Computer Engineering (MS with Thesis)

Course Requirements

The Master of Science in Computer Engineering program consists of at least seven 3 credit hours courses, making a total of 21 credit hours of course work, in accordance with the EMU by-laws. Students accepted in probation status must complete the undergraduate courses assigned to them by the Graduate Committee, and pass these courses, before they can become regular MS students. Graduate courses shall be selected by the student from the computer Engineering Department graduate curriculum, or from another related graduate curriculum, under the supervision of his/her thesis supervisor, or with the consent of the Graduate program supervisor of the Department.

Thesis Requirements

All MS students are required to prepare and defend an MS thesis under the supervision of a faculty member approved by the Department. Every student must find an MS thesis supervisor, the latest at the end of the first semester of his/her graduate study. The MS thesis should present the results of scholarly investigation of a topic related with the field of Computer Engineering. An MS student should complete all the required studies, including courses and thesis work, within the minimum and maximum time set by the EMU by laws.

The courses covered in the program are as follows:

Ref. Code	Course Code	Course Name	Credit
255R0	CMPE500	M.S. Thesis	0
255RS	CMPE598	Seminar	0
255R1	RES1	Restricted Elective Course	3
255R2	RES2	Restricted Elective Course	3
255R3	RES3	Restricted Elective Course	3
255R4	RES4	Restricted Elective Course	3
255R5	REQ1	Elective Course	3
255R6	REQ2	Elective Course	3
255R7	REQ3	Elective Course	3

RESTRICTED ELECTIVE COURSES**

** All Computer Engineering MS courses (CMPE5XX) will be considered in this list:

CMPE 523 Parallel and Distributed Programming

CMPE 528 Computational Principles of Robotics

CMPE 531 Logic Programming

CMPE 532 Constraint Programming

CMPE 534 Automated Deduction

CMPE 535 Knowledge Engineering

CMPE 536 Metaheuristics

CMPE 537 Evolutionary Neuro-Fuzzy Systems

CMPE 538 Evolutionary Multi-Objective Optimization

CMPE 539 Multiagent Systems

CMPE 541 Networks and Distributed Systems

CMPE 542 Advanced Networks

CMPE 543 Randomized Algorithms

CMPE 547 Queuing Networks for Computer Applications

CMPE 548 Analysis of Computer Communication Networks

CMPE 549 Wireless Personal Communications

CMPE 551 Database Theory

CMPE 552 Database and File Security

CMPE 553 Cryptography and Network Security

CMPE 554 Introduction to Natural Language Processing

CMPE 556 Information Retrieval

CMPE 558 Data Mining

CMPE 561 Neural Networks

CMPE 562 Pattern Recognition

CMPE 564 Ensemble Learning

CMPE 572 Digital Forensics

CMPE 573 Computer Vision

CMPE 574 Biometrics

CMPE 576 Advanced Systems Simulation

CMPE 581 Modeling Multimedia Systems

CMPE 583 Web Semantics

CMPE 586 Software Implementation of Fuzzy Systems

ELECTIVE COURSES***

*** Students may take Restricted Elective Computer Engineering MS courses (CMPE5XX), or Software Engineering MS courses (CMSE5XX), or other Engineering Faculty MS courses, or at most 1 non-engineering course by the approval of their thesis supervisors.

Course Descriptions

CMPE500 Thesis

The MS thesis should be carried out under the supervision of a faculty member (thesis supervisor) and present the results of scholarly investigation of a topic related with the field of Computer Engineering. The thesis report should be written according to the Graduate Institute's rules and must be submitted to the Department at least 15 days before the jury date.

CMPE 523 Parallel and Distributed Programming (3 / 0) 3

Types of parallel systems and their peculiarities, approaches for programming supercomputers using various versions of FORTRAN language, OCCAM and ANSI C languages for transputer systems, C and Assembler languages for parallel neuro-processor, using of parallel constructions in Win32 operating systems, using of parallel programming in the distributed environment on the base of CORBA, DCOM approaches for Win32 and PVM for Unix.

CMPE 528 Computational Principles of Robotics (3 / 0) 3

Computational Principles of Robotics course covers an introduction to robotics, the kinematics of manipulators, differential motion relations, robot dynamics, path and trajectory planning, actuators, sensors, vision systems, and computational intelligence through fuzzy logic at an introductory level. The course include project to develop a simulation software for each section of the course material, yielding to an intelligent robotic simulation tool for two-link robot arm.

CMPE 531 Logic Programming (3 / 0) 3

Declarative Prolog programming, unification and resolution, backtracking, cut and fail, nondeterminism, representation of data structures, meta-programming, constraint-logic programming, parallel Prolog.

CMPE 532 Constraint Programming (3 / 0) 3

Constraint programming is a programming paradigm in which a set of constraints that a solution to a problem must satisfy are specified rather than set of steps to obtain such a solution. Techniques used in constraint programming come from diverse fields such as artificial intelligence, computational logic and operations research. The process of solving problems by only stating constraints which must be satisfied by a solution to a problem involves modeling the problem by means of a set of variables, each ranging over a specific domain, and constraints to restrict the variables' domain values. Constraint problems can then be specified and solved by means of a constraint

programming language. The aim of this course is to create an understanding of the fundamental concepts underlying constraint programming, develop skills in modeling and solving combinatorial optimization problems, and provide an opportunity for applying constraint solving techniques to real-life problems using a modern constraint programming environment. Topics covered will include constraints and valuations, modeling with constraints, constraint satisfaction, examples of constraint domains, constraint simplification, optimization, the Simplex algorithm, backtracking, node and arc consistency, constraint logic programming (CLP), modeling in CLP, using data structures, controlling search, advanced programming techniques and incremental constraint solving.

CMPE 534 Automated Deduction (3 / 0) 3

This course is about automatically (and mechanically) proving theorems in first order predicate calculus. Introduction to propositional logic, predicate calculus and proof methods. Herbrand's theorem. The resolution principle (in its various forms) as the theoretical background for the programming language Prolog. Paramodulation, term rewriting systems and e-unification under equational logic. Applications of automated reasoning.

CMPE 535 Knowledge Engineering (3 / 0) 3

An overview of AI, Knowledge-based systems - a survey, Knowledge Engineering concepts; Human Problem Solving, Human Information Processing System, Cognition Models; Knowledge Acquisition; Knowledge Representation, Production Rules; Inference, Forward Chaining, Backward Chaining, Mixed Chaining; Uncertainty, Certainty Factors, Bayesian, Fuzzy set based and Dempster-Shafer methods; Automated Knowledge Acquisition, Machine Learning Approaches in Expert Systems, Rule and Decision-Tree Induction; Connectionist expert systems; Expert System Building Tools, Development languages, Shells, Environments; Expert system design using rule-based shells; Expert system development life-cycle; Blackboard architectures; Truth Maintenance Systems.

CMPE 536 Metaheuristics (3 / 0) 3

Heuristics and meta-heuristics, neighborhood search, local and global optimization, simulated annealing, greedy randomized adaptive search, tabu search, evolutionary algorithms, ant-colony optimization, Lagrangean relaxation, hybrid methods, performance evaluation oh metaheuristics.

CMPE 537 Evolutionary Neuro-Fuzzy Systems (3 / 0) 3

Evolutionary algorithms: genetic algorithms, evolutionary programming and evolution strategies. Discussion of algorithmic aspects and case studies with evolutionary algorithms. Artificial neural networks: artificial neurons, networks of artificial neurons, neural learning, supervised and unsupervised learning. Discussion of implementation aspects through case studies. Fuzzy systems: fuzzy sets, fuzzy relations, the extension principle, fuzzy logic, fuzzy inference and fuzzy rule-base systems, defuzzification methods. Applications of fuzzy systems. Evolutionary design of artificial neural networks: evolving weights in a predefined network, evolving network architecture, evolving learning rules, ANN input data selection. Evolutionary design of fuzzy systems: evolutionary design of fuzzy rule-based systems, evolving fuzzy decision trees, evolving

fuzzy filters. Neuro-fuzzy systems: Fuzzy neural networks, cooperative neuro-fuzzy systems. Fuzzy evolutionary algorithms: Fuzzy control of evolution, evolutionary algorithms with fuzzy components.

CMPE 538 Evolutionary Multi-Objective Optimization (3 / 0) 3

This graduate-level course introduces the basic concepts of evolutionary and other nature-inspired multi-objective optimization techniques. The course starts with an introduction to multi-objective optimziation. Basic definitions, notations, quality assessment methods, and benchmarking principles are introduced. This lecture is followed with the introduction of fuzzy sets, fuzzy numbers, fuzzy functions, and formulation of fuzzy multiobjective optimization. In the third part of the lectures, basic evolutionary and nature-inspired metaheuristics are described together with principles of their practical implementations. In this respect, multiobjective implementation details are given a special emphasis. The fourth and the final phase of lectures cover the use of nature-inspired metaheuristics for fuzzy multiobjective implementation. Case studies on fuzzy versions of well-known multiobjective optimization problems are studied in detail. This is a unique course where students get an exposure to latest developments in soft computing, particularly nature-inspired methods and fuzzified formulation of well-known problems of practical importance. Strengths and weaknesses of the presented approaches are highlighted. The course also discusses a number of current research issues, besides discussing a number of interesting case studies. Active student participation is necessary in lectures. The students, by the end of this course, are expected to get a detailed understanding of nature-inspired methods in fuzzy multiobjective optimization.

CMPE 539 Multiagent Systems (3 / 0) 3

Introduction to the concepts of autonomous agents and multiagent systems: intelligent autonomous agents, reactive and hybrid agents. Autonomous agents as rational decision makers: utility function, Markov decision problems and optimal policies. Interaction between agents: agent communications, rules of conversation, social choice and voting methods. Cooperative interaction between agents: modeling learning as cooperative interaction of multiple agents, distributed constraint satisfaction problems. Competitive interactions between agents: introduction to game theory, noncooperative and cooperative games, prisoners dilemma, negotiations, auctions, and voting mechanisms. Real- world applications of agent-based systems.

CMPE 541 Networks and Distributed Systems (3 / 0) 3

Evolution of computer networks, distributed systems and distributed information processing. Basic characteristics of distributed systems. Design goals of distributed systems. Networking for distributed systems. Distributed systems and the Internet. TCP/IP protocols for distributed systems in the Internet. The role of the remote interprocess communication for distributed systems. Advanced Internet sockets and Remote Procedure Call (RPC). Group communication. Message ordering in group communication. Time and synchronization in distributed systems. Mutual exclusion and election in distributed systems. Distributed transaction processing. Concurrency control

of transactions. Handling with deadlocks. Survey of architectures and packages for the organization of distributed data processing. Formal techniques for the description and investigation of distributed systems.

CMPE 542 Advanced Networks (3 / 0) 3

Layered network systems, cross-layer design, design trade-offs; modeling network traffic, fluid models of network traffic, models for data, voice, and video traffic; access control: leaky buckets; flow and congestion control and models; broadband wireless, design challenges, recent trends and models; embedded network systems: deployment, data dissemination, coverage, and connectivity.

CMPE 543 Randomized Algorithms (3 / 0) 3

Fundamental tools of probabilistic analysis and applications of these tools to understand the behaviors of random processes and algorithms in modern computer science and engineering. Topics include moments and deviations, bounds, random graphs, the probabilistic method, Markov chains and random walks, entropy, the Monte Carlo method, coupling of Markov chains, martingales, pairwise independence and universal hashing.

CMPE 547 Queuing Networks for Computer Applications (3 / 0) 3

Basic probability and statistics overview, transforms, discrete and continuous time Markov chains, steady-state solutions of Markov chains, queuing systems, queuing networks and their applications in computer systems.

CMPE 548 Analysis of Computer Communication Networks (3 / 0) 3

Advanced topics in communication networks. Topics include Markov processes, renewal theory, queues, stochastic networks, network calculus, routing and congestion control, utility functions, max- min and proportional fairness.

CMPE 549 Wireless Personal Communications (3 / 0) 3

Wireless communication, mobile analog cellular telephony, GSM: channels, messages, mobility management, handoff issues, data and multimedia communication over mobile systems, recent advances in mobile systems, wireless ATM.

CMPE 551 Database Theory (3 / 0) 3

Predicate calculus, first-order logic, relational databases: representation, updating, querying, completeness, model theory, proof theory, incomplete and deductive databases.

CMPE 552 Database and File Security (3 / 0) 3

Confidentiality, discretionary security, multilevel security, security levels, Trojan horse, covert channel.

CMPE 553 Cryptography and Network Security (3 / 0) 3

This is a course on Cryptography and Network Security, objectives are: Classical encryption techniques, Block ciphers and the Data Encryption Standard, Basics of finite fields, Advanced Encryption Standard, Contemporary Symmetric Ciphers, Confidentiality Using Symmetric Encryption, Basics of Number Theory, Key Management; Other Public Key Cryptosystems , Message Authentication, Hash Functions and Algorithms, Digital Signatures and Authentication Protocols, Network Security Practice, Applications, E-Mail, IP and Web Security, System Security, Intruders, Malicious Software, Firewalls.

CMPE 554 Introduction to Natural Language Processing (3 / 0) 3

This course introduces the students to fundamental techniques used in Natural Language Processing. Topics covered include, morphological analysis, lexical acquisition, corpus based work, N-gram models, smoothing, Hidden Markov Models, Part-of-Speech tagging, Probabilistic context free grammars, probabilistic parsing, word-sense disambiguation, information extraction, text categorization, text mining, and machine translation.

CMPE 556 Information Retrieval (3 / 0) 3

Boolean retrieval, term vocabulary and postings lists, dictionaries and tolerant retrieval, index construction and compression, scoring, term weighting, vector space model, score computation in search systems, evaluation techniques in information retrieval systems, xml retrieval, probabilistic information retrieval, text classification using Naïve Bayes, vector space classification, use of support vector machines in information retrieval.

CMPE 558 Data Mining (3 / 0) 3

Data types, data preprocessing, measures of similarity, classification, classifier evaluation and comparison techniques, basic concepts in association, clustering analysis, cluster evaluation, anomaly detection, issues in multimedia mining and text mining.

CMPE 561 Neural Networks (3 / 0) 3

Human brain and biological neurons, artificial neuron models, the perceptron and the perceptron learning algorithm, the least-mean square algorithm, multilayer networks and the backpropagation algorithm, unsupervised and reinforcement learning, growth algorithms, Hopfield networks and other recurrent networks, simulated annealing, the Boltzmann machine, self-organizing systems.

CMPE 562 Pattern Recognition (3 / 0) 3

An introduction to probability and random variables, feature vectors, pattern classes, decision rule, discriminant function, Bayes decision rule, Bayes discriminant functions, minimum error classification, linear discriminant functions and their training, parametric classification, maximum likelihood estimation, Bayesian parameter estimation, clustering techniques, multiple classifier systems.

CMPE 564 Ensemble Learning (3 / 0) 3

Learning associations, classification, regression, unsupervised learning, supervised learning, linear discriminant classifier, quadratic discriminant classifier, decision trees, interpolation, k-means and fuzzy c-means clustering, abstract level fusion, voting, weighted voting, naive Bayesian fusion, Borda count method, diversity in ensembles, diversity generation methods, measures of diversity, measurement level fusion, linear and logarithmic opinion pools, decision templates, static and dynamic expert selection, bagging, random forests, boosting, Adaboost, random subspace method, cluster ensembles, majority vote clustering, evidence accumulation algorithm.

CMPE 572 Digital Forensics (3 / 0) 3

Introduction to digital forensics, file carving, cloning detection, camera-scanner-printer forensics, searching for suspects using visual attributes, spoofing creation and detection, multimedia phylogeny, computer-generated images versus digital photographs, information hiding by steganography and steganalysis.

CMPE 573 Computer Vision (3 / 0) 3

Introduction to computer vision, the goal of computer vision, applications of computer vision, special effects such as shape capture, motion capture and camera tracking, difficulties of computer vision, image formation, filtering, edge detection, feature detection and matching, segmentation, feature based alignment, structure from motion, image stitching, computational photography.

CMPE 574 Biometrics (3 / 0) 3

Introduction to biometrics, person recognition, modules of biometric systems, biometric functionalities: verification and identification, biometric system errors and performance measures, the design cycle of biometric systems, applications of biometric systems, face recognition, iris recognition, fingerprint recognition, additional biometric traits, introduction to multibiometrics.

CMPE 576 Advanced Systems Simulation (3 / 0) 3

Systems and their models. Analytical and simulation modeling. Structure of a discrete event simulation algorithm. Randomness in simulation. Queuing systems. Simulation languages and ools. Extended Petri Nets for simulation. Simulation experiments. Statistical processing of output results of simulation.

CMPE 581 Modeling Multimedia Systems (3 / 0) 3

Digital representations of multimedia information, multimedia devices and system architectures, interactive and distributed multimedia systems, programming environments, timed-automata and petri-ts, temporal synchronization models for multimedia systems, timed extensions of HTML, SMIL.

CMPE 583 Web Semantics (3 / 0) 3

Course will cover URI scheme; XML and processing; resource description framework (RDF): model, syntax, schema and languages; ontology concept, Web-based ontologies,

integration and interoperability, semantics and abstract syntax of OWL, DAML; semantic grid concept and applications; Web services and agents; best practice case studies; W3 Consortium, current activities and future directions.

CMPE 586 Software Implementation of Fuzzy Systems (3 / 0) 3

Uncertainty, imprecision and vagueness, fuzzy sets and systems, membership function design, inference principles and techniques, approximate reasoning, possibility distributions, fuzzy systems as universal approximators, fuzzy software packages, research fields in fuzzy theory.

CMPE 598 Seminar Course (3 / 0) 3

This course will be given as seminars by teaching staff covering their specialties and research interests of students. Students will write and present research reports.

Contact Information

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