Department of Computer Software Engineering

Revised Curriculum of Postgraduate Program

Approved by Board of Studies on: 12th April, 2018

University of Engineering & Technology, Mardan

List of Core Courses

S. No	Course Code	Course Title	Credit Hours
1	SE5901	Advanced Software System Architecture	3
2	SE5902	Advanced Requirements Engineering	3
3	SE5903	Software Testing and Quality Assurance	3
4	SE5904	Advanced Software Project Management	3
5	SE5913	Research Methods	3

List of Elective Courses

S. No	Course Code	Course Title	Credit Hours
1	SE5905	Software Measurement and Metrics	3
2	SE5906	Component Based Software Engineering	3
3	SE5907	Software Configuration Management	3
4	SE5908	Empirical Software Engineering	3
5	SE5909	Intelligent System Design	3
6	SE5910	Software Design Patterns	3
7	SE5911	Bio-Inspired Computation	3
8	SE5912	Software Risk Management	3
9	SE5914	Agile Software Development Methods	3
10	SE5915	Advanced Web Engineering	3
11	SE5916	Advanced Formal Methods	3
12	SE5917	Software Engineering Ontology	3
13	SE5918	Semantic Web Enabled Software Engineering	3
14	SE5919	Model Driven Software Development	3
15	SE5920	Machine Learning Application in Software Engineering	3
16	SE5921	Software Case Tools & Applications	3
17	SE5922	Information System Security	3
18	SE5923	Design and Analysis of Network System	3
19	SE5924	Data Warehousing	3
20	SE5925	Advanced Human-Computer Interaction	3
21	SE5927	Reliability Engineering	3
22	SE5928	Complex Networks	3
23	SE5929	Agent Based Modeling	3
24	SE5930	Data Mining	3
25	SE5931	Internet of Things	3
26	SE5926	Special Topic Related to Software Engineering	3

Master's and PhD Thesis

S. No	Code	Title	Credit Hours
1	SE5999	Master's Thesis	6
2	SE6999	PhD Thesis	3-9

Contents of Core Courses

SE5901 Advanced Software System Architecture (3-0-3)
Quality attributes in the context of architecting. Qualitative and quantitative assessment of architectures. Architectural modeling through Architecture Description Languages. System modeling its relation to software architecting. Architecting for evolution and variability. Partitioned and layered architectures. System-of-Systems and Ultra-Large Scale Systems. Software Product Lines and Configurable Software. Self-Adaptive Software. Architectural Description Languages. Feature Modeling. Architecture and Model-Based Testing. Current research topics in software system architecture.

Recommended Books:

1. Designing Software Architectures: A Practical Approach (SEI Series in Software Engineering), Humberto Cervantes, Rick Kazman, 1st Edition, Addison-Wesley Professional, 2016.
2. Software Product Lines: Practices and Patterns, P. Clements and L. Northrup, Addison-Wesley, 2002.
3. Software Architecture : Foundations, Theory, and Practice, R. Taylor, N. Medvidović and E.M. Dashofy, John Wiley, 2010.

SE5902 Advanced Requirements Engineering (3-0-3)
Software Requirements Fundamentals: Product and process requirements, Functional and non-functional requirements, Emergent properties, Quantifiable requirements, System and software requirements. Requirements Process: Process models, Process actors, Process support and management, Process quality and improvement. Requirements Analysis: Requirements sources, Elicitation techniques. Requirements Analysis: Requirements classification, Conceptual modeling, Architectural design and requirements allocation, Requirements negotiation, Formal analysis. Requirements Specification: System definition document, System requirements document, Software requirements specification. Requirements Validation*:* Requirements reviews, Prototyping, Model validation, Acceptance tests. Practical Considerations: Iterative nature of the requirements process, Change management, Requirements attributes, Requirements tracing, Measuring requirements. Software Requirements Tools. Current research topics in requirement engineering.

Recommended Books:

1. Software Engineering: A Practitioner's Approach, Roger S. Pressman, Bruce R. Maxim, 8th Ed, McGraw-Hill Education, 2015.
2. Object-Oriented Analysis, Design and Implementation, Brahma Dathan, Sarnath Ramnath, 2nd Ed, Universities Press, India, 2014.
3. Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures, Hassan Gomaa, Cambridge University Press, 2011.
4. Applying UML & Patterns: An Introduction to Object-Oriented Analysis & Design and Iterative Development, Craig Larmen, 3rd Edition.
5. Head First Design Patterns, Eric Freeman, Elisabeth Freeman, Kathy Sierra and Bert Bates, O'Reilly Media, Inc., 2004.

SE5903 Software Testing and Quality Assurance (3-0-3)
Testing techniques. Black Box testing, White Box and Grey Box testing techniques. Quality Assurance planning and execution. Automated testing topics include constructing a framework, scripting techniques, generating a test data, generating test architecture, pre/post-processing, test maintenance, and job specific metrics. Current research topics in Software Testing and Quality Assurance.

Recommended Books:

1. Software Quality Assurance: Integrating Testing, Security, and Audit (Internal Audit and IT Audit), Abu Sayed Mahfuz, Auerbach Publications, 2016.
2. Practical Model-Based Testing: A Tools Approach, Mark Utting and Bruno Legeard, Morgan Kaufmann Publishers Inc., San Francisco, CA, 2006.
3. Software Quality Engineering, Testing, Quality Assurance, and Quantifiable improvements, Jeff Tian, IEEE Computer Society, 2005.
4. Introduction to Software Engineering, P Ammann and J Offutt, Cambridge University Press, 2008.

SE5904 Advanced Software Project Management (3-0-3)
Introduction to project management. Algorithmic cost estimation models. Advanced cost estimation models. Function points estimation Risk assessment. Life cycle models. Prototyping. Management of software reuse. Software maintenance. Software maturity framework. An Overview of Project Planning. Program Management and Project Evaluation. Software Effort Estimation. Activity Planning. Risk Analysis and Management. Resource Allocation. Project tracking and Control. Contract Management. Software Quality Assurance. Configuration Management. Various tools of Software Project Management. Project Cost Management. Project Human Resource Management. Project Communications Management. Project Procurement Management. Case studies, Current research topics in Software Project Management.

Recommended Books:

1. Software Project Management, Bob Hughes & Mike Cotterell, 3rd Ed., McGraw-Hill Publication, 2003, ISBN: 0707709834X.
2. Software Project Management in Practice, Pankaj Jalote, Addison-Wesley, 2002, ISBN 0-201-73721-3.

SE5913 Research Methods (3-0-3)
Introduction to Research. Objectives of Research. Importance of Research Methodology in Research Study. Types of Research. Steps in Conducting Research. What is Literature Review? Need of Literature Review. Types of Literature Review. Systematic Literature Review Protocol. Problem Statement and Problem formulation. Criteria for selecting a problem. Identifying Types of variables in Research. Types of hypothesis. Identifying Target Population. Types of Sampling. Sampling Techniques. Quantitative Research Methods. Scientific Methods. Design of Quantitative Surveys. Techniques to Conduct Quantitative Methods. Introduction to Qualitative Research. Qualitative Research Methods. Data Analysis and Theory in Qualitative Research Articles. Introduction to Mixed Methods Research. Design of Mixed Methods Research. Evaluation of Mixed Methods Research. Case Study. How to Conduct a Case Study. Case Study Protocol. Importance and Benefits of Case Study. Types of Statistical Tests to Conduct Data Analysis. Data Analysis Tools. Introduction to SPSS. Hands on Practice of SPSS. How to Define variables in SPSS. How to Record Collected Data in SPSS. Types of Tests via SPSS including Regression. Correlation. Cross tabulation and others. How to write Good Research Proposal. Contents of Thesis. Important Elements of Research Thesis.

Recommended Books:

1. Research design: Qualitative, quantitative and mixed methods approaches, Creswell, J. W. Thousand Oaks, CA: Sage,4th Ed. 2014.
2. A Gentle Guide to Research, Gordon Rugg & Marian Petre, Open University Press McGraw-Hill Education, 2007.
3. Practical Research Methods, Catherine Dawson, How To Books Ltd,3 Newtec Place, 2002.

Contents of Elective Courses

SE5905 Software Measurement and Metrics (3-0-3)
Introduction to quality control and planning needs (Measurement Concepts, Measurement as a support process, Review Metrics Models and Standards). Measurement goals (Formulating problem and goal statement, prioritize information needs and objectives, Formalize measurement goals). Specify Measures (Identify questions and indicators, Identify data elements, Operational definitions for measures). Specify Data Collection and Storage Procedures. Sources of data. How to collect and store the measurement data? Specify Analysis Procedures. Potential data analyses. Methods and tools for measuring software. Develop software measurement reporting. Current research topics in Software Measurement and Metrics.

Recommended Books:

1. Metrics and Models in Software Quality Engineering, Stephen H. Kan, Addison Wesley, 2003.
2. Measuring the Software Process, Anita Carleton, William A. Florac, Addison-Wesley 1999
3. The Big Book of Six Sigma Training Games, Chris Chen and Hadley Roth, McGraw-Hill, 2005.

SE5906 Component Based Software Engineering (3-0-3)
Introduction to Software Component (Component. Definition and Essentials, what is CBSE? Why CBSE? The Anatomy of Components: internals, application interfaces, platform interfaces, middleware, Component

Characteristics: Properties of Software Component in CBSE). Basic Concepts in CBSE (Improving SW through Software Process Improvement (SPI)), Component-Based Software Development (CBSD). Approach. Component Patterns & Abstraction. Challenges of CBSE. Technical Issues and Objectives of Component Based Software Engineering. Reuse Dimensions. Software Components Types: open, closed, COTS, in house. Challenges in Software Reuse. Software Component Specification. Specification Techniques. Specifying the Semantics of Components. Specifying Extra-Functional Properties. Architecting component based systems (Software Architecture Parts, The Roles of Software Architecture, Designing Software Architectures, Architectural Styles, Architecture-Driven Component Development, Components and Component Models, Component Model Implementation, Component Frameworks, Black-Box and White-Box Frameworks, how do we use Framework in CBSE? Component Interface Specification). Component Engineering Process: Domain Engineering, Domain Engineering pattern based design. Domain Engineering: Component Repositories, Overview of Existing Component Techniques, Component testing in CBSE. Current research topics in Component Based Software Engineering.

Recommended Books:

1. Software Engineering: A Practitioner's Approach, Roger S. Pressman, 8th Edition, McGraw-Hill Higher Education, 2015.
2. Building Reliable Component Based Software Systems, Ivica Crnkovic and Magnus Larsson, Artech House Publishers; 1st edition, 2002.
3. Component-Based Development: Principles and Planning for Business Systems, Katharine Whitehead, Addison Wilsey, 2010.

SE5907 Software Configuration Management

Management of the SCM Process. Organizational Context for SCM. Constraints and Guidance for the SCM Process. Planning for SCM. SCM Plan. Surveillance of Software Configuration Management. Software Configuration Identification. Identifying Items to Be Controlled. Software Library. Software Configuration Control. Requesting, Evaluating, and Approving Software Changes. Implementing Software Changes. Deviations and Waivers. Software Configuration Status Accounting. Software Configuration Status Information. Software Configuration Status Reporting. Software Configuration Auditing. Software Functional Configuration Audit. Software Physical Configuration Audit. In-process Audits of a Software Baseline. Software Release Management and Delivery. Software Building. Software Release Management. Software Configuration Management Tools. Current research topics in Software Configuration Management.

Recommended Books:

1. Software Configuration Management Patterns: Effective Teamwork, Practical Integration by Stephen P. Berczuk, Brad Appleton, 2003.

SE9508 Empirical Software Engineering

Quantitative study design. Qualitative study designs. Measurement and data collection. State-of-the practice. Archival data analysis. Human variation & impact of experience. Evidence-based software engineering. Simulation of software process. Current research techniques in Empirical Software Engineering.

Recommended Books:

1. Experimentation in Software Engineering by C. Wohlin , Kluwer, 2000. ISBN 0-7923-8682-5.
2. Research Methods Knowledge Base, by William M.K., 2002.

SE5909 Intelligent System Design

Introduction to Intelligent Systems, Adaptation, Learning, Memory Development, Instinctive Behavior, Artificial Neural Network (ANNs), History of ANN, Mode of Operation, Learning rules, History of ANN, Mode of Operation, Training of ANNs, Back propagation, Types of Neural Networks, Kohonen Self Organizing Maps, Hopfield Networks, Spiking Neural Networks (SNN), Heb's Rule, Spiking time dependent plasticity networks, Neuro-Evolution, Topology and Weight evolutionary ANNs), Neuro-evolution of Augmented topologies, Neural development.

Recommended Books:

1. Artificial Intelligence-A Guide to Intelligent Systems, by: Michael Negnevitsky, Publisher: Addison Wesely, Publication Year: 2011, ISBN-13: 978-1408225745.

SE5910 Software Design Patterns

What is a design pattern, history, Creational patterns (Abstract Factory, Builder, Factory method, Lazy initialization, multiton, object pool, prototype, singleton), Structural patterns (Adaptor, bridge, composite, decorator, façade, flyweight, proxy), Behavioral Patterns (blackboard, chain of responsibility, command, interpreter, iterator, mediator, momento, null object, observer or publish subscribe, state, strategy, template method, visitor), Concurrency patterns.

Recommended Books:

1. Design Patterns: Elements of Reusable Object-Oriented Software, by: Erich Gamma, John Vlissides, Ralph Johnson, and Richard Helm, Publisher: Addison-Wesely, Publication Year: 1994, Edition: 1st, ISBN: 978-0201633610.

SE5911 Bio-Inspired Computation

Introduction to bio-inspired computation, Conventional and un-conventional programming, Evolutionary Computation, Evolutionary Strategies and Evolutionary Programming, Genetic Algorithms and Genetic Programming, Genetic Algorithms Methods and implementation, Mutation and Cross Over, Genetic Encoding, Fitness Landscape, Selection Methods, Cartesian Genetic Programming, Ants Colony Optimisation, Swarm Intelligence, Co-evolution, Evolutionary Development.

Recommended Books:

1. Bioinspired Computation in Combinatorial Optimization: Algorithms and Their Computational Complexity, by: Neumann, Frank, Witt, Carsten, Publisher: Springer, Year of publication: 2010, ISBN: ISBN 978-3-642-16544-3

SE5912 Software Risk Management

What is risk and risk management? Motivation for risk management. Reasons we don't do risk management. SEI's Risk Management paradigm. Identifying and recording software risk. Risk Taxonomy. Tools and methods for identifying and recording risks. Analyzing and classifying risks. Complex project management theory. Software Risk Identification. Software Risk Analysis. Software Risk Planning. Software Risk Monitoring. Software Qualitative Risk Analysis. Quantitative Risk Analysis. Risk management and the SDLC. Risk management in CMM. Other useful tools for successful risk management. Current research topics in Software Risk Management.

Recommended Books:

1. Software Engineering Risk Management by Dale Walter Karolak, 1995, ISBN9780818671944.
2. Applied Software Risk Management: A Guide for Software Project Managers by C. Ravindranath Pandian, 2006, ISBN 9780849305245.
3. Software Risk Management by Boehm, Barry, W. IEEE Computer Society Press, ISBN 10: 0818689064.

SE5914 Agile Software Development Methods

Agile values and principles. Agile Practices. Pair programming Refactoring. Test-driven development. Continuous integration and delivery. Automated build. Coding standards simplicity. SMART user stories and release and deployment. Applying Agile methods: Integration, XP+SCRUM, SCRUM +Kanban, Agile methods +User-Centered Design. Distributed Agile teams. Current research topics in Agile Software Development.

Recommended Books:

1. Agile Software Development, Principles, Patterns, and Practices, Robert C. Martin, Pearson, 2002.
2. Extreme Programming Explained, Kent Back & Cynthia Andres, 2nd Edition, Addison-Wesley Professional 2005.
3. Learning Agile: Understanding Scrum, XP, Lean, and Kanban, Andrew Stallman and Jennifer Greene, O'Reilly Media, 2014.

SE5915 Advanced Web Engineering

Web engineering introduction, Requirements engineering for Web applications, design methods and technologies, interface design, usability of web applications, accessibility, testing, metrics, operation and maintenance of Web applications, security, and project management. Specific technologies covered in this course include client-side (XHTML, JavaScript, and CSS) and server-side (PHP, JSP and servlets). Data driven technologies PHP and MySQL.

Recommended Books:

1. Web Engineering: The Discipline of Systematic Development of Web Applications, Edited by: Gerti Kappel, Birgit Prýýll, Siegfried Reich, Werner Retschitzegger, edition: 1st, Publication Year: 2006, ISBN:978-0470015544.

2. Web Engineering: A Practitioner's Approach, by: Roger S. Pressman and David Lowe, 1st edition, Publication Year: 2008, ISBN: 978-0073523293.

SE5916 Advanced Formal Methods (3-0-3)
Introduction to formal methods and specification. State-Based Formal Methods. Transformational systems. Traditional approaches. Z specification. Formal development cycle. Temporal Specification: reactive systems, syntax and semantics of temporal logic, temporal specification of reactive systems (safety, aliveness, fairness). Model Checking: Generating finite models, Analysis of a simple model checking algorithm. Symbolic model checking. Overview of reduction methods. Spin and Promela. Case study and practical verification of properties. Current research topics based on Formal Methods.

Recommended Books:

1. Z: An Introduction to Formal Methods by Antoni Diller, 2nd Edition, John Wiley & Sons, Inc.,1994.

SE5917 Software Engineering Ontology
Ontology Engineering: Principles, Methods, Tools, and Languages. Using Ontology in Software Engineering. Development of Ontologies for SWEBOK (Software Engineering Body of Knowledge): Issues and Techniques.
Some Ontologies for Software Development: Ontologies for Requirements, Design, Maintenance, Measurements,
Use of Ontologies in Domain Oriented Software Development Environments Comparative Study of Semantics Coverage in Ontologies as per SWEBOK. Alignment of Different Available Ontologies.
Recommended Books:

1. Ontologies for Software Engineering and Software Technology, by:Coral Calero, Francisco Ruiz, Mario Piattini, edition: 2016, Published by: Springer, Publication year: 2006, ISBN: 978-3540345176.

SE5918 Semantic Web Enabled Software Engineering
Semantic web introduction, Metadata, metadata standards, XML+metadata specification, RDF and metadata processing, OWL. Semantic application. Classification and semantic metadata extraction techniques. Current problems and research possibilities.
Recommended Books:

1. Semantic Web Enabled Software Engineering (Studies on the Semantic Web), by: Jeff Z. Pan, Zhao , Y , Yuting Zhao, Published by: IOS Press, Publication year: 2014, ISBN: 978-1614993698.

SE5919 Model Driven Software Development
Models, Modeling, and Model-Driven Architecture (MDA). Basic Ideas and terminology, MDSD concept and terminology, Architecture centric MDSD, Generative Programming, Data driven development, Agile software development, Metamodeling, MDSD-capable target architecture, Building domain architectures, code generation techniques, Model Transformation, MDA standards, testing, versioning. Current research topics as decided by instructor.
Recommended Books:

1. Model-Driven Software Development With UML and Java, by: Kevin Lano, Publisher: Cengage Learning Emea, Year of publication: 2009, ISBN:978-1844809523.

SE5920 Machine Learning Application in Software Engineering
Introduction to Machine Learning and Software Engineering, ML Applications in Prediction and Estimation, ML Applications in Property and Model Discovery ML Applications in Transformation, ML Applications in Generation and Synthesis, ML Applications in Reuse, ML Applications in Requirement Acquisition, ML Applications in Management of Development Knowledge.
Recommended Books:

1. Advances in Machine Learning Applications in Software Engineering, by: Du Zhang (Author, Editor), Jeffrey J. P. Tsai (Editor), edition: 1st, Published by: IGI Global, Year of publication: 2007, ISBN: 978-1591409410.

SE5921 Software Case Tools & Applications
The students will be appraised of; Case tools & techniques, CASE in software development process, Traditional CASE methodologies, Emerging CASE methodologies, OO Design, Specific CASE tools, specialized design tools, Managing CASE methodologies. As part of course, students will be assigned a real life problem for development through CASE tools.
Recommended Books: To be suggested by the course instructor.

SE5922 Information System Security

Security Introduction, Cryptography, Essential Security Concepts, Trusted Systems and Security Models, Authentication, Kerberos, Availability, DoS Attacks ATM Networks – Performance and Attacks, IP Network Performance – QoS and DoS, Key Management for Secure Networks, Security Protocols, Biometrics, TEMPEST, Student final project "presentations".

Recommended Books:

1. Information Security: The Complete Reference, by: Mark Rhodes-Ousley, 2nd Edition, Publisher: McGraw-Hill Education, Publication Year: 2013, ISBN: 978-0071784351.
2. Cryptography and Network Security: Principles and Practice, by: William Stallings, 7th edition, Publisher: Pearson, Publication Year: 2016, ISBN: 978-0134444284.
3. CISSP (ISC)2 Certified Information Systems Security Professional Official Study Guide, by: James M. Stewart, Mike Chapple, Darril Gibson, 7th edition, Publisher: Sybex, Year of publication: 2015, ISBN: 978-1119042716.

SE5923 Design and Analysis of Network Systems

Basic Concepts in Networking Protocols and Layers, process to process lifetime of a packet in network, Example Networks and Network Components, Introduction to Network Analysis, Architecture, and Design, Network Requirements Analysis: Concepts, Network Requirements Analysis: Process, Flow Analysis, Network Architecture, Addressing and Routing Architecture, Network Management Architecture, Performance Architecture, Security and Privacy Architecture, Selecting Technology for the Network Design, Interconnecting Technologies with the Network Design.

Recommended Books:

1. Network Analysis, Architecture & Design, by: James D. McCabe, edition: 3rd, Publisher: The Morgan Kaufmann, Year of publication: 2007, ISBN: 978-0123704801.
2. Computer Network: A Systems Approach, by: Larry L. Peterson, Bruce S. Davie, 5th edition, Publisher: The Morgan Kaufmann, Year of publication: 2011, ISBN: 978-0123850591.

SE5924 Data Warehousing

DW fundamentals, need for a DW, decision support vs. transaction processing, evolution of a DW. Business requirements as the driving force for the DW, matching information to classes of users. Dimensional modeling. Architecture and Infrastructure, data extraction, transformation and loading, data quality. Selected de-normalizations, horizontal and vertical partitioning, materialized views, Physical design, Data mart design, web data warehousing. Current topics in data warehousing.

Recommended Books:

1. Data Warehousing Fundamentals for IT Professionals, by: Paulraj Ponniah, 2nd Edition, Publisher: Wiley, Year of publication: 2010, ISBN: 978-0470462072.

SE5925 Advance Human-Computer Interaction

Introduction to HCI. Importance of usable and useful software products. The theories of HCI. How to evaluate/develop software products. How to apply theoretical results from HCI research to software products. How to conduct their own research about aspects of usability and user experience, Concepts of Human Computer Interaction. The psychology of usable things. Usability Engineering. Prototypes. Usability inspection methods. Usability testing methods. Usability in practice. User Experience (UX). Web Usability. Mobile Usability. Mobile User Experience. Site objectives and user needs. Information architecture. Information and navigation design. Implementation and optimization. Experiments and HCI guidelines. Current research topics in Human-Computer Interaction.

Recommended Books:

1. About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, Wiley, 4th Edition, 2014.
2. Designing the User Interface, Ben Shneiderman and Catherine Plaisant, Pearson, 5th Edition, 2013.
3. Research Methods in Human-Computer Interaction, Lazar, Feng, Hochheiser, Wiley, 2010.

SE5927 Reliability Engineering

Introduction to Reliability Engineering. The Need for Reliable Software. Software Reliability Engineering Concepts. Basic Definitions. Software Reliability and System Reliability. The Dependability Concept. Reliability Modeling. Availability Modeling. Statistical Reliability Models for Software Reliability. Best Current Practices of software Reliability Engineering. Software Metrics for Reliability Assessment. Software Testing and Reliability. Software Reliability Tools. Review of Reliability Theory. Analytical Techniques and Basic Statistics for Reliability Engineering. Current research topics in Reliability Engineering.

Recommended Books:

1. An Introduction to Reliability and Maintainability Engineering, Ebeling, C. E., Waveland Press, Inc., 2^{nd} edition. 2009 (ISBN 1-57766-625-9).
2. IEEE Recommended Practice in Software Reliability Handbook of Software Reliability Engineering by Michael R. Lyu. Published by IEEE Computer Society Press and McGraw-Hill Book Company, 2008.

SE5928 Complex Networks

Introduction to complex networks. What is a complex system? Basic metrics. Degree distribution (DD).Clustering coefficient (CC). Centrality. Page Rank. Hubs and authorities. Bib-coupling. Co-citation index. Edge reciprocity. Rich club phenomenon. Social Network. Homophily. Cohesiveness. Equivalence of ties. Ego-centric networks. Community Structures. Hierarchical Agglomerative. Linear algebra techniques and spectral methods. Citation Networks, Rise and fall of CS fields. Inter-disciplinarily of CS fields. Temporal structures of citation profiles. Citation count prediction. Co-authorship circles. Economic and financial network analytics. Graph mining. Measuring user engagement. Basic definitions and metrics: walks, paths, cycles, connectedness, trees. The clustering coefficient. The World Wide Web. Scale-free networks. Random graphs with a given degree sequence. The Barabasi-Albert model and other models of growing graphs. Degree correlations. The Internet and other assortative and dissertated networks. Community structures: spectral bisection and hierarchical clustering methods. The modularity and Girvan-Newman algorithm. Current research topics in Complex Networks.

Recommended Books:

1. Complex networks, Ronaldo Menezes, Alexandre Evsukoff, Marta C. González, Springer-Verlag Berlin Heidelberg, 2013.

SE5929 Agent Based Modeling

Introduction to agent based modeling. Introduction to Net Logo. Complexity in Social Worlds. Net Logo Commands. Net Logo Procedures. Model properties (Why agent-based objects? Agents, environments, and timescales). Biological systems: fireflies, flocking, slime mold, bees, ants (flocking behavior slime mold).Biological systems: predator/prey, debugging (Verification and validation).Social systems: segregation, Schelling, Micro motives and Macro behavior. A self-forming neighborhood model. Cellular automata. Critical phenomena. Sand piles. Current research topics in Agent Based Modeling.

Recommended Books:

1. Agent-Based Models, Nigel Gilbert, SAGE Publications, 2008.

SE5930 Data Mining

Introduction: Machine Learning and Data Mining, Data Flood, Data Mining Application Examples, Machine Learning and Classification Examples, Input: Concepts, instances, attributes, Preparing the data, Decision tables, Decision trees, Decision rules, Rules involving relations, Instance-based representation. Classification - Basic methods, Decision Trees , Handling Numeric Attributes , Finding Best Split, Dealing with Missing Values, Pruning , Pre-pruning, Post-Pruning, Estimating Error Rates, From Trees to Rules, Regression, Evaluation and Credibility, Data understanding, Discretization, False predictors , Feature reduction, Randomization, Learning with unbalanced data, Clustering, Associations, Visualization, Summarization and Deviation Detection, Predicting Performance, Bootstrap, Choosing a Loss Function.

Recommended Books:

1. Introduction to Data Mining, by: Pang-Ning Tan, Michael Steinbach, Vipin Kumar, 1st edition, Publisher: Pearson, Publication Year: 2005, ISBN: 978-0321321367

2. Data Mining: Concepts and Techniques, Third Edition 3rd Edition, by: Jiawei Han , Micheline Kamber , Jian Pei, Publisher: Morgan Kaufmann, Publication year: 2011, ISBN: 978-9380931913.

SE5931 Internet of Things

Internet of Things Promises–Definition– Scope–for IoT Applications, Structure of IoT– Introduction to Cloud, Edge and Fog Computing. IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Basic Electrical and Electronics Concepts, Devices-> Most common Sensors and Actuators. Discussion on current applications of IoT vision, Most common platforms i.e. ThingSpeak, AndroidThings, Xively, Samsara, etc. IoT development platform such as Arduino, Edison & Raspberry PI. Characteristics, Architecture, Sensing & Actuating devices and Programming tutorials. Implementations using Arduino platform and completion of a term project based on IoT applications.

Recommended Books:

1. Learning Internet of Things by Peter Waher, PACKT Publishing, 2015
2. Internet of Things with Arduino Cook Book, Marco Schwartz, PACKT Publishing, 2016.
3. Hacking Electronics- An illustrated DIY guide for makers & hobbyists by Simon Monk, McGraw Hill Education, 2013
4. Internet of Things- Key Applications & Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi, WILEY Publication, 2012.
5. Al-Fuqaha et. al, “Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications”, IEEE Communication Surveys & Tutorials, Vol. 17, No. 4, 2015.
6. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
7. Keysight Technologies, “The Internet of Things: Enabling Technologies and Solutions for Design and Test”, Application Note, 2016.

SE5926 Special Topics Related to Software Engineering (06 credit hours)

SE5999 Master’s Thesis (6 credit hours)

SE6999 PhD Thesis (3-9 credit hours)