MS Program in Advanced Computing Technologies

"With the emergence of chip multiprocessors, highly affordable high performance clusters and storage arrays, and globally spanning grids, advanced computing technologies and applications will be the key drivers of the IT industry in the 21st century"

- Dr Vijay Bhatkar

The sustained growth in the IT industry in India and all over the world with ever expanding arena of applications is driven by relentless advances in hardware technology. Over the years, not only the processor and memory speeds have enhanced but also several advances have taken place in the processor architecture. Latest to arrive on the scene is chip-multi processor architecture and placing several such chip-multi processors on a board to realize high performance servers. Interconnecting such servers in a cluster and grid architecture are creating next generation advanced computing infrastructures. Computer engineers now need to know such architectures, their emerging programming environments, parallel algorithms and a whole range of applications in both scientific and technical computing as well as in business and enterprise computing. This high-end course is designed to create such new generation computer engineers who can learn the emerging advanced computing technologies and applications.

Program

This four Semester 24-month, 72 Credits, full-time Master's Program in Advanced Computing Technologies is designed to equip students to acquire in-depth knowledge in the following areas:

- High Performance Computing Architecture
- Multi-Core Technology
- Parallel Algorithms and Programming
- Design and Development concepts of application solution with parallel architecture
- Grid Computing

Program Structure

- Successful completion requires 72 Credits.
- To bridge the gap between theory and practice project work worth 18 Credits should be completed in the last semester.
- The program is distributed over FOUR semesters. First three semesters are the academic semesters, comprising of theoretical courses, laboratory, seminar / mini project. The fourth semester is for the final project carrying 18 credit.
- The entire curriculum is distributed over six levels to aim at transcending the students' level of understanding for corporate readiness. The levels are respectively, Bridge, Foundation, Core, Advanced, Electives and Project.
- Students are allowed to take 9 credit courses from this program stream or from any other suitable stream provided they are fit academically for pursuing such courses.
- Students are required to take any three courses from the list of Electives.
- To be eligible for MS in ACT student has to take minimum subjects worth 63 credits from ACT stream out of 72 credits.

Program Pedagogy

All courses are designed to address the key areas like theoretical foundation, practical relevance and the real life problem solving approach. To achieve that courses will be delivered using collaborative learning process through class room lectures, laboratory sessions, assignments, student seminars, lectures by industry experts, case studies, relevant industry visits and research / industry projects.

Distinctive Features

- Laboratory sessions to gain hands-on experience on various technological tools and platforms
- Exposure to Parallel Algorithms and Programming Development Methodology
- Elaborate case studies by leading experts from the industry
- The Development platform is available in 'Intel Multi-Core Lab' created jointly by I^2IT and Intel
- The Lab comprising of Intel C++ compiler, Intel Visual Fortran, Intel Math Kernel Library, Intel IPP, Intel Vtune Performance Analyzer, Intel Thread Checker, Intel Thread Profiler, Intel MPI Library, Intel Trace Analyzer and Intel Threading Building Blocks
- Hands-on experience with Grid infrastructure
- Option to work on projects that require working with faculty members and students from other streams such as advanced networking and telecom, Embedded Systems and VLSI.

Eligibility

Graduates with any recognized Bachelors Degree of Engineering in Computer Science/ IT, M.Sc. in Computer Science, M.Sc. in Mathematics / Statistics / Physics / Electronics with exposure in Computer Science with at least 50% marks at the graduation level. Proficiency in C /C++ programming is desired.

Program Commencement

The program commences in July / October.

Evaluation and Certification

- Periodic evaluation and performance improvement program
- Course-wise Credits
- Balanced assessment based on internals, examination and project
- Detailed transcripts along with certificate

Placement Assistance

- Career guidance at the institute
- Pre-placement facilitation / development and Campus Interview by leading Industries
- Active interface with Technology and user companies

Selection Process

The selection of an applicant for the course is based on the following:

- Application forms shall be scrutinized for academic profile in line with the eligibility criteria.
- Scores received at the Graduation level like BE / B Tech / M.Sc. etc
- Scores received at the "Accepted Qualifying Examinations" Like GRE / GMAT / XAT / CAT / GATE & Performance in the Entrance Test
- Personal Interview

Basic Courses

COM001: LIFE SKILLS DEVELOPMENT
This basic course prepares students for the rigors of the masters' level program and professional careers that will follow. The course is divided into 9 sections, which will be conducted throughout the program.

The program stresses on: communication and presentation, leadership development, working in teams, time management, negotiation skills, stress management through yoga, multicultural and diversity management and offsite experiential learning. The ultimate objective of this course is to develop individuals with high Intelligence, Emotional and Spiritual Quotients (IQ, EQ and SQ).

COM002: FOREIGN LANGUAGE (LEVEL 1)
In order to equip students to take up global careers, a choice of foreign languages as a major subject is offered. Medium of instruction is English.

Bridge Courses

- Keeping in view the diverse background of students, a variety of courses are offered under bridge program to attain the requisite level of competency for further learning.
- Students will undergo entrance examination and interview as part of selection process. Depending on the performance, students will be advised to undergo the bridge program.
- Duration of the bridge program is 3 weeks prior to the beginning of the academic term.
- Performance in the bridge courses count towards partial weightage in the relevant foundation courses.

AST001: COMPUTER ARCHITECTURE AND OPERATING SYSTEMS
This course covers operating system design concepts with examples from Linux and windows operating system. It also focuses on the study of the hardware structure of computer systems and sub-systems. The topics in operating system include: Operating system structures, Process and thread management, Memory management Virtual memory, File system, I/O subsystem and device Communication, Introduction to Linux commands and shell scripts knowledge of a Linux text editor. Protection and Security management. The topics in computer architecture include: Processor architecture Parallelism and pipelining, Cache and memory organization, I/O controllers and interconnection structures.

AST 002: DATABASE TECHNOLOGIES
This course focuses on the theory of database engineering. The course includes topics like file processing, introductory data structures, the differences between file processing and database processing, fundamental concepts of the relational model, normalization of data, database integrity issues, database design, SQL and an overview of the functions of a database management systems.

AST003: DATA STRUCTURES AND ALGORITHMS USING C
This course focuses on different data structures and their applications in computer programming. The data structures covered here are array, stack, queue, linked lists, binary tree and various sorting and searching algorithms.

Literals, Scope, Namespaces, Primitive Data Types, Conditional and Iterative Constructs, Unconditional Transfer of Control, Basic Operator Syntax and Semantics, Basic I/O, Enumerated Types, Pointers, Arrays, Dynamic Memory Allocation, Run-time, Compile-time and Automatic Memory Allocation, Parameter Passing (simple types, pointers, arrays), Constants, Defining Types with typedef, Typecasting.

NTC002: COMPUTER NETWORKS
This course shall emphasis on developing on understanding of the underlying principle of computer networking. Students will learn fundamental concepts of communication protocol stocks: OSI and TCP / IP, IP addressing schemes, subneting, LAN, MAN, WAN fundamentals, circuit and packets switching, networking devices, network protocols, standards, Internet Intranet, network security and allied technologies

Foundation Courses

ACT501: COMPUTER ARCHITECTURE EVOLUTION (2 CREDITS)
Uniprocessor Architecture, Constraint's on existing architecture e.g. Granularity, communication, software aspect, synchronization, shared memory, portability, Need of parallel processing; Different laws Grosch's Law, Minskey's Law, Amdahl's Law; Evolution of Parallel Processing; Pipeline processing; Vector Processors; Array Processors; Multiprocessor Architecture; Multithreaded Architecture; Parallel Software Issues; Case Studies (UltrSparc Etc)

ACT502: DISCRETE MATHEMATICS (2 Credits)
Topics include Set Theory, Logic, Switching Circuits, Mathematical Proof techniques, Induction, Recursion, Combinatorics, System of linear equations, Matrices, Algebraic structures, Polynomial.

ACT503: STATISTICAL METHODS FOR ADVANCED COMPUTINGS (1 Credit)
Discrete probability: Bayes theorem and probability distribution: Normal / Gaussian, exponential, t, and F. Cross and auto correlation, Introduction to Fourier transformation, Least square best fit, Error analysis, A brief introduction to ANOVA.

ACT504: SYSTEMS PROGRAMMING - I (2 Credits, T=1, L=1)
Basics of System programming, Elements of system programming, Introduction to Linux operating system, kernel, File Handling, Memory Management. Development tools, debugging, System Calls, Processes and signals, posix threads, Inter Process communication, semaphores, shared memory and sockets.

ACT505: DATABASE APPLICATION DEVELOPMENT (2 Credits, T=1 L=1)
This course discusses concepts like

database transaction handling and concurrency control. It also focuses on the application development features of the databases. Programming features of a database like PL/SQL, PSP, features for web application, Java-stored procedures and SQLJ are covered here.

ACT506: ADVANCED C++ PROGRAMMING (2 Credits T=1, L=1)
Introduction, Programming Paradigms, Techniques Of Object-Oriented Programming, Classes and Objects, Designing Class Hierarchie.

Traditional Error Handling Methods, Enter Exception Handling, Applying Exception Handling, Exceptions During Object's Construction and Destruction, Global Objects: Construction and Destruction, Advanced Exception Handling Techniques, Exception Handling Performance Overhead.

Class Templates, Function Templates, Performance Considerations.

Generic Programming, Organization of STL Header Files, Containers, Iterators, Algorithms, Function, Objects, Adaptors, Allocators, Specialized Containers, Associative Containers, Class auto_ptr, Nearly Containers, Class string.

Sequential Access files, Random Access Files and related Operations.

ACT507: JAVA PROGRAMMING - I (2 Credits, T=1, L=1)
This course provides the student with thorough knowledge of web architecture, role of application servers and database management systems and HTML application development. The topics covered include HTML programming, Java script, Core Java applications, applets and multithreading, n-tier architecture

ACT508: SEMINAR - I (1 Credit)
Students have to study the pre-assigned topic in depth, prepare seminar report and present the same to the designated panel.

Core Courses

ACT601: CHIP-MULTI PROCESSOR ARCHITECTURE (2 Credits)
Introduction to parallel computers: Instruction level parallelism (ILP) vs. thread level parallelism (TLP); Performance issues: Brief introduction to cache hierarchy and communication latency; Shared memory multiprocessors: General architectures and the problem of cache coherence; Synchronization primitives: Atomic primitives; locks: TTS, ticket, array; barriers: central and tree; performance implications in shared memory programs; Chip multiprocessors: Why CMP (Moore's law, wire delay); shared L2 vs. tiled CMP; core complexity; power / performance; Snoopy coherence: invalidate vs. update, MSI, MESI, MOESI, MOSI; performance trade-offs; pipelined snoopy bus design; Memory consistency models: SC, PC, TSO, PSO, WO/WC, RC; Chip multiprocessor case studies.

ACT602: GRAPH THEORY AND ALGORITHMS (2 Credits)
Paths and Circuits: Euler graphs, Hamiltonian paths and circuits.

Trees: rooted and binary trees, spanning trees, fundamental circuits, spanning trees in a weighted graph, Prim Algorithm, Kruskal Algorithm, Heuristic Algorithms.

Minimum Routes, Dijkstra Algorithm. Cut-sets: fundamental circuits and cut-sets, network flows, 1-isomorphism, 2-isomorphism. Planar Graphs: Kuratowski two graphs, detection of planarity, geometric dual, thickness and crossing. Matrix representation of graphs: Colouring and Covering.

Directed graphs: Digraphs and binary relations, Euler digraphs.

ACT603: DESIGN AND ANALYSIS OF ALGORITHMS (3 Credits)
Turing machines, the Church-Turing thesis, decidability and computability, the halting problem.

Polynomial time, the class P, the notion of reductions, examples. Verification problems, the class NP, NP-completeness, NP hardness, examples, Reductions among NP-complete problems.
Sorting algorithms, lower bounds for minimum and sorting, Divide and Conquer algorithms: geometric algorithms, Strassen's matrix multiplication, String matching, other string type algorithms,
Randomized Algorithms, Dynamic Programming, Approximation Algorithms.

Linear programming formulation and geometric intuition.The Simplex algorithm.

ACT604: DESIGN AND ANALYSIS OF PARALLEL ALGORITHMS (3 Credits, T=2 L=1)
Introduction to Parallel Algorithms; Models of Parallel Computation; Parallel Prefix Computation; Parallel Merging and Accelerated Cascading; Parallel List Ranking; Parallel Tree Computation; Parallel Searching, Merging and Sorting; Parallel Graph Algorithms I – Optimal connected components algorithm for dense graphs; Parallel Graph Algorithms II – An efficient connected components algorithm for sparse graphs; Parallel Geometric Algorithms; Introduction to P-completeness; Models, complexity and architectures: Models of computation, shared memory and message-passing, PRAM; Complexity; The NC class and its critique; Basic architecture; Basic Parallel algorithms: Parallel Prefix, List Ranking; Maximum, Sorting, selection; Graph algorithms, Connected components; Randomized matching in RNC; Basic message-passing algorithms: Communication complexity, Broadcast-convergecast, Spanning Tree.

ACT605: THEORY OF COMPILER DESIGN (2 Credits)
Compiler structure, Lexical and syntax analysis, Data structures organization, symbol table management, intermediate code forms, static and dynamic memory allocation, code generation for arithmetic expressions and control structures, subroutine calls and parameter transmission, code optimization.

ACT606: SYSTEM PROGRAMMING - II (2 Credit, T=1, L=1)
Introduction to Win32 API SDK programming; Application development using MFC with menu creation, Document View Architecture, Concepts like serialization, multi threaded programming, socket programming using VC++; COM / DCOM.

ACT607: CONCURRENT AND PARALLEL PROGRAMMING (3 Credit, T=1, L=2)
An introduction to concurrent and parallel programming, with an emphasis on

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language constructs. Parallel programming algorithms and their limits; Major topics include: exceptions, coroutines, atomic operations, critical sections, mutual exclusion; Data Dependence Analysis data parallel algorithms; Parallel scientific computing; Semaphores: mutual exclusion, signaling, split binary, resource counting; high-level concurrency, deadlock, inter process communication, process structuring, shared memory and distributed programming. Message Passing Programming; Distributed programming using MPI; Threaded programming: shared-memory parallel concepts, OpenMP syntax, hyper-threading considerations, and tools for correctness checking and load balancing; Concept of structure, debugging and Tuning parallel programs.

ACT608: JAVA PROGRAMMING - II (2 Credit, T=1, L=1)
Web Application Architecture: Application Severs & Web Servers, Servlets, Servlets and Servlet APIs, Deploying Servlets, Servlet JDBC, Sessions & Cookies.

Java Server Pages: Architecture, Syntax, Access Model, ASP/JSP comparison, JSP or Servlets, Deploying JSPs , JSP Implicit Objects & Session Management, Exception Handling, JSP with JavaBeans.

ACT609: SEMINAR - II (1 Credit)
Students have to study the pre-assigned topic in depth, prepare seminar report and present the same to the designated panel.

Advanced Courses

ACT701: MIDDLEWARE AND MESSAGING (2 Credits, T=1, L=1)
Middleware systems introduction and overview - Definition, scope, high-level description of middleware. Categories of middleware, Reference models: open distributed processing reference model (RM ODP); object management architecture (OMA), RPC/RMI-based middleware platforms an implementation issues, Overview of CORBA architecture implementation of CORBA mechanism, Publish and Subscribe Paradigm. Event Services and XML, SOA: Overview of SOA, SOA methodology, Layering of services, Modeling the Architecture, Orchestrating Services with BPEL, Implementing SOA. EDA, Messaging – Message Queuing Middleware, Integration Broker, Integration Broker Architecture, Integration Brokers – Business Process Integration, XML and B2BI. Principles of Enterprise Systems, Application Integration, Loosely Coupled, Environments & Their Enabling Technologies, Hub & Spoke Technologies & Architecture, MOM Strategies & Implementation Approaches, Message Bus Design & Architecture, Enterprise Service Bus Technologies & Architecture, Design & Architecture, Adapter & Connector Technologies & Implementation.

ACT702: HIGH PERFORMANCE COMPUTING (2 Credits, T=1 L=1)
HPC infrastructure design-Concepts of HPC infrastructure design, Requirement analysis, Hardware and software selection; Hardware Architecture of HPC systems-Nodes: processors, cache, RAM, disks, RAID, Networks: Ethernet, Myrinet, Infiniband, FibreChannel, iSCSI, SAN; Software Architecture HPC systems-Nodes: operating systems (Linux), Networks: sockets, remote procedure call (RPC), network file system, Clusters: nodes, communication, storage, message passing interface (MPI), parallel file system, workload management systems, Grids: clusters, middle ware; HPC Architecture & System Administration-Installation of the Operating System, Inter-network connectivity configurations, Installations of Cluster management tools; HPC Security-HPC Internetworking Security, HPC Security Management, HPC Intrusion Detection, HPC Security Applications.

ACT703: INTELLIGENT SYSTEMS (2 Credits, T=1 L=1)
Data, information and knowledge; Model of an intelligent system; Models of knowledge representations; Knowledge based systems - Software architecture of a knowledge-based system, Rule-based programming and production systems; Intelligent agents; Agent theory and languages, Inter-agent communication; Applications of AI.

ACT704: MULTITHREADED PARALLELISM: LANGUAGES AND COMPILERS (2 Credits, T=1 L=1)
Languages and compilers to exploit multithreaded parallelism, Implicit parallel programming using functional languages and their extensions, Higher-order functions, non-strictness, and polymorphism, Explicit parallel programming and nondeterminism, The lambda calculus and its variants, Term rewriting and operational semantics, Compiling multithreaded code for symmetric multiprocessors and clusters, Static analysis and compiler optimizations.

ACT705: DISTRIBUTED AND CLUSTER COMPUTING (2 Credits, T=1 L=1)
Distributed system characterization and models, Networking and internetworking, Interprocess communication, Distributed objects, Security, Name services, Operating system support, Distributed file systems, Introduction to high performance computing, basic definitions; cluster. Parallel computing concepts, models of parallel computation (i.e., PRAM, BSP, LOGP, etc), running an MPI program on a cluster; Architecture of cluster-based systems. Issues in cluster design.

ESD806: GRAPHICS AND VISUALIZATION (2 Credits, T=1 L=1)
This course starts with introductory mathematics of computer graphics, and physics and electronics of computer graphics. These aspects are followed with attributes of output primitives, 2D geometric transformations, 2D viewing, and numerical methods in computer graphics. Course concludes with lighting and color models, rendering aspects and parametric and nonparametric descriptions of curves and surfaces for Geometric modeling. Also covers Embedded hardware accelerators and graphics co-processors for real-time rendering. Theory is supplemented with multiple lab experiments in C and C++

Electives

The complete set of elective courses are listed below. Each student has to select any **three** elective courses from the followings.

ACT 801: PROGRAMMING ENVIRONMENT FOR MULTI-CORE ARCHITECTURE (2 Credits, T=1 L=1)
Multicore Programming Models, Profilers, Compilers, Debuggers, Linux & Windows Programming (threads etc), Case Studies, Desktop system, server system, cluster of multicores,grids; Programming models, Threading Methodology, Porting legacy applications, Database Porting (Oracle 10G etc), Multithreading (PThreads etc), Load

Balancing, SDK's or API's for specific architectures, Virtualization.

ACT802: MULTI-CORE APPLICATION DEVELOPMENT (2 Credits, T=1 L=1)
Web applications, Image Processing, Scientific application (OpenMP), Database Application, Memory Transaction Operation, Standard Benchmarks on multicore, Security Issues, Protocol for IPC's between cores,

ACT803: EMBEDDED SYSTEM DESIGN AROUND CHIP MULTI PROCESSOR ARCHITECTURE (2 Credits)
Advanced Embedded system design concept, System design issues, Integration of control and signal processing blocks of a system, System integration Issues, Timing Issues, Embedded system development steps, Need for Chip-Multiprocessor Architecture, Architecture selection criteria, Operating system development for Embedded system and need for multiprocessor core, Performance evaluation methods, Case study of embedded system development around Chip-Multiprocessor Architecture.

ACT804: GAME PROGRAMMING (2 Credits, T=1 L=1)
Introduction, types of games, Overview of the gaming world and market, different technologies used in developing games, Devices, Devices currently available in the market, Setting up the development environment, Using different Emulator Plug-in the emulator with the IDE used (NetBeans 5.5), Photoshop and Fireworks, Game Time, Minimax, Minimax with Alpha-Beta Pruning. Perfect and non-perfect information games, Optimal Decisions in Games, Optimal strategies, the minimax algorithm, Optimal decisions in multiplayer games, Imperfect Real-Time Decisions, Evaluation functions, Cutting off search, Games That Include an Element of Chance, Position evaluation in games with chance nodes Complexity of expectiminimax, State-of-the-Art Game Programs. Developing your first simple game, developing a complete game.

ACT805: GRID COMPUTING (2 Credits, T=1 L=1)
Introduction to high performance computing, basic definitions; cluster; Grid computing, virtual organizations; Grid computing Attributes; Core components of Grid computing, computational grid projects; Service-Oriented Architecture (SOA), XML, SOAP, WSDL; Architecture of Grid systems; Grid Service concepts; Open Grid Services Architecture (OGSA), OGSI; Introduction to PVM and MPI: MPI, process creation, communicators, running an MPI program on a cluster; Architecture of cluster-based systems. Issues in cluster design; Database–Oriented Grid Support; Globus: - Information services, resource discovery, LDAP, centralized system, GT4 information services (MDS), GRIS, GIIS; Grid security infrastructure. Applications.

ACT806: DATA MINING APPLICATION IN PARALLEL COMPUTING (2 Credits, T=1 L=1)
Machine learning, mathematical statistics, neural network; Data Mining goals; stages of the data mining process; survey of data mining applications, techniques and models; Topics may include decision trees, classification, association, clustering, attributes, statistical and linear modeling, Bayesian classification, k-nearest neighbors, CART. OLAP mining; Text mining; Web mining. Methods for mining distributed datasets, Distributed & partial model learning, Distributed systems and tools for data mining and data exploration.

ACT807: SCIENTIFIC AND TECHNICAL COMPUTING (2 Credits, T=1 L=1)
Large scale problem in science and engineering. Types of mathematical problem to be tackled: algebraic, differential equations, partial differential equations and boundary value problem, evolutionary problems, AI problems etc. Parallelizing applications using parallel programming environments including integrated development environment. Developing applications for various high performances computing infrastructures such as multithreaded, multicore, clusters and grids. Case studies in science and engineering areas.

ACT808: ENTERPRISE COMPUTING (2 Credits)
Large scale problem in business and enterprise computing. Types of applications: web applications, database applications, transaction processing applications, enterprise application integration environment and implication, media application, on-demand service oriented application. Developing enterprise computing applications on high performance computing infrastructure such as multithreaded, multicore, clusters and grids. Case studies in business and enterprise computing areas.

ACT809: HPC INFRASTRUCTURE: DESIGN, IMPLEMENTATION AND MANAGEMENT (2 Credits)
Advance Processor Architectures, (SUN)-Woodcrest (Intel)-Cell (IBM) & AMD, Server Board Architectures, Storage Systems, SAN/NAS FC Switch, Disk Types SATA FC, High Performance Interconnect, Myrinet, Gigabit, Ethernet, 10G, Quadrics, Infiniband, Security Infrastructure, Signed Certificates ,IDS, Firewall, Data Center Design, AC, UPS, Power, Fire Fighting System, Linux / UNIX System Administration, Network Management System, SNMP, IPMI, Ganglia, SCMS, Cluster Installation Case Studies, LVS Cluster, HA Cluster, MPI Linux Based Cluster, OSCAR, Cents OS Based ROCKS, Lustre File System, OpenMosix Single System Image, PBS Cluster Scheduler, WAN Technologies MPLS-VPN, Diffserv.

ACT810: ADVANCES IN OPERATING SYSTEM DESIGN (2 Credits)
Operating System issues for multiprocessing; Need for pre-emptive OS; Scheduling Techniques; Usual OS scheduling techniques; Threads; Distributed scheduler; Multiprocessor scheduling; Gang scheduling; Communication Models; Distributed Concurrency, Transactions, Deadlock; Inter-Process Communication; Message boxes; Shared Memory; Sharing issues and Synchronization; Shared memory and other structures; File Systems; Sharing I/O devices; Distributed Semaphores; Monitors; Spin-locks; Kernel Programming; Fault-tolerance; Security; Implementation techniques on multi-core.

ACT811: ADVANCES IN COMPILER CONSTRUCTION (2 Credits)
Compiler Algorithms Notation, Symbol table structure, Intermediate representation, Run time support, Producing code generators automatically, Control flow analysis, Data flow analysis, Pointer Analysis, Dependence analysis and dependence graphs, Garbage collection; Alias analysis, Introduction to optimizations, Early optimizations, Constant expressions, scalar replacements, copy propagation, strength reduction; common sub-expressions, loop-invariant code motion, redundancy elimination; Loop optimizations, procedure optimizations, Register allocation, Code scheduling, control flow and low level optimizations, Inter procedural Analysis and optimizations, Optimization for memory hierarchy, Secure Compiler; Case studies.

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Project

ACT901: MINI PROJECT (2 Credits)
Students are expected to undertake a project that includes extensive literature survey and/or design and development of system. An internal faculty guides the project. The project has to be submitted in the form of a dissertation, which will be examined by experts nominated by the institute.

ACT902: PROJECT (18 Credits)
Students can take up an industry-sponsored project or a research based in-house project leading to Master's level competency.

For industry-sponsored projects, the Career Management Center facilitates interaction between students and the industry. Students are encouraged to work on projects that will enhance their understanding in certain technology domains in real-life scenario.

The research project includes researching on the given/chosen seminar topic, which will generally be state-of-the-art in the field and then delivering the seminar to peers and faculty along with its documentation in the prescribed IEEE format. Following the seminar the student has to undertake a research project under the guidance of tenure track/visiting faculty/and industry experts. The research project has to be submitted in the form of a dissertation, which will be examined by experts nominated by the institute. The research project is the culmination of the student's learning in the institute and is expected to be of high standards as demanded by the industry from time to time.

Total Course Credits: 72

NOTE: Foreign language is an independent certificate program, compulsory for all students.

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Course Structure

	Code	Course Name	Credits*
BRIDGE	AST001	Computer Architecture & Operating System	
	AST002	Database Technology	
	AST003	Data Structures & Algorithms using C	
	NTC002	Computer Networks	
FOUNDATION	ACT501	Computer Architecture Evolution	2
	ACT502	Discrete Mathematics	2
	ACT503	Statistical Methods for Advanced Computing	1
	ACT504	System Programming – I	2
	ACT505	Database Application Design	2
	ACT506	Advanced C++ Programming	2
	ACT507	Java Programming- I	2
	ACT508	Seminar - I	1
CORE	ACT601	Chip-Multi Processor Architecture	2
	ACT602	Graph Theory and Algorithms	2
	ACT603	Design and Analysis of Algorithms	3
	ACT604	Design and Analysis of Parallel Algorithms	3
	ACT605	Theory of Compiler Design	2
	ACT606	System Programming – II	2
	ACT607	Concurrent and Parallel Programming	3
	ACT608	Java Programming – II	2
	ACT609	Seminar - II	1
ADVANCED	ACT701	Middleware and Messaging	2
	ACT702	High Performance Computing	2
	ACT703	Intelligent System	2
	ACT704	Multithreaded Parallelism: Languages and Compilers	2
	ACT705	Distributed and Cluster Computing	2
	ESD806	Graphics and Visualization	2
ELECTIVES	ACT801	Programming Environment for Multi-Core Architecture	2
	ACT802	Multi-Core Application Development	2
	ACT803	Embedded System Design around Chip-Multiprocessor Architecture	2
	ACT804	Game Programming	2
	ACT805	Grid Computing	2
	ACT806	Data Mining Application in Parallel Computing	2
	ACT807	Scientific and Technical Computing	2
	ACT808	Enterprise Computing	2
	ACT809	HPC Infrastructure: Design, Implementation and Management	2
	ACT810	Advances in Operating Systems Design	2
	ACT811	Advances in Compiler Construction	2
PROJECT	ACT901	Mini Project	2
	ACT902	Project	18

** 1 Credit Hr = 16 Class Hrs / 32 Lab Hrs in a semester*

MS Program in Networking and Telecommunications

'A world linked by high-quality personalized video generating 15 exabytes (an exabyte equals a billion gigabytes) per month in Internet traffic by 2010, using technologies such as telepresence'

- A world envisioned by John Chambers,
Chairman and CEO, Cisco Systems in ITU Telecom World 2006

Modern information infrastructure that covers Global Information Infrastructure (GII), National Information Infrastructure (NII), Wide Area Networks (WANs), Metropolitan Area Networks (MANs) and Local Area Networks (LANs) must provide multiple services with high Quality of Service (QoS) and security as demanded by corporates, institutions and individuals. Convergence is redefining the boundaries of data, voice and video services. Consumer market for broadband applications such as combined voice, data, multimedia, video, gaming, voice over Internet Protocol (VoIP) and entertainment signal transport is growing at the drastic rates. Service providers are actively moving towards IP-based Next-Generation Networks (NGNs), where transport over existing TDM infrastructure is being replaced with transport over IP infrastructure with very high QoS quality. IP Multimedia Subsystem (IMS) is emerging as the industry standard of choice for the NGNs. Such convergence of communication networks is posing interesting technological and business challenges, as the deployment of broadband networks grows aggressively. Service providers need to protect their existing investment while upgrading to IP systems. They are focusing on revenue enhancement opportunities by offering 'Triple Play' (data, voice and video) over broadband wired and wireless networks. Before 'Triple Play gets stabilized in the market, the developments on 'Multiple Play' are already started. The forecast projects 80 million IPTV subscribers by the end of 2010 with global IPTV revenue of $28 billion. The revenue building promise brings to manufacturers, vendors, and operators, along with the questions concerning the practicalities of delivering these services, how to design the networks and manage them? How to bill consumers for them? And how to regulate an environment where telecommunications, computing and broadcasting are all combined on one platform. As networks become more complex and use multiple converged technologies, it is now imperative for service providers to manage these networks efficiently. This MS Program in Networking and Telecom is devised to prepare the students to handle all such challenges in the fastest growing networking and telecom industry. The program provides comprehensive, theoretical, practical and real life knowledge of advanced networking and telecom technologies as demanded by the industry today and for the future.

Program

This autonomous, four semester, 24-month, 72 Credits, full-time Masters Program in Networking and Telecommunications is designed to propel students to accept design, development, testing, deployment and management of infrastructure, and application development for providing variety of services in the areas of:

- Internet Technologies
- Telecom Technologies
- Next Generation Networks
- Broadband Communication Technologies
- Network Planning, Design, and Optimization
- Network Management and Security
- Communication Software Development

Program Structure

- Successful completion requires 72 Credits.
- To bridge the gap between theory and practice, project work worth 18 Credits in the last semester.
- The entire curriculum is distributed over six levels to aim at transcending the students' level of understanding for corporate readiness. The levels are respectively, Bridge, Foundation, Core, Advanced, Electives and Project.
- As an option to the advanced courses of this program, a student can take total 9 Credits courses from any other suitable MSP / MBAP program provided they are fit for such courses.
- Students have to carry out one mini project in specified semester to consolidate the technical knowledge in the selected specialization stream.
- Students are required to take three electives during the program.
- To be eligible for MSP in Advanced Networking and Telecommunications, a student has to take minimum subjects worth 63 Credits from this stream out of 72 Credits.

Program Pedagogy

All courses are designed to address the key areas like theoretical foundation, practical relevance and the real life problem solving approach. To achieve that courses will be delivered using collaborative learning process through class room lectures, laboratory sessions, assignments, student seminars, lectures by industry experts, case studies, relevant industry visits and research / industry projects.

Distinctive Features

- Theory and laboratory sessions to gain experience of practical situations in carrier class networks and convergence technologies.
- Working with the state-of-the art networking and telecom hardware and software tools in the laboratories.
- Practical exposure on Computer Associates (CA) Network Management tools.
- Expert lectures, seminars and case studies