

# MS Program in Embedded Systems Design

## with specialization in Smart Card Technology

*In association with Giesecke & Devrient, Germany*

*"The key is making information as mobile as they are- delivering it securely to mobile phones, pagers, PDA's, laptops and often overlooked in discussions of mobility, stationery systems. Smart cards are at the center of this development"*

- Scot McNealy

Authenticity of individuals is becoming increasingly important for companies and government agencies involved in financial transactions, health care information, social security, secure data communications and wireless applications. Smart cards play major role in these developments. Multiple corporate in India are established business verticals in smart card services. Government agencies are also actively preparing for smart card implementations in multiple areas. Trained manpower is a critical need for growth in this segment. This program has been designed with active support and participation from Giesecke & Devrient, a market leader in smart card technology. The program provides a comprehensive foundation in this exciting technology and has been designed for the requirement of smart card manufacturers, service providers, and value added resellers

### 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 semester 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 semester to consolidate the technical knowledge in selected specialization stream.
- ▲ Students are required to take two electives from the elective courses listed.
- ▲ To be eligible for MSP-ESD with

specialization in Smart Card Technology, 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, smart card application development and smart card design cycle
- ▲ Coverage of design and development domains of smart card
- ▲ Smart card application development experience in real environment.
- ▲ Application specific course design
- ▲ 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 / B Tech / 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.

### 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

Keeping in view the diverse background of students, variety of bridge courses are offered to attain the requisite level of competency for further learning. Students will undergo an entrance examination and an interview as a part of selection process. Depending on the performance, students will be advised to undergo bridge courses. Duration of the bridge courses is 4 weeks prior to the beginning of the academic term. Performance in the bridge courses count towards partial weight age in the 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.

#### 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.

#### MVD002: 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 multiplexers, 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, subnetting, LAN, MAN, WAN fundamentals, circuit 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.

#### 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 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, n-tier architecture.

#### AST602: OBJECT ORIENTED ANALYSIS AND DESIGN USING UML (3 credits T=2 T=1)

This course focuses on the major techniques of UML, object oriented analysis and design notation and how these techniques can be applied to improve quality of productivity during the analysis and design. The topics covered include object models, analyzing system requirements, modeling concepts provided by UML, analysis and documentation of software designs using unified process, identification of use cases,

behavioral design, design partners to refine analysis and design models, implementation, testable and adaptable designs.

#### 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 & 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 design issues, testing hardware software functionality, code analysis using pc-lint and verification & validation process for complete embedded systems. Code analysis and hardware verification methods will form part of the laboratory-based learning.

##### SCT601: SMART CARDS – I PHYSICAL DESIGN & SYSTEM SOFTWARE (3 credits T=2 L=1)

This course covers the Physical design of smart cards- Physical and electrical properties, Physical transmission of data, micro controllers and memory architecture for smart cards, introduction to smart card operating systems, Features of smart card OS, encryption & Cryptography, Data compression, Data transmission protocols, Application programming interface (API for smart OS).

##### NTC601: WIRELESS COMMUNICATIONS (3 Credits, T=2 L=1)

This course begins with discussion on antennas and propagation, spread spectrum theory, cellular mobile telephone architecture, characterization of wireless channel, including path loss for different environments, multi-path fading. It also covers wireless channel impairments, cellular spectrum, cellular channels assignments, frequency reuse, fundamentals of cdmaOne and GSM cellular networks, concepts of mobility and handover in wireless cellular networks. Fundamentals and overview of PAN, Infrared, Bluetooth, Zigbee, 802.11 standards, and other 2.5G/3G wireless technologies.

#### Advanced Courses

##### ESD701: ADVANCED MICRO CONTROLLER BASED SYSTEM DESIGN (3 Credits T=2 L=1)

This course introduces 32-bit ARM processors - architecture and organization, instruction set, programming model, exception handling, assembly and C programming.

##### 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.

##### SCT702: INTRODUCTION TO CRYPTOGRAPHY (3 credits T=2 L=1)

Introduction to cryptography, pseudo-Random number generators, Hashing, principal of encryption, common encryption and decryption algorithms, Cryptography in e- business, encryption in wireless applications. Embedded and VLSI based solutions will be covered. Lab sessions will involve demonstration of

cryptographic procedures at the PC level and embedded systems levels.

##### SCT703: SMART CARDS – II APPLICATION SOFTWARE (3 credits T=2 L=1)

This course covers smart card life cycle – software development life cycle, Hardware design life cycle, interleaving the hardware design and software design. Application design methodology, Quality assurance and testing – standard compliance, ISO, IEC etc., Quality assurance and quality control with respect to smart cards. Application domains case studies- Telecom, Payment systems, Terminals, Air transportation. Sample applications.

#### Electives

##### 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

# MS Program in Embedded Systems Design

## with specialization in Smart Card Technology

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.

##### 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.

##### SCT704: RFID ARCHITECTURE AND APPLICATIONS (2 Credits)

Automated Data Collection – Electronic Product Code – RFID transponder, reader, frequency ranges – Protocols – Interoperability (sensors, tag, software, internet) – compatibility and fail safe issues in RFID classes. Tag anti-collision, reader anti-collision, security, privacy, advanced sensor networks, data routing and handling applications: controls / automation, manufacturing systems, supply chain, cargo tracking, etc. System integration issues with the existing setup like database connectivity

##### SCT705: SOFTWARE ENGINEERING AND PROJECT MANAGEMENT (3 Credits T=2 L=1)

This course provides a comprehensive analysis of software engineering techniques and shows how they can be applied in practical software projects, all with an object-oriented approach. This course extensively covers software process technology, system integration, requirement management, software project management, verification and validation, risk analysis, pattern based reuse, dependable system development, distributed system engineering and legacy systems. This course covers SW reference and models like CMMI and SPICE (ISO

15504) and ISO quality management according to ISO 9000.

#### Project

##### ESD901: 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 in relation to smart card technology. 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

with specialization in Smart Card Technology

## Course Structure

|                   | Code  | Course Name  | Credits* |
|-------------------|---|--|----------|
| <b>BRIDGE</b>     | ESD001  | Computer Architecture                              |          |
|                   | ESD003  | Introduction to Programming Languages              |          |
|                   | MVD002  | Introduction to Logic Design                       |          |
|                   | NTC002  | Computer Networks                                  |          |
| <b>FOUNDATION</b> | ESD501  | Analog and Digital Systems Design                  | 3        |
|                   | ESD502  | Micro Computer Based System Design                 | 3        |
|                   | ESD504  | Advanced C Programming                             | 3        |
|                   | ESD505  | Theory of Operating Systems                        | 3        |
|                   | ESD506  | Seminar Series – I                                 | 1        |
|                   | ACT507  | Java Programming – I                               | 2        |
|                   | AST602  | Object oriented Analysis and Design Using UML      | 3        |
| <b>CORE</b>       | ESD601  | Embedded Systems Design                            | 3        |
|                   | ESD602  | Real-Time Operating Systems                        | 3        |
|                   | ESD603  | Embedded Design Cycle                              | 2        |
|                   | SCT601  | Smart Cards – I Physical Design & Systems Software | 3        |
|                   | NTC601  | Wireless Communication                             | 3        |
| <b>ADVANCED</b>   | ESD701  | Advanced Micro-Controller Based System Design      | 3        |
|                   | ESD703  | Seminar Series – II                                | 1        |
|                   | ESD704  | Tech & IP Management                               | 1        |
|                   | SCT702  | Introduction to Cryptography                       | 2        |
|                   | SCT703  | Smart Card – II Application Software               | 3        |
| <b>ELECTIVES</b>  | <b>Select suitable subjects of total 10 Credits</b> |  |          |
|                   | ESD802  | Embedded Communication Systems                     | 3        |
|                   | ESD805  | Research Study                                     | 2        |
|                   | ESD702  | Embedded Multimedia Technology                     | 3        |
|                   | SCT704  | RFID Architecture and Applications                 | 2        |
|                   | SCT705  | Software Engineering and Project Management        | 3        |
|                   |   | Elective(s) from MBAP-TCM                          | Max 6    |
| <b>PROJECT</b>    | ESD901  | Mini Project                                       | 2        |
|                   | ESD902  | Project  | 18       |

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

# MS Program in Embedded Systems Design

with specialization in

## Automation and Control Systems

*In Association with ESIGELEC, France*

*"We believe that wireless network embedded systems represent the infrastructure of the future, in that they will be used to monitor and control a number of physical infrastructures such as electric power, water, communications, oil and gas, and chemical refineries."*

- Prof. S. Shankar Sastry,  
University of California, Berkeley.

Automation and control is not a new concept; the area is receiving periodic spurts of development and the most recent one has come from the developments in embedded systems. Thinking of automation is exciting, working on automation is fun and safe and stable implementation is a challenge. The well established areas of automation are process control and industrial automation and the newer areas are intelligent or smart homes, automated robotic vehicle plants, driverless taxis, guided missiles, auto answering machines, ATM machines, and the like. The idea is to make the systems more and more smart and secure. Design of automation and control systems involves smart integration of advanced controllers, networking and communication standards with latest developments in software technology. Another development is happening with the miniaturization of devices leading to deployment in multiple locations and communicating to each other. Distributed control and automation systems are present in multiple application areas including automotive, industrial automation and avionics, the role of embedded systems that can communicate to each other has become the central point in the design. Present curriculum provides a unified learning methodology to understand the end-to-end solutions in this emerging technology of embedded automation and control systems.

### Program

This four-semester, 24-months, full-time MS program in Embedded Systems Design with specialization in Automation and Control Systems in collaboration with ESIGELEC, France is designed to equip the students to gain industry oriented technical knowledge and also imparts hardcore skills in the high-end technologies incorporated in the area related to embedded control systems. This curriculum starts with introductory concepts in conventional control & instrumentation, and incorporates an essential knowledge base of computer control through hardware and software co-design along with application specific embedded control system design concepts. Electives related to Embedded Automation and Control has been introduced to prepare students in this emerging area.

### 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 stream 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.
- Automotive Application specific course design
- Flexibility in the choice of project domain related to automotives
- A choice of research or automotive industry project

### Eligibility

Graduates with at least a Bachelors Degree, and a minimum of 4 years study in Electrical

/ Instrumentation / Electronics / Communication / Information Technology / Computer Science or equivalent. 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 / B Tech / M.Sc (Electronics) or equivalent.
  - Scores received at the "Accepted 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