DELHI TECHNOLOGICAL UNIVERSITY
SCHEME OF TEACHING AND EVALUATION
M.TECH SOFTWARE ENGINEERING

The following alphanumeric coding scheme has been adopted
Core Courses XXXYMN
Elective Courses XXXYCMN
XXX abbreviates a particular M. Tech. program, Y – (5 for M. Tech. 1 st year, 6 for M. Tech. 2 nd year),
C – credit of the course (4/3/2),
MN – Subject code (Odd number for odd semester and even number for even semester courses

Semester-I

	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group A	1	SWE501	Software Requirement Engineering	Core	4	3	0	2	15	25	20	40	-	17
	2	SWE503	Object Oriented Software Engineering	Core	4	3	0	2	15	25	20	40	-	
Group B	3	SWE5401/5403/……	Elective 1	Elective	4	3	0	2	15	25	20	40	-	
	4	SWE5301/5303/……	Elective 2	Elective	3	3	0	0	20	-	30	50	-	
	5	SWE5201/5203/…… / UEC5201/5203/……	Elective 3	Elective	2	2	0	0	20	-	30	50	-	

Semester-II

	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group C	1	SWE502	Software Testing	Core	4	3	0	2	15	25	20	40	-	17
	2	SWE504	Empirical Software Engineering	Core	4	3	0	2	15	25	20	40	-	

Group D	3	SWE5402/5404/……	Elective 4	Elective	4	3	0	2	15	25	20	40	-	
	4	SWE5302/5304/……	Elective 5	Elective	3	3	0	0	20	0	30	50-	-	
	5	SWE5202/5204/…… / UEC5202/5204/……	Elective 6	Elective	2	2	0	0	20	0	30	50	-	

Semester-III

	S.No.	**Course Code**	**Course Name**	**Type/ Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRE**	**MTE**	**`ETE**	**PRE**	**Total Credits**
	Track 1													**12**
Group E	1	SWE651	Research Project	Core	12	0		12	0	0	-	100	-	
	Track 2													
	1	SWE601	Major Project I	Core	3				0	0	40	60	-	**12**
	2	SWE6401/6403/……	Elective 7	Elective	4	3	0	2	15	25	20	40	-	
	3	SWE6301/6303/……	Elective 8	Elective	3	3	0	0	20	0	30	50	-	
	4	SWE6201/6203/……	Elective 9	Elective	2	2/0	0	0/4	20/ 0	0/ 40	30/0	50/0	0/60	

Semester-IV

	S.No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRE	MTE	`ETE	PRE	Total Credits
Group F	**Track 1**													
	1	SWE652	Research Project	Core	12	0		12	0	0	-	100	-	**12**
	Track 2													
	1	CSE602	Major Project II	Core	12	0		12	0	0	40	60	-	**12**

LIST OF ELECTIVES :

	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 1	1	SWE5401	Advanced Database Management Systems	Elective	4	3	0	2	15	25	20	40	-
	2	SWE5403	Programming Languages		4	3	0	2	15	25	20	40	-
	3	SWE5405	Advanced Operating System		4	3	0	2	15	25	20	40	-
	4	SWE5407	Advanced Data Structures		4	3	0	2	15	25	20	40	-
	5	SWE5409	Data Warehousing Data Mining		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 2	1	SWE5301	Project Work	Elective	3	0	0	-	-	40	-	-	60
	2	SWE5303	Artificial Intelligence		3	3	0	0	20	-	30	50	-
	3	SWE5305	Information Retrieval		3	3	0	0	20	-	30	50	-
	4	SWE5307	Fuzzy Logic and Neural Networks		3	3	0	0	20	-	30	50	-
	5	SWE5309	Software Project Management		3	3	0	0	20	-	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**

Elective 3	1	SWE5201	SEMINAR	Elective	2	2	0	0	2	-	100	-	-
	2	SWE5203	Probability and Statistics		2	2	0	0	20	-	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 4	1	SWE5402	Software Design Patterns	Elective	4	3	0	2	15	25	20	40	-
	2	SWE5404	Soft Computing		4	3	0	2	15	25	20	40	-
	3	SWE5406	Machine Learning		4	3	0	2	15	25	20	40	-
	4	SWE5408	Big Data Analytics		4	3	0	2	15	25	20	40	-
	5	SWE5410	Wireless and Mobile Computing		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 5	1	SWE5302	MINOR PROJECT	Elective	3	0	0	-	-	40	-	-	60
	2	SWE5304	Optimization Techniques		3	3	0	0	20	-	30	50	-
	3	SWE5306	Pattern Recognition		3	3	0	0	20	-	30	50	-
	4	SWE5308	Distributed Systems		3	3	0	0	20	-	30	50	-
	5	SWE5310	Natural Language Processing		3	3	0	0	20	-	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 6	1	SWE5202	Research Methodology	Elective	2	2	0	0	20	-	30	50	-
	2	SWE5204	Predictive Modelling		2	2	0	0	20	-	30	50	-
	3	SWE5206	Operational Research		2	2	0	0	20	-	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 7	1	SWE6401	Advances in Software Engineering	Elective	4	3	0	2	15	25	20	40	-
	2	SWE6403	Cloud Computing		4	3	0	2	15	25	20	40	-

	3	SWE6405	Things of the Internet		4	3	0	2	15	25	20	40	-
	4	SWE6407	Multimedia Applications		4	3	0	2	15	25	20	40	-
	5	SWE6409	Information Theory and Coding		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 8	1	SWE6301	Agile Methods	Elective	3	3	0	0	20	-	30	50	-
	2	SWE6303	Software Reliability		3	3	0	0	20	-	30	50	-
	3	SWE6305	Cluster and Grid Computing		3	3	0	0	20	-	30	50	-
	4	SWE6307	Software Quality & Metrics		3	3	0	0	20	-	30	50	-
	5	SWE6309	Swarm and Evolutionary Computing		3	3	0	0	20	-	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 9	1	SWE6201	Data Security & Privacy	Elective	2	2	0	0	20	-	30	50	-
	3	SWE6203	Bio Informatics		2	2	0	0	20	-	30	50	-
	5	SWE6205	Statistical Tools		2	0	0	4	-	40	-	-	60

SEMESTER I

Courses

SWE501 Software Requirement Engineering

The primary objective of the course is to understand the software requirements, how to effectively collect them and to learn the corresponding tools that aid in requirements engineering. The topics include essential of software requirements, different dimensions and good practices for requirements engineering, improving requirements processes, and risk management. It also incorporates review of various activities of requirements engineering and discussion on current trends. Principles and practices of software requirements management, requirements attributes, change management process, requirements traceability matrix, links in requirements chain are also included. RM Tools, implementing requirements management automation and current trends such as aspect-oriented requirement engineering and agent-based requirement engineering are a part of the course structure.

Suggested Books:

1. R. Naik and S. Kishore, "Software Requirements and Estimation", Tata McGraw Hill, 2007.
2. K. E. Weigers, "Software Requirements" Microsoft Press, 1999.
3. E. Gottesdiener, "Requirements by Collaboration: Workshops for Defining Needs", Addison Wesley, 2002.

SWE503 Object-Oriented Software Engineering

The goal of this course is to make one design, assess and analyze object-oriented philosophy at each phase of software development life cycle. Basic concepts: Software engineering, object-orientation, object-oriented methodologies and modelling. Software development life cycles, object-oriented software life cycle models, software requirements elicitation and analysis, use case

approach. Object-oriented Software Estimation: Need, Lorenz & Kidd estimation, use case points method, class point method, object-oriented function point, risk management. Object-oriented analysis, Object-Oriented design, Software testing.

Suggested Books:

1. Y. Singh, R. Malhotra, "Object-Oriented Software Engineering", PHI Learning, 2012.
2. I. Jacobson, "Object Oriented Software Engineering: A Use-case Driven Approach", Pearson Education, 2009.
3. R. Laganiere & T.C. Letbridge, "Object-oriented Software Engineering: Practical Software Development Using UML and Java", Tata McGraw Hill, 2004.

SWE5401 Advanced Database Management

This course covers topics of Relational Databases Integrity Constraints, Extended ER diagram, Relational Algebra & Calculus, Functional, Muiltivalued and Join Dependency, Normal Forms, Rules about functional dependencies. Advanced Transaction Processing, Query Processing, Query Optimization: Indexing and Query Optimization, Parallel and Distributed Databases: Distributed Data Storage – Fragmentation & Replication, Location and Fragment Transparency Distributed Query Processing and Optimization, Active Database and Real Time Databases: Triggers in SQL, Event Constraint and Action.

Suggested Books:

1. R. Elmasri, S..B. Navathe, "Fundamentals of Database Systems", Sixth Edition, Pearson Education, 2017.
2. Garcia-Molina, "Database Systems, The complete book", Pearson, 2014.
3. A. Silberschatz, H. F. Korth, S. Sudarshan, "Database System Concepts", Sixth Edition, Mcgraw Hill, 2013.
4. C.J. Date, A. Kannan, S. Swaminathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2007.

SWE5403 Programming Languages

The objective of the course is to introduce programming fundamentals through Python language.

Planning the Computer Program, Techniques of Problem Solving, Overview of Programming: Structure of python program, basic elements of python program. Introduction to Python: Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings, Operators. Creating Python Programs: Input and Output Statements, Control statements, Defining Functions, default arguments, Errors and Exceptions. Iteration and Recursion, Strings and Lists, Object Oriented Programming: Introduction to Classes, Objects and Methods, Standard Libraries. Data Structures: Arrays, list, set, stacks and queues. Searching and Sorting.

Suggested Books:

1. T. Budd, "Exploring Python", First Edition, Tata McGraw Hill, 2011.
2. A. Downey, J. Elkner, C. Meyers. "How to think like a computer scientist learning with Python", First Edition, Freely Available Online, 2012.

SWE5405 Advanced Operating System

The objective of the course is to learn various concepts related to operating systems. Operating system concepts: history, evolution and philosophy of operating systems. Concurrent processes, process coordination and synchronization, CPU scheduling, deadlocks,

memory management, virtual memory, secondary storage and file management, device management, security and protection, networking, and distributed and real-time systems.

Suggested Books:

1. A Silberschatz, P.B. Galvin, G. Gagne, "Operating Systems Concepts", Eighth Edition, John Wiley Publications, 2008.
2. A.S. Tanenbaum, "Modern Operating Systems", Third Edition, Pearson Education, 2007.
3. W. Stallings, "Operating Systems, Internals & Design Principles", Fifth Edition, Prentice Hall of India, 2008.

SWE5407 Advanced Data Structures

This course covers topics of Review of Elementary data structures, Sparse matrices, Advanced Data Structures: data structures for combinatorial, Operations on Disjoint Divide and Conquer approach, Graph Algorithms: Definitions and Algorithms, Greedy Method and Dynamic Programming, Dynamic Programming, Advanced Algorithms: NP Complete problems, Approximation algorithms for NP complete problem, Algorithms for matching, Flow and circular problems, Bio Inspired Algorithm- Genetic Algorithm, Particle Swam, Artificial Bee Colony, Firefly Algorithm, Bat Algorithm.

Suggested Books:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, "Introduction to Algorithms", MIT Press, 2009.
2. R.E. Tarjan, "Data Structures and Network algorithms", SIAM Regional Conference series in Applied Mathematics, 1987.
3. Aho, Hopcraft & Ulman, "The Design and Analysis of Computer algorithms", Addison Wesley, 1974.
4. S. Dasgupta, C. H. Papadimitriou, and U.V.V Azirani, "Algorithms", Tata McGraw Hill, 2017.
5. Y. Langsam, M. J. Augenstein, A. M. Tenenbaum, "Data Structures using C and C++", Pearson, 2006.

SWE5409 Data Warehousing and Data Mining

This course contains topics of Data Warehousing, Data Warehouse Architecture, Design, Implementation & Maintenance, Data Mining Concepts, Mining Association Rules in Large Databases, Classification and Prediction, Cluster Analysis in Data Mining, Mining Complex Types of Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Time Series and Sequence Data, Mining Text Databases, Applications, Trends in Data mining, spatial mining, and Web Mining.

Suggested Books:

1. P. Ponniah, "Data Warehousing Fundamentals", John Wiley, 2001.
2. M.H. Dunham, "Data Mining Introductory & Advanced Topics", Pearson Education, 2011.
3. H. Kamber, M. Kaufman, J. Pie, "Data Mining Concepts & Techniques", Third Edition, Morgan Kaufmann, 2012.

SWE5301 Minor Project-I

SWE5303 Artificial Intelligence

This course covers topics of AI Problems, Task Domains of AI, AI Techniques, Basic Problem solving Method: state space search, problem characteristics, Heuristic search Techniques, Knowledge Representation Knowledge Representation: using Predicate Logic: Unification, resolution. Natural deduction, using Rules, Structured Knowledge Representation, Programming Languages: Prolog or Lisp , Symbolic Reasoning under uncertainty, Statistical Reasoning, Concept of learning, learning in problem solving, learning by inductions, genetic algorithm, , Neural Network, Genetic theorem, Expert Systems Research issues in different domains.

Suggested Books:

1. J E. Rich. K. Knight, "Artificial Intelligence", Tata McGraw Hill, Second Edition, 1992.
2. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 1990.
3. D.W. Patterson, "Introduction to AI and Expert Systems", PHI, 1992.
4. M. Negnevitsky, "Artificial Intelligence: A Guide to Intelligent Systems", Second Edition, Addison-Wesley, 2005.

SWE5305 Information Retrieval

This course contains topics of Introduction and Search engine architecture, Search engine architecture, Retrieval models, Retrieval evaluation, classical evaluation metrics, e.g., Mean Average Precision, and modern advance, e.g., interleaving. Relevance feedback, Link analysis and Search applications, recommendation, personalization, and online advertising.

Suggested Books:

1. C. D. Manning, P. Raghavan and H. Schutze. "Introduction to Information Retrieval", Cambridge University Press, 2008.

SWE5307 Fuzzy Logic and Neural Networks

This course intends to introduce the functioning and application of fuzzy logic and neural networks. Classical & Fuzzy Sets: Properties, Operations and relations, Fuzzy sets, Membership, Uncertainty, fuzzy relations, cardinalities, membership functions. Fuzzy Logic System Components: Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods. Introduction to Neural Networks: Biological and Artificial Neuron Models, Characteristics, McCulloch-Pitts Model. Essentials of Artificial Neural Networks: Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules. Single Layer and Feed Forward Neural Networks. Associative Memories: Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory, Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms, Architecture of Hopfield Network. Applications.

Suggested Books:

1. S. Haykins, "Neural Networks- A comprehensive foundation", Pearson Education, 1999.
2. S. Rajasekharan and G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications", PHI Publication, 2003.
3. J. Yen, R. Langari, "Fuzzy Logic: Intelligence, Control and Information", First Edition, Pearson, 1998.
4. J.A. Freeman, D. Skapura, "Neural Networks", Pearson Education, 2002.

SWE5309 Software Project Management

This course contains topics of Project Management concepts, Process Framework, Project Planning Software Life Cycle Models, Artifacts of the Project Management Process, Cost and Scheduling Estimation Models, Project Management Techniques, Project Closure, Software Project Management Renaissance, Advance Topics in Software Project Management

Suggested Books:

1. W. S. Humphrey, "Managing the Software Process", Pearson Education, 1990.
2. W. Royce, "Software Project Management", Pearson Education, 2002.
3. P. Jalote, "Software Project Management in Practice", Pearson Education, 2002.
4. B. Hughes, "Software Project Management", Tata McGraw Hill, 1995.

SWE5201 SEMINAR

SWE5203 Probability and Statistics

This course contains topics of Introduction to Probability theory, Through set and Relative Frequency: Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability and Axioms, Probability as a Relative Frequency, Joint and Conditional Probability, Random Variables, Distribution Function, Density Function, Operations on Random Variables, Sampling Distributions, Estimation, Testing of Hypotheses, Neyman-Pearson Fundamental Lemma, , Chi-square goodness of fit test and its applications, problems.

Suggested Books:

1. P. Peebles, "Probability random variables and random signal principles", Fourth Edition, Mc Graw Hill, 2013.
2. A. Poupolis, S. Pillai, "Probability: Random Variables and Stochastic Processes and Probability", Fourth Edition, Mc Graw Hill, 2017.
3. D. A. Lind, W. G. Marchal and S. A. Wathen, "Statistical Technics in Business and Economics", Thirteenth Edition, Tata McGraw Hill, 2007.

SEMESTER II

SWE502 Software Testing

The goal of the course is to make one understand software testing concepts and applications. Introduction: Software Failures, Testing Process, Some Terminologies, Limitations of Testing, The V Shaped Software Life Cycle Model. Functional Testing: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique. Essentials of Graph Theory: Graph introduction, Matrix Representation of Graphs, Paths and Independent Paths, Generation of a Graph from Program, Identification of Independent Paths. Structural Testing: Control Flow Testing, Data Flow Testing, Slice Based Testing, Mutation testing. Selection, Minimization and Prioritization of Test Cases for Regression Testing: Regression Testing, Regression Test Cases Selection, Reducing the Number of Test Cases, Risk Analysis, Code Coverage Prioritization Technique. Software Testing Activities: Levels of Testing, Debugging, Software Testing Tools. Web Based Testing: Functional Testing, User Interface Testing, Performance Testing, Configurability Testing, Database Testing, Security Testing.

Suggested Books:

1. Y. Singh, "Software Testing", 1st Ed., Cambridge University Press, 2012.
2. P. C. Jorgenson, Software Testing A Craftsman's approach, CRC Press, 1997.
3. B. Beizer, "Software Testing Techniques", Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.

SWE504 Empirical Software Engineering

The goal of the course is to instill the concepts and applications of empirical software engineering. Introduction: What Is Empirical Software Engineering? Overview & Types of Empirical Studies, Empirical Study Process, Ethics, Importance and Basic Elements of Empirical Research, Some Terminologies. Systematic Literature Review, Software Metrics, Experimental Design, Mining Data from Software Repositories, Data Analysis and Statistical Testing, Model Development and Interpretation, Validity Threats, Reporting Results, Mining Unstructured Data, Case Study & Tools.

Suggested Books:

1. R. Malhotra, "Empirical Research in Software Engineering: Concepts, Analysis & Applications", CRC press, 2016.
2. B. Boehm, H. D. Rombach, M. V. Zelkowitz, "Foundations of Empirical Software Engineering: The Legacy of Victor R. Basili", Springer, 2010.

SWE5402 Software Design Patterns

This course gives an overview of software architecture and the various design patterns used. Envisioning Architecture: Defining, documenting and reconstructing software architecture. Creating Architecture: Quality Attributes, Moving from quality to Architecture, Architectural styles and patterns, Operations, Achieving qualities, shared information systems. Analyzing Software Architecture: Analyzing development qualities at the architectural level, SAAM, ATAM, CBAM, Architecture Reviews. Moving from Architecture to Systems Software: Product Lines, Building systems from off the shelf components, Reuse of Architectural assets within an organization. Patterns Definition: Pattern categories, Pattern Description, Patterns and Software Architecture, Pattern Systems, Classification, Selection, Design Patterns Catalog Creational Pattern, Structural Pattern, Behavioral Patterns, Pattern Community, Designing a document editor. Advanced studies.

Suggested Books:

1. E. Gamma, R. Helm, R. Johnson, J. Vlissides, G. Booch, "Design Patterns: Elements of Reuseable Object-Oriented Software", Addison Wesley, 1997.
2. L. Bass, P. Clements, R. Kazman, "Software Architecture in Practice", Pearson, 2013.
3. F. Buschmann, R. Meunier, H. Rohnert, P. Sommerlad, M. Stal, "Pattern-Oriented Software Architecture, A System of Patterns", First Edition, Wiley, 2013.

SWE5404 Soft Computing

This course contains topics of Soft Computing & Artificial Intelligence, Applications of Soft Computing, AI Search Algorithm, Predicate Calculus, Rules of Interference, Semantic Networks, Frames, Objects, Hybrid Models. Artificial Neural Networks, Back propagation Networks, Applications of NN. Fuzzy Logic and Fuzzy Sets , Fuzzy Arithmetic, Neuro - Fuzzy Modeling , Genetic Algorithms and Swarm Optimizations: Fitness Computations, Evolutionary Programming, Genetic Programming Parse Trees, Variants of GA, Applications.

Suggested Books:

1. S. Patnaik, B. Zhong, "Soft Computing Techniques in Engineering Applications", Springer, 2014.
2. H. J. Krogh, R.G. Palmer, "Introduction to the Theory of Neural Computation", Addison-Wesley, 1991.
3. M. Mitchell, "An Introduction to Genetic Algorithm", PHI, 1998.
4. S. Kaushik, "Artificial Intelligence", Cengage Learning, 2007.
5. J.A. Anderson, "An Introduction to Neural Networks", MIT Press, 1997.
6. G.J. Klir & B. Yuan, "Fuzzy Sets & Fuzzy Logic", PHI, 1996.

SWE5406 Machine Learning

The objective is to make the student understand the different supervised, unsupervised and reinforcement learning algorithms and choose the appropriate machine learning tool for different real-world examples. This course contains topics Machine Learning, Types of Machine Learning :Supervised, Unsupervised Learning, Reinforcement Learning, Categories of Supervised Learning; Predictive Modeling, Steps in Model Prediction: Metric Data Analysis, Attribute Reduction, Hypothesis Testing, Performance Evaluation Measures, Model Development, Model Development, Model Validation, Model Comparison Tests, Decision Trees, Artificial Neural Networks (Single-Layer Networks, Multi-layer Perceptron, Nearest Neighbor, Computing Distance. Dimensionality Reduction, Ensemble Learning. Research applications.

Suggested Books:

1. T. Mitchell, "Machine Learning", McGraw Hill, 1997.
2. S. Shalev-Shwartz, S. Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
3. J. D. Kelleher, B. M. Namee, A. D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies", MIT Press, 2015.

SWE5408 Big Data Analytics

The objective is to get students exposed with the basic rudiments of business intelligence system, understand the modeling aspects behind business intelligence and understand the business intelligence life cycle and the techniques used in it. This course contains topics of Evolution of Big data, Big data characteristics, Big Data Use Cases, Advanced Analytical Theory and Methods, K-means, Decision Tree, Advanced Analytical Theory and Methods-Association Rules, Naïve Bayes, Bayes' Theorem, Naïve Bayes Classifier. Stream Memory, NoSQL Data Management For Big Data And Visualization, Review of Basic Data Analytic Methods using R.

Suggested Books:

1. P.C. Zikopoulos, C. Eaton, D. Deroos, T. Deutsch, J. Lapis, "Understanding Big Data", McGraw Hill, 2012.
2. J. Leskovec, A. Rajaraman, J. D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
3. B. Lublinsky, K.T. Smith, A. Yakubovich, "Professional Hadoop Solutions", Wiley, 2015.
4. T. White, "HADOOP: The definitive Guide", O Reilly, 2012.

SWE5410 Wireless and Mobile Computing

This course covers topics of Network Technologies and Cellular Communications, Discussion on Bluetooth & GSM. Introduction to Mobile Computing, Medium Access Control, Mobile Architecture, Mobile Network Layer, Mobile Transport Layer, Mobile Ad hoc Networks (MANETs), Wireless Sensor Networks, Protocols and Tools: Wireless Application Protocol WAP. (Introduction, protocol architecture, and treatment of protocols of all layers), J2ME and latest technologies.

Suggested Books:

1. R. Kamal, "Mobile Computing", Second Edition, Oxford Higher Education, 2002.
2. W. Stallings, "Wireless Communication and Networks", Pearson Education, 2003.
3. V. Garg, J. Wilkes, "Wireless and Personal Communications Systems", Prentice-Hall, 1996.
4. M. LotherMerk, S. Nicklaus, T. Stober, "Principle of Mobile Computing", Second Edition, Springer, 2003.

SWE5302 Minor Project II

SWE5304 Optimization Techniques

This course contains topics of Introduction to Linear Programming, Graphical method, The Simplex Method, Post optimality Analysis, Duality Theory and Sensitivity Analysis, Dynamic Programming, Integer Programming, Nonlinear Programming, Queuing Theory.

Suggested Books:

1. H.A. Taha, "Operations Research", Ninth Edition, Pearson Education, 2011.
2. J.K. Sharma, "Operations Research", Third Edition, Mcmillan, 2007.
3. F. Hiller & J. Lieberman, "Operations Research", Eighth Edition, Tata McGraw Hill, 2005.
4. K. Swarup, P.K. Gupta, M. Mohan, "Operations Research", Sultan Chand & Sons, 2017.

SWE5306 Pattern Recognition

This course contains topics of Pattern Recognition, Feature Detection, Classification, Review of Probability Theory, Conditional Probability and Bayes Rule, Decision Theory, Sufficient Statistics, Template-based Recognition, Feature Extraction, Eigenvector and Multilinear Analysis, Training Methods, Maximum Likelihood and Bayesian Parameter Estimation, Linear Discriminant/Perceptron Learning, Optimization by Gradient Descent. Support Vector Machines, K-Nearest-Neighbor Classification, Non-parametric Classification, Unsupervised Learning Algorithms, Linear Dynamical Systems, Kalman Filtering, Bayesian Networks.

Suggested Books:

1. R. O. Duda, P. Hart, D. Stork, "Pattern Classification", Second Edition, Wiley, 2000.
2. C.M. Bishop,"Pattern Recognition and Machine Learning", Springer, 2007.
3. C.M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995.
4. S. Theodoridis, K. Koutroumbas, "Pattern Recognition", Fourth Edition, Academic Press, 2008.

SWE5308 Distributed Systems

This course covers topics of Distributed System Models, Transparency, Scalability, Inter-process Communication, Middleware, issues in design of Distributed systems: current & future, Communications, Process and Synchronization, Serializability, Resource

Allocation, Distributed Shared Memory, Process Scheduling, Load Balancing & Load Sharing, Mutual Exclusion, Election algorithms. Distributed File Systems Overview of security techniques, Cryptographic algorithms , Digital signatures, Cryptography pragmatics.

Suggested Books:

1. A. S. Taenbaum, M. V. Steen, "Distributed Systems: Principles and Paradigms", Prentice Hall, 2015.
2. G. Coulouris, J. Dollimore, T. Kindberg, "Distributed Systems Concepts and Design", Addison Wesley, 1994.
3. A. Kshenkalyani, M.Singhal, "Distributed Computing", Cambridge University Press, 2008.

SWE5310 Natural Language Processing

This course contains topics Phases in natural language processing, applications. Words and Word Forms, Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields. Morphology, acquisition models, Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality, Web 2.0 Applications.

Suggested Books:

1. D. Jurafsky, J. H. Martin, "Speech and Language Processing", Second Edition, Pearson Education, 2009.
2. A. James, "Natural Language Understanding", Second Edition, Pearson Education, 1994.
3. A. Bharati, R. Sangal V. Chaitanya, "Natural Language Processing: A Paninian Perspective", PHI, 2000.
4. T. Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", OUP, 2008.

SWE5202 Research Methodology

This course contains topics of Foundation of Research and Problem Definition, Meaning, Objective and Importance of research, Types of research, steps involved in research, identification of research problem and its formulation. Research Design, Methods of research design, research process and steps involved, Literature Survey. Data Collection and Analysis,, Reporting of Research, Types of research report, Referencing and referencing styles, Indexing and citation of Journals, Reference management software like Mendeley, Intellectual property, Plagiarism.

Suggested Books:

1. C. R. Kothari, G. Garg, "Research Methodology Methods and Techniques", Third Edition, New Age International, 2019.
2. D. Cooper, P. Schindler, "Business Research Methods", Ninth Edition, Tata McGraw Hill, 2006.
3. J.W. Creswell, "Research design: Qualitative, quantitative, and mixed methods approaches", Sage publications, 2013.

SWE5204 Predictive Modelling

The course aims at introducing the framework of predictive modeling process to students. Introduction: classification & prediction, key ingredients of predictive models, goals of a regression analysis, regression models, data in a regression analysis. Data preparation: analyzing the metric data, outlier analysis, correlation analysis, attribute reduction methods, attribute extraction. Statistical tests: categories, one-tail and two-tail, Type I and Type II errors, interpreting significance results. Model Development: data partition, attribute reduction, model construction, model validation, hypothesis testing, results interpretation, cross-validation.

Hypothesis testing and model-comparison tests. Model evaluation: performance measures for categorical and continuous dependent variables, ROC analysis.

Suggested Books:

1. M. Kuhn and K. Johnson, "Applied Predictive Modelling", Springer Verlag, 2013.
2. R. Malhotra, "Empirical Research in Software Engineering: Concepts, Analysis & Applications", CRC press, 2016.
3. E.E. Frees, E.W. Derrig, and G. Meyers, "Predictive Modeling Techniques in Actuarial Science", Vol. I: Predictive Modeling Techniques. Cambridge University Press, 2014.

SWE5206 Operational Research

This course aims at familiarizing the students with quantitative tools and techniques, which are frequently applied to business decision-making. Introductory linear algebra: system of linear equations, matrices, rank and determinant of a matrix, linearly dependent and independent vectors, basis of a matrix. Linear programming: optimization problems, introduction to LP formulation, convex sets, extreme points, geometry of linear programs, basic feasible solutions, neighborhoods, local and global optima, profitable column, pivoting, simplex algorithm, graphical method. Duality: definition of the dual problem, primal-dual relationships, economic interpretation of duality, complementary slackness conditions. Transportation models: transportation algorithm, assignment model, hungarian method. Queuing models: elements of queuing model, exponential distribution, poisson distributions, poisson queuing models, single server model, multiple server model.

Suggested Books:

1. G. Hadley, "Linear Programming", Narosa, 2002.
2. H. A. Taha, "Operations Research-An Introduction", Prentice Hall, 8th Edition, 2008.
3. A. Ravindran, D. T. Phillips and J. J. Solberg, "Operations Research-Principles and Practice", John Wiley & Sons, 2005.

SEMESTER III

Major Project I

SWE6401 Advances in Software Engineering

A primary goal of this course is to introduce advanced software engineering concepts and their usefulness. Topics include formal methods used in software development, cleanroom software engineering including its specification, design and testing, component-based software engineering, the process of web engineering and testing web applications, reengineering of business process and software, reverse engineering, restructuring and forward engineering, along with various approaches and tools for automated test data generation.

Suggested Books:

1. Y. Singh, "Software Testing", Cambridge University Press, 2012.
2. R.S. Pressman, "Software Engineering: A Practitioner's Approach", 7th Edition, Mc Graw Hill, 2017.
3. F. Buschmann, R. Meunier, H. Rohnert, P. Sommerlad, M. Stal, "Pattern-Oriented Software Architecture", John Wiley, 1996.

SWE6403 Cloud Computing

The goal of this course is to introduce the concepts and applications of cloud computing. Overview of Computing Paradigm and introduction to cloud computing: Recent trends in computing, Evolution of Cloud Computing, Cloud service providers, Properties, Characteristics & Disadvantages, Cloud computing vs. Cluster computing vs. Grid computing, Role of Open Standards. Cloud computing architecture, Role of networks and web services in cloud computing, Service models, Deployment Models. Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS). Service management in Cloud Computing, Cloud Security.

Suggested Books:

1. B. Sosinsky, "Cloud Computing Bible", Wiley, 2010.
2. R. Buyya, J. Broberg, A. M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley, 2011.
3. N. Antonopoulos, L. Gillam, "Cloud Computing: Principles, Systems and Applications", Springer, 2012.
4. R. L. Krutz, R. D. Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley, 2010.

SWE6405 Things of the Internet

This course contains topics of Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT communication models, Iot Communication APIs IoT enabaled Technologies , IoT and M2M , Introduction to Python , IoT Physical Devices and Endpoints , IoT Physical Servers and Cloud Offerings – Introduction to Cloud Storage models and communication APIs Webserver – Web server for IoT, Cloud for IoT, Python web application framework designing a RESTful web API.

Suggested Books:

1. A. Bahga, V. Madisetti, "Internet of Things – A Hands-on Approach", University Press, 2015.
2. M. Richardson, S. Wallace, "Getting Started with Raspberry Pi", O'Reilly, 2014.
3. J. Holler, V. Tsiatsis, C. Mulligan, S. Avesand, S. Karnouskos, D. Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", First Edition, Academic Press, 2014.
4. B. Scholz-Reiter, F. Michahelles, "Architecting the Internet of Things", Springer, 2011.

SWE6407 Multimedia Applications

This course contains topics of Introduction to Multimedia Systems Architecture and Components, Multimedia Distributed Processing Model, Synchronization, Orchestration and Quality of Service Architecture. Usage of Text in Multimedia, Families and Faces of Fonts, Outline Fonts, Bitmap Fonts International Character Sets and Hypertext, Digital Fonts Techniques. Audio and Speech , Images and , Multimedia and Hypermedia, Hypermedia Presentation.

Suggested Books:

1. T. Vaughan, "Multimedia: Making it work", Tata McGraw-Hill, Ninth Edition, 2017.

2. R. Aggarwal, B. B Tiwari, “Multimedia Systems”, Excel Publication, 2007.
3. Z. Li & M.S. Drew, “Fundamentals of Multimedia”, Pearson Education, 2009.
4. D. Hillman, “Multimedia Technology and Application”, Galgotia Publication, 2000.

SWE6409 Information Theory and Coding

This course is an introduction to various information theory concepts and applications. Introduction to Probability, Elementary Theorems, Random Variable, Uncertainty and Information, Shannon Entropy, Joint and conditional Entropies Mutual Information, Uniquely decipherable and Instantaneous codes, Noiseless coding problem. Source coding Theorem, Block coding, construction of Optimal codes, Huffman’s & Shannon – Fano methods. Discrete memory less channel, channel capacity BSC and other channels. Information measure for continuous ensembles capacity of AWGN channel. Error control coding. The channel coding Theorem, Application to BSC , Source Coding with fidelity criteria. Types of codes, error and error control strategies, Linear block codes, syndrome and error detection, Minimum distance, Error detecting and correcting capabilities of a block code, Syndrome decoding, Hamming codes. Cyclic codes, Generator and parity, Latest Research.

Suggested Books:

1. R. B. Ash, “Information Theory”, Dover Science Publications, 1965.
2. T. M. Cover, J.A. Thomas, “Elements of Information Theory”, John Wiley & Sons, 2006.
3. S. Lin, D. J. Costello Jr, “Error Control coding: Fundamental & Application”, Prentice Hall, 1983.
4. C. E. Shannon, W. Weaver, “A Mathematical Theory of Communication”, University of Illinois Press, 1998.

SWE6301 Agile Methods

This course is an introduction to agile methodology and how it is practiced. Introduction: Iterative development, evolutionary and adaptive development, evolutionary requirement analysis, evolutionary and adaptive planning, incremental delivery, evolutionary delivery. Agile and its significance: Classification of methods, the agile manifesto, agile project management, sustainable discipline, research evidence. Agile Methodology: Overview, lifecycle work products, roles and practices values, sample projects, adoption strategies. Case Study. Agile Practicing and Testing.

Suggested Books:

1. C. Larman, “Agile and Iterative Development – A Manager’s Guide”, Pearson Education, 2004.
2. Elisabeth Hendrickson Quality Tree Software Inc, “Agile Testing”, 2008.
3. A. Cockburn, “Agile Software Development series”, Safari Books, 2001.

SWE6303 Software Reliability

This course gives a detailed introduction to software reliability concepts, how it can be measured and improved. Introduction to System Reliability: Reliability mathematics, probability distributions, system reliability, maintainability and availability, designing for higher reliability, redundancy. System Reliability Concepts: Software and hardware reliability, basic concepts, reliability model classification, software reliability growth models, markovian models. Non-homogeneous poisson process models: NHPP models, Musa models, Okumoto model, Yamada delayed S-shaped model, Imperfect debugging models, Kapur- Garg model, Subburaj-

Gopal model for the learning phenomenon, Subburaj-Gopap-Kapur versatile debugging model. Comparison of software reliability models. Advanced topics in software reliability.

Suggested Books:

1. J. D. Musa, A. Iannino, K. Okumoto, "Software Reliability – Measurement, Prediction, Application, Series in Software Engineering and Technology", McGraw Hill., 1987.
2. M. Lyu, "Handbook of Software Reliability Engineering", IEEE Computer Society Press, 1996.
3. J. D. Musa, "Software Reliability Engineering", Tata McGraw Hill, 1999.
4. P. D. T. O'Connor, "Practical Reliability Engineering", Fourth Edition, John Wesley & sons, 2003.

SWE6305 Cluster and Grid Computing

This course contains topics of Cluster and Grid computing, Meta-computing, Web services and Grid Computing, e-Governance and the Grid, OGSA and WSRF, Technologies and Architectures for Grid Computing- Issues, Functional requirements, Web Services and the Service Oriented Architecture, Globus Toolkit, GT4 Architecture, GT4 Containers, The Grid and Databases, Cluster Computing, Cluster Middleware, Networking, Protocols and I/O for clusters, Setting Up and Administering a Cluster, Cluster Technology for High Availability, Process Scheduling, Load Sharing and Load Balancing.

Suggested Books:

1. W. Gropp, E. Lusk, T. Sterling, "Beowulf Cluster Computing with Linux", Second edition, MIT Press, 2003.
2. B. Jacob, M. Brown, K. Fukul, N. Trivedi, "Introduction to grid computing", IBM, 2005.
3. G. F. Pfister, "In Search of Clusters: The ongoing battle in lowly parallel computing", Second Edition, PHI, 1998.
4. C.S.R. Prabhu, "Grid and Cluster Computing", PHI, 2008.
5. R. Buyya, "High Performance Cluster Computing: Architectures and Systems", Volume 1, Pearson Education, 2008.

SWE6307 Software Quality & Metrics

The primary objective of the course is to make one understand software quality concepts and associated metrics to deliver good quality maintainable software. Introduction to software quality: What is software quality? software quality attributes, elements of a quality system, software quality models. Software metrics, their categories and application areas, measurement scales, analyzing metric data, metrics for measuring size, structure and software quality. Software maintenance: categories, challenges, maintenance of object-oriented software, software rejuvenation, estimation of maintenance effort, configuration management, regression testing. Case study pertaining to software quality improvement.

Suggested Books:

1. Y. Singh, R. Malhotra, "Object-Oriented Software Engineering", PHI Learning, 2012.
2. S.H. Kan, "Metrics and Models in Software Engineering", Second Edition, Pearson Education, 2003.
3. A. Basu, "Software Quality Assurance Testing and Metrics", PHI Learning, 2015.

SWE6309 Swarm and Evolutionary Computing

The course is designed to introduce the basic concepts of evolutionary and swarm computing along with their applications. Introduction to Evolutionary Computing: Components, global optimization, evolution strategies, fitness functions, learning classifier systems, parameter control, multi-modal problems. Swarm Intelligence: Its application to optimization problems, particle

swarm optimization. Genetic Algorithm: Basics, reproduction, cross-over and mutation, Genetic algorithm convergence, Genetic programming. Hybrid Methods and Multi-objective Evolutionary Algorithms: Variants of Particle Swarm optimization and Genetic Algorithm, their hybridization, hybrid Multi-objective Optimization algorithms. Other recent algorithms: Cockoo search algorithm, Artificial Bee Colony Optimization, Ant Colony Optimization, Fire-fly algorithm, Bacterial Foraging, Application to the travelling salesman problem. Application to real world optimization problems.

Suggested Books:

1. A. P. Engelbrech, "Computational Intelligence", Second Edition, John Wiley & Sons, 2008.
2. M. Mitchell, "An Introduction to Genetic Algorithm", MIT Press, 1996.
3. D. Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Addison-Wesley, 1989.
4. A.E Eiben, J.E. Smith, "Introduction to Evolutionary Computing", Second Edition, Springer, 2007.
5. K. DeJong, "Evolutionary Computation: A Unified Approach", MIT Press, 2006.

SWE6201 Data Security & Privacy

This course contains topics of Introduction to Data Security, Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, Modern Block Ciphers, Public-key cryptography Principles, Latest Trends and solutions in Information Security, IP Security, Web Security: Secure Socket Layer(SSL) and transport layer security, TSP, Secure Electronic Transaction (SET), Electronic money, WAP security, firewall design principals, Virtual Private Network (VPN) security.

Suggested Books:

1. W. Stallings, "Cryptography and Network Security", William Stallings, Seventh Edition, PHI, 2017.
2. Jan C A, "Basic Methods of Cryptography", Cambridge University Press, 2000.
3. T. Calabrese, "Information Security Intelligence: Cryptographic Principles & Applications", Thomson Learning., 2003.
4. W. Mao, "Modern Cryptography: Theory and Practice", Pearson Education, 2003.
5. D. Elizabeth, R. Denning, "Cryptography and Data Security", Addison Wesley, 1992.

SWE6203 Bio-Informatics

This course contains topics of Algorithms For Bioinformatics, Pattern Matching And Clustering, Exact Pattern Matching , Clustering Basics, Multiple Sequence Alignment: Bioinformatics – Techniques And Applications, Words method of alignment, Macromolecular Structure Analysis , Numerical And Biostatistical Methods: Distributions – Binomial, Poisson and Normal, Handling Univariate, Bivariate and Multivariate data- Introduction to Probabilities, Interval Estimation.

Suggested Books:

1. N. C. Jones, P. A. Pevzner, "An Introduction to Bioinformatics Algorithms", MIT Press, 2005.
2. C. Gibas, P. Jambeck, "Developing Bioinformatics Computer Skills", O'Reilly Media,Inc, 2001.
3. S. Schulze-Kremer, "Molecular Bioinformatics: Algorithms and Applications", Walter de Gruyter, 1996.
4. G. W. Collins, "Fundamental Numerical Methods and data analysis", Harvard university Press, 2003.

SWE6205 Statistical Tools

This course contains topics of Review of Probability and Distributions, Rules for probability, random variables and their distributions, moments, special discrete and continuous distributions, laws of large numbers and central limit theorem, sampling distributions. Parametric Methods, Testing of Hypotheses , Multivariate Analysis, Nonparametric Methods, Kolmogorov Smirnov one sample statistics, sign test, Wilcoxon signed rank statistics, two sample problems, Mann-Whitney-Wilcoxon tests, scale problems, KolmogorovSmirnov two sample criterion, Hoeffding's U-statistics.

Suggested Books:

1. V.K. Rohatgi, A.K. Md.E.Saleh, "An Introduction to Probability and Statistics", Wiley, 2008.
2. S.M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Fifth Edition, Academic Press, 2014.
3. E.J. Dudewicz, S.N. Mishra, "Modern Mathematical Statistics", Wiley, 1988.
4. T. W. Anderson, "An Introduction to Multivariate Analysis", Wiley, 2009.
5. J.D. Gibbons, S. Chakraborti, "Nonparametric Statistical Inference", Fourth Edition, Marcel Dekker, 2003.