MS Program in Wireless Technologies

Course Structure

	Code	Course Name	Credits*
BRIDGE	AST 001	Computer Architecture and Operating Systems	
	ESD 002	Signals and Systems	
	NTC 001	Communication Systems	
	NTC 002	Computer Networks	
FOUNDATION	NTC 501	Programming Methodologies	3
	WLT 501	Switching and Routing Technologies	3
	WLT 502	Coding Techniques	3
	WLT 503	Antenna and Radio Wave Propagation	2
	AST509	Introduction to Database Design	2
	WLT 504	Linux Programming Laboratory	1
	WLT 505	Seminar – I	1
CORE	WLT 601	Cellular Networks	4
	WLT 602	WLAN Technologies	3
	WLT 603	2.5/3G Wireless Networks	3
	NTC 604	Network Programming	3
	AST 603	Software Engineering and Project Management	2
	WLT 605	Seminar – II	1
ADVANCED	NTC 701	Multimedia Technologies	3
	WLT 701	Wireless Network Management and Security	3
	WLT 702	MANETs and Sensor Area Networks	3
	NTC 704	Next Generation Networks	3
ELECTIVES	Elective – I (Select any ONE)		3
	ESD 503	Digital Signal Processing	
	WLT 811	Wireless Network Planning and Optimization	
ELECTIVES	Elective – II (Select any TWO)		3 each
	NTC 702	Broadband Technologies	
	WLT 821	Performance Evaluation of Wireless Networks	
	WLT 822	Wireless Application Development	
	NTC 823	Multiple Play Services	
	NTC 824	OSS and BSS	
	NTC 826	Embedded Software Design for Networking and Telecom	
PROJECT	WLT 901	Mini Project	2
	WLT 902	Project	18

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

MS Program in Embedded Systems Design

"Everything will be connected, and I mean literally everything. Not just electronic devices, but everything down to your piano. We'll have as many as four or five (embedded) Internet devices on our bodies."

- John Chambers

Recent developments in embedded systems are spanning new applications in computing, communications, networking, automotive electronics, medical electronics, avionics and the like. A three-dimensional growth is taking place in this high-end technology sector, with increasingly powerful micro-controllers and digital signal processors competing with emerging tools in Field Programmable Gate Arrays (FPGAs). Embedded systems range in size from pacemakers, and intelligent sensors, to cell phones and PDAs, to stand alone and distributed elements like set top boxes, modems, network elements and to large-scale systems deployed in process control, manufacturing, power generation, defense applications, telecommunications, automotive electronics, air traffic control, video-on-demand and video-conferencing. Embedded systems actually account for more than 90 percent of the manufactured processors. India is emerging as a global embedded design and software destination due to its cost advantages and emerging talent pool in this domain. Demand is continuing to outstrip the availability of highly skilled pool of graduates for the fast evolving embedded systems industry. This program introduces students both, to the state-of-the-art and state-of-the-practice in the broad field of embedded and real-time computing, control, and communication and enables them to pursue rewarding careers in these frontier areas of technology.

Program

This autonomous four-semester, 24-month, 72 credit full-time Masters Program in Embedded Systems Design is designed to equip the students to gain industry oriented technical knowledge and also imparts hardcore skills in the high-end technologies related to embedded systems. This curriculum starts with introductory concepts in hardware and software, and incorporates an essential knowledge base of hardware and software co-design along with application specific embedded design concepts. Nearly one third of learning happens through hands on practice.

Program Structure

- 72 Credits required for successful completion.
- Project work of 18 Credits incorporated in the last trimester to bridge the gap between theory and practice.
- Curriculum categorized into six levels of increasing complexity and corporate readiness: Basic, 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 MS Program provided they are fit for such courses.
- The student has to carry out at least one mini project in the specified trimester to consolidate the technical knowledge in selected specialization stream.
- Students are required to take four electives from the elective courses listed.
- To be eligible for MSP-ESD, a student has to take minimum subjects worth 63 Credits from this program out of 72 Credits.

Program Pedagogy

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

Distinctive Features

- Exposure to state-of-the-art micro-controllers, digital signal processors and programmable logic arrays in the laboratories
- Coverage of all the above three embedded system domains
- Development experience in real environment.
- Application specific course design
- Flexibility in the choice of project domain
- A choice of research or industry project

Eligibility

Graduates with recognized Bachelors Degree of Engineering in Electrical / Instrumentation / Electronics / Communication / Information Technology / Computer Science/ M.Sc. in Electronics or equivalent with at least 50% marks at the graduation level. Proficiency in C, C++ and Java is desired.

Program Commencement

The program commences in July / October.

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 / BTech, M.Sc (Electronics) or equivalent.
- Scores received at the qualifying examinations like GRE / GATE & performance in the Entrance Test.
- Personal interview.

Evaluation and Certification

- Continuous evaluation and performance improvement program. Course-wise Credits.
- Balanced assessment based on internals,

mid-term, laboratory and final theory examinations and project.
- Detailed transcripts along with certificate

Placement Assistance

- Career guidance at the institute.
- Pre-placement facilitation/development and campus interviews 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.
- Score received at the Graduation level.
- Scores received at the 'Accepted Qualifying Examinations' like GRE / GMAT / XAT / CAT / GATE and Performance in the Entrance Test
- Personal Interview

Basic Courses

COM001: LIFE SKILLS DEVELOPMENT
This basic course prepares students for the rigors of the master's level program and professional careers that will follow. The course is divided into 9 sections that will be conducted throughout the program. The course stresses on: communication and presentation, leadership development, working in teams, time management, negotiation skills, and 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 a foreign language as a major subject is offered. Medium of instruction is English.

Bridge Courses

KKeeping in view the diverse background of students, variety of courses is offered under bridge courses 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 courses.
- Duration of the bridge courses is three weeks prior to the beginning of the academic term.
- Performance in the bridge course count towards appropriate weightage in relevant foundation courses.

ESD001: COMPUTER ARCHITECTURE
This course focuses on the study of the hardware structure of computer systems and sub-systems. The topics included are Processor architecture Parallelism and pipelining, cache and memory organization, I/O controllers and interconnection structures.

ESD002: SIGNALS AND SYSTEMS
This course deals with the representation of signals and systems, system properties, mathematical models of continuous-time and discrete-time signals and systems, time-domain and frequency domain concepts, sampling, Laplace and Z-transforms, transfer functions and frequency response, convolution, stability, Fourier series and Fourier transform, probability and description of random signals.

ESD003: INTRODUCTION TO PROGRAMMING LANGUAGES
This course deals with the programming aspects of C, C++ and Java at the introductory level. Topics include basic data types, constants, variables and simple library/user defined functions and header files. Compilers, Linkers and other utilities will be discussed with different variants. It also includes in-class demonstrations of problems solved in all three languages. Also discusses programming best practices.

MVD003: INTRODUCTION TO LOGIC DESIGN
This course covers binary and non-binary systems, Boolean algebra, digital design techniques, logic gates, combinational circuits, K maps, flip-flops, sequential circuits and state machine theory. This course also includes preliminary timing analysis, digital circuit building blocks such as multiplexes, decoders, counters, PLA, PAL, PLD, various logic families, I/O standards, bipolar based logic, ECL, Bi-CMOS; memory; SRAM, DRAM, EEPROM, and I/O circuits.

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

Foundation Courses

ESD501: ANALOG AND DIGITAL SYSTEMS DESIGN (3 Credits T=2 L=1)
This course covers analog components, basic analog IC's, need for data acquisition system, operational amplifiers and their applications: linear and non-linear, active filters, converters; digital circuit, CMOS logic circuits, combinational logic design, logic building blocks, sequential logic design and timing analysis, clocks, synchronization, and finite state machines.

ESD502: MICROCOMPUTER BASED SYSTEM DESIGN (3 Credits T=2 L=1)
This course is designed to introduce 8-bit micro-controllers and also covers RISC / CISC, Harvard / Princeton architectures, timers / counters, UART, SPI, PWM, WDT, input capture, output compare modes, I2C, interfacing LED, switches, ADC, DAC, LCD, RTC, types of memories, programming in assembly and 'C'.

ESD503: DIGITAL SIGNAL PROCESSING (3 Credits T=2 L=1)
This course introduces the basics of discretetime signals and systems, and covers the system characterization in time and frequency domains, discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, linear and circular convolution, digital signal processing of continuous time signals, digital filter blocks (FIR and IIR), and finite word length affects in digital systems. This module also includes software implementation of DSP algorithms.

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ESD504: ADVANCED C PROGRAMMING (3 Credits T=2 L=1)
This course is designed to address the more advanced use of 'C' programming with standard 'C' library functions, arrays, pointers, structures, unions, linked lists, trees, file handling, interrupts, real-time concepts, and macros. Lab sessions involve implementation of algorithms, review of common errors in 'C' programming, to facilitate better debugging and analysis capabilities.

ESD505: THEORY OF OPERATING SYSTEM (3 Credits T=2 L=1)
This course covers operating system design concepts with examples from Linux and windows operating system. The topics in operating system include: Operating system structures, Process and thread management, Memory management Virtual memory, File system, I/O subsystem and Protection and Security management.

ESD506: SEMINAR SERIES – I (1 Credit)
This course includes seminars by experts from industry and academia providing introduction to advances and possibilities in the advanced technology. Students are given a bird's eye view of multiple technological frontiers.

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 and n-tier architecture

Core Courses

ESD601: EMBEDDED SYSTEMS DESIGN (3 Credits T=2 L=1)
This course covers the embedded system design issues, challenges and trends in embedded systems, assemblers, compilers, linkers, loaders, debuggers, profilers and test coverage tools, writing time and space sensitive programs. Lab sessions are geared towards the cross-compilation aspects of embedded systems design.

ESD602: REAL-TIME OPERATING SYSTEMS (3 Credits T=2 L=1)
This course covers the principles of real time operating systems, threads, process, scheduling, inter process communication, synchronization, memory and I/O operations. Various RTOS kernel architectures are studied for their relative merits. Issues involved in porting of RTOS to specific processor are to be discussed. Lab sessions will include the programming in the user space and kernel modules.

ESD603: EMBEDDED DESIGN CYCLE (3 Credits T=2 L=1)
This course introduces fundamental aspects of embedded systems design cycle, implementation, hardware – software co-design issues, testing hardware software functionality, multi-source code analysis using software testing tools and verification & validation process for complete embedded systems. Code analysis and hardware verification methods will form part of the laboratory-based learning.

EESD604: EMBEDDED COMPUTING (3 Credits T=2 L=1)
In this course, the basic requirements of modern architectures and the algorithm modifications for embedded computing are dealt with. The architecture requirements like parallel processing, pipelining, use of MAC architectures, use of series expansion and the like are linked with algorithm level computations needed for real-time, low memory, low power, just in time computations. Specific case studies in signal and image processing, and in encryption areas are dealt with. Architecture examples include DSP processors, ARM architectures and FPGA architectures.

MVD601: ASIC MODELING (2 Credits T = 1 L= 1)
This course covers introduction to VHDL/ Verilog history, importance & capabilities and synthesis issues. Gives insight understanding the basic construction & Modeling features for VHDL / Verilog. Study of different data types & operators associated VHDL / Verilog language. Implement state machine and sequential & combinational circuits. Introduces different packages & libraries available in VHDL. Writing efficient test bench.

Advanced Courses

ESD701: ADVANCED MICRO CONTROLLER BASED SYSTEM DESIGN (3 Credits T=2 L=1)
This course introduces 32-bit processors, ARM/ OMAP architecture and organization, ARM / OMAP programming model, ARM / OMAP instruction set, ARM / OMAP exception handling, ARM / OMAP assembly and 'C' programming.

ESD702: EMBEDDED MULTIMEDIA TECHNOLOGY (2 Credits)
Methods for data representation in digital domain (1D, 2D, 3D), text representation, combination of media, role of transforms, principles of CODEC design, audio, video and image CODEC's, data encryption and security algorithms, relation to networking and communication channels, introduction to protocols, digital architectures for multimedia.

ESD703: SEMINAR SERIES – II (1 Credit)
Students are required to present a seminar on relevant topics in embedded application domain for campus- wide audience.

ESD704: TECH & IP MANAGEMENT (1 Credit)
This course covers fundamental aspects of Tech management, SE Knowledge areas, SDLC- PM, Components of PM, Project life cycle, Project management Tool, MSP Case study assignment, Tips for project execution, Innovation and need for technology management, Need for IP management, IP Practices in India, Copyright, Patent. TM, CMM, CRM, Global IP Practices, Outsourcing.

Electives

ESD606: AUTOMOTIVE EMBEDDED SYSTEMS – I (3 Credits T=2 L=1)
This course gives the overview of automotive embedded system. Automotive systems, electronic systems; automotive sensors – types, characteristics, processes, data acquisition; computational requirements; microcontrollers for automotive applications, real time requirements, architecture using RTOS. Assignments and case studies are incorporated to emphasize the above areas.

Lab practice includes software simulations using Simulink, and other simulation software.

ESD705: DIGITAL SIGNAL PROCESSING with FPGA (3 Credits T=2 L=1)
This course covers introduction to FPGA technology, FPGA design of IIR filters, FPGA design of FIR filters, FPGA design of Fourier Transforms, advanced design concepts Fourier related transforms, rectangular and number theoretical transforms, error control and cryptography, modulation and demodulation, downloading and testing of signal processing blocks with suitable FPGA board, IP cores and glue logic concept.

ESD706: AUTOMOTIVE EMBEDDED SYSTEMS – II (3 Credits T=2 L=1)
This course deals with modeling concepts and UML applications in automotive embedded systems, Introduction to Rational Rose, Visual Paradigm, SE – PM issues in Automotive industry, HIL concepts, Protocols – CAN, LIN, MOST, Flex ray; Implementation issues, VANET, Auto Electronic systems & diagnostics and Infotainment. Lab practices using UML and Rational Rose are also included.

ESD801: ADVANCED DIGITAL SIGNAL PROCESSING (3 Credits T=2 L=1)
This course covers various emerging techniques in the area of digital signal processing such as multi rate signal processing, multidimensional signal processing, short-time Fourier transform, signal expansion in discrete and continuous time, filter banks, multi-resolution analysis, wavelets and their applications to image compression, wavelet transform, high performance digital signal processors, benefits of these DSP's to wireless infrastructure, base band processing and packet telephony applications. Relevant case studies or mini-project will have to be done demonstrating the programming skills.

ESD802: EMBEDDED COMMUNICATION SYSTEMS (3 Credits)
This course deals with communication channel issues, signaling and synchronization, common architectures for embedded communication, embedded network protocols including IEEE 802.x, IEEE 1394, CAN, UWB, USB, Bluetooth and Zigbee are covered. Design issues in short-range radio devices, embedded communication interface in bluetooth enabled devices, and wireless routers & access points will also be presented. The emphasis will be on power consumption, throughput, fault tolerance, real-time requirements and security among other things.

ESD804: EMBEDDED DIGITAL SIGNAL PROCESSORS (3 Credits T=1 L=2)
This course introduces the design path of a (digital) signal processing system, determining a suitable filter approximation, choosing the correct filter structure for limit cycle suppression and minimization of quantization noise, applying multi-rate signal processing techniques, and using design software. Emphasis is placed on efficient implementation using both assembly and C level programs. Architecture specific design process is illustrated. C language based Cross Compilers for Texas Instruments DSPs are utilized.

ESD805: RESEARCH STUDY (2 Credits)
The subject aims to impart detailed knowledge of a highly specialized topic within the field of embedded systems. The directed reading and independent research will involve an in-depth study of an advanced embedded technology and its application to embedded systems under the guidance of a faculty member. The directed reading subject will be chosen in consultation with a supervisor. Admission into the subject requires agreement by a proposed supervisor and submission of a proposal to the School (via the program director) during the first two weeks of the semester in which the course will be taken.

ESD806: GRAPHICS AND VISUALIZATION (3 Credits T=2 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++

MVD602: SYSTEM ON PROGRAMMABLE CHIP (3 Credits T=2 L=1)
This course focuses on implementation, testing of digital blocks on targeted CPLD / FPGA to form a complete system. The course covers techniques to implement and synchronize basic computational blocks on CPLD / FPGA. It further covers implementation of hardware drivers for basic peripheral devices such as UART, I2C compatible devices, RAM, ADC, LCD, Printer etc along with how to set the constraints for proper implementation of logic. It also introduces to implementation of analog system using FPGA.

Project

ESD 901: MINI PROJECT (2 Credits)
This module is designed to introduce the complete design cycle of software or hardware in the development of an embedded system. Students are expected to design an end-to-end embedded solution to a practical problem in a particular domain.

ESD902: 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 a real-life scenario. The research project includes researching on the given/chosen seminar topic that 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 that 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.

MS Program in Embedded Systems Design

Course Structure

	Code	Course Name	Credits*
BRIDGE	ESD001	Computer Architecture	
	ESD002	Signals and Systems	
	ESD003	Introduction to Programming Languages	
	MVD003	Introduction to Logic Design	
	NTC002	Computer Networks	
FOUNDATION	ESD501	Analog and Digital Systems Design	3
	ESD502	Micro Computer Based System Design	3
	ESD503	Digital Signal Processing	3
	ESD504	Advanced C Programming	3
	ESD505	Theory of Operating Systems	3
	ESD506	Seminar Series - I	1
	ACT507	Java Programming - I	2
CORE	ESD601	Embedded Systems Design	3
	ESD602	Real-Time Operating Systems	3
	ESD603	Embedded Design Cycle	3
	ESD604	Embedded Computing	3
	MVD601	ASIC Modeling	2
ADVANCED	ESD701	Advanced Micro-controller Based System Design	3
	ESD702	Embedded Multimedia Technology	3
	ESD703	Seminar Series - II	1
	ESD704	Tech & IP Management	1
ELECTIVES	**Select suitable subjects of total 12 Credits**		
	ESD606	Automotive Embedded Systems - I	3
	ESD705	DSP with FPGA	3
	ESD706	Automotive Embedded Systems - II	3
	ESD801	Advanced Digital Signal Processing	3
	ESD802	Embedded Communication Systems	3
	ESD804	Embedded Digital Signal Processors	3
	ESD805	Research Study	2
	ESD806	Graphics and Visualization	3
	MVD602	System on Programmable Chip	3
		Elective(s) from MSP-ACT	Max 6
		Elective(s) from MSP-WLT	Max 6
PROJECT	ESD901	Mini-Project	2
	ESD902	Project	18

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