

Prerequisite

None

Course Outcomes

- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Understand core techniques, algorithms, and design philosophies – all centered around distributed systems.
- Analyze and implement concepts include: clouds, MapReduce, key-value/NoSQL stores, classical distributed algorithms, widely-used distributed algorithms and scalability.
- Learn the key and enabling technologies that help in the development of cloud.
- Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
- Evaluate and choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

Syllabus

UNIT 1:

Introduction: Introduction to Cloud Architecture and Computing Concepts, Why Clouds, What is a Cloud, Introduction to Clouds: History, What's New in Today's Clouds, New Aspects of Clouds, Economics of Clouds, cloud distributed system, MapReduce: Paradigm, Scheduling, Fault-Tolerance.

UNIT 2:

Multicast Problem and P2P Systems: Introduction to Multicast Problem, Gossip Protocol – analysis – implementation, Failure Detectors, Gossip-Style Membership, Dissemination and suspicion, Grid Applications, Grid Infrastructure, P2P Systems Introduction, Napster, Gnutella, FastTrack and BitTorrent, Chord, Pastry, Kelips.

UNIT 3:

Design of key-value/NoSQL storage/database systems: Introduction to Key-Value/NOSQL, Cassandra, Cap Theorem, Consistency Spectrum, HBase, Cristian's Algorithm, Network Time Protocol (NTP), Lamport Timestamps, Vector Clocks

UNIT 4:

Design of key-value/NoSQL storage/database systems: Introduction to Key-Value/NOSQL, Cassandra, Cap Theorem, Consistency Spectrum, HBase, Cristian's Algorithm, Network Time Protocol (NTP), Lamport Timestamps, Vector Clocks

UNIT 5:

Transactions and Replication Controlling Cloud Systems: Remote Procedure Calls (RPCs), Transactions, Serial Equivalence, Pessimistic Concurrency, Optimistic Concurrency Control, Replication, Two-Phase Commit.

UNIT 6:

Virtualbox/VMware Workstation installation, Google App Engine installation, Generating cloud scenario using CloudSim, Hadoop Single Node Cluster programs.

Reference Books

1. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, "Distributed and cloud computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier, 2012.
2. Rittinghouse, John W., and James F. Ransome, "Cloud Computing: Implementation, Management and Security", CRC Press, 2017.
3. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, "Mastering Cloud Computing", Tata Mcgraw Hill, 2013.
4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009
5. Barrie Sosinsky, "Cloud Computing Bible" John Wiley & Sons, 2010.
6. Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy An Enterprise Perspective on Risks and Compliance", O'Reilly, 2009.

HD-6001	Deep and Reinforcement Learning Techniques	L	T	P	Credit
		3	1	0	4

Preamble

This course aims at providing the fundamental principles and techniques in deep and reinforcement learning. It helps the students to understand different algorithms in deep and reinforcement learning.

Prerequisite

None

Course Outcomes

- Ability to explain and describe the basics of deep learning and reinforcement techniques
- Ability to investigate different regularization and optimization techniques for training deep neural networks.
- Ability to implement convolution and recurrent neural networks
- Ability to implement and compare various iteration, Monte Carlo temporal-difference reinforcement learning algorithms
- Ability to construct and apply on-policy and off-policy reinforcement learning algorithms with function approximation

Syllabus

UNIT 1:

Introduction- Historical Trends in Deep Learning, Machine Learning Basics, History of Reinforcement Learning – Examples - Elements of Reinforcement Learning - Limitations and Scope.

UNIT 2:

Deep Feedforward Networks-Example-Gradient-Based Learning-Hidden Units-Architecture Design- Back-Propagation and Other Differentiation Algorithms, Regularization for Deep Learning, Optimization for Training Deep Models - Challenges - Basic Algorithms - Parameter Initialization - Algorithms with Adaptive Learning Rates - Approximate SecondOrder MethodsOptimization Strategies and Meta-Algorithm

UNIT 3:

Convolutional Networks -Operation - Motivation - Pooling - Variants of the Basic Convolution Function -Efficient Convolution Algorithms -Random or Unsupervised Features, Sequence Modeling: Recurrent and Recursive Nets - Unfolding Computational Graphs - Recurrent Neural Networks - Bidirectional RNNs - Encoder-Decoder Sequence-to-Sequence Architectures -Deep Recurrent Networks -Recursive Neural Networks, Applications.

UNIT 4:

Multi-armed Bandits-Dynamic Programming - Monte Carlo Methods -Temporal-Difference Learning -n-step Bootstrapping.

UNIT 5:

On-policy Prediction with Approximation -On-policy Control with Approximation –Off policy Methods with Approximation -Policy Gradient Methods.

Reference Books

1 Ian Goodfellow, YoshuaBengio, and Aaron Courville, "Deep Learning" MIT Press, 2016.

2 Richard S. Sutton and Andrew G. Barto,"Reinforcement Learning: An Introduction" second edition, MIT Press.

3 CosmaRohillaShalizi, Advanced Data Analysis from an Elementary Point of View, 2015.

4 Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.

HD-6003	Stochastic Processes and Queuing Theory	L	T	P	Credit
		3	1	0	4

Preamble

This purpose of learning this course is to understand and apply various theoretical distributions. This course also discusses different cases of stochastic processes along with their properties.

Prerequisite

None

Course Outcomes

- Students will be able characterize probability models using probability mass (density) functions & cumulative distribution functions.
- Students will be introduced to the techniques of developing discrete & continuous probability distributions and its applications.
- Students will be able to describe a random process in terms of its mean and correlation functions.
- Students will be able to specify a given discrete and Markov chain in terms of a transition matrix & transition diagram
- Students will be able to formulate concrete problems using queueing theoretical approaches.

Syllabus

UNIT 1:

Poisson Processes: Introduction to stochastic processes, Poisson process: Definition, Properties of Poisson processes, Generalization of Poisson processes

UNIT 2:

Renewal Theory and Regenerative Processes: Renewal Process: Introduction, Limit Theorems, Blackwell's Theorem, Renewal Equation, Renewal theorems, Regenerative Processes

UNIT 3:

Discrete Time Markov Chains: Markov Chains: Definitions, Class Properties of Transience and Recurrence, Limiting distributions of Markov chains, Tests for transience, null recurrence and positive recurrence, Reversible Markov Chains, Rate of convergence to the stationary distribution

UNIT 4:

Continuous-Time Markov Chains: Introduction, Markov property, Minimal construction, Chapman Kolmogorov equations, Irreducibility and Recurrence, Time Reversibility, Birth-Death process, Reversibility of Birth-Death process

UNIT 5:

Martingales: Introduction, Sampling Theorem, Martingale inequalities, McDiarmid's Inequality: Applications, Martingale Convergence Theorem, Applications to Markov chain, Random Walks Definitions, Ladder Heights, Maxima, GI/GI/1 Queue, Ladder Epochs

UNIT 6:

Queuing Theory: GI/GI/1 Queue, Palm Theory, PASTA, Rate conservation laws, PASTA, Product-form Networks, M/M/1 queue, Tandem Queues, Open Jackson, Closed queueing networks, Product-Form Networks: Quasireversible networks, Quasireversible Queues, Networks of Quasireversible Queues.

Reference Books

1 Stochastic Processes, Sheldon M. Ross, 2nd edition, 1996.
2 Introduction to Stochastic Processes, Erhan Cinlar, 2013.
3 Markov Chains: Gibbs Fields, Monte Carlo Simulation, and Queues, Pierre Bremaud, 1999.
4 S. Assmussen,"Applied Probability and Queues", 2nd ed., Springer, 2003.
5 B. Hajek, "Random Processes for Engineers", Cambridge University press, 2015
6 S. Karlin and H.M. Taylor,"A First Course in Stochastic Processes", 2nd ed., 1975. [4] S.M. Ross, "Stochastic Processes",2nd ed., Wiley, 1996.
7 J. Walrand,"An introduction to Queueing Networks", Prentice Hall, 1988.

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