Master of Science Programme in Advanced Information Technology (MSP-AIT)

with specialisation in

VLSI and Embedded Systems Design

An autonomous full-time Masters Programme of I²IT

The ever-growing IT industry, exceeding a trillion dollars in revenue is founded on the semiconductor chips and the appliances built with them. Over the years, the semiconductor technology has been pushed to sub-micron level and new hardwares are demanding more and more embedded systems designs. The design tools for VLSI have become highly sophisticated and require indepth knowledge of their capabilities. Embedded system design that is required to create innovative products in computing, communications, networking, automotive electronics, power electronics, medical electronics require indepth knowledge of hardware as well as low level software which can be directly embedded on the hardware. This unique programme provides adequate knowledge and imports skills for modern VLSI design and embedded technologies.

THE PROGRAMME

This four trimester full-time Masters programme with specialisation in VLSI and Embedded Systems Design is conceptualised, developed and delivered by experts from the VLSI and Embedded System industries under the inspiring guidance of an internationally acclaimed panel of visionary leaders and innovators of the IT industry. It is designed to cater to the emerging market needs by providing practical knowledge of VLSI and Embedded technologies focusing on the design and implementation techniques.

DISTINCTIVE FEATURES

- Laboratory sessions to gain experience of projects
- Exposure to PLD programming and verification kits and PLDs such as CPLD & FPGA
- Exposure to industry standard tools such as ModelSim, Leonardo Spectrum, HDL Designer, Xilinx - ISE Series, etc

ELIGIBILITY

- Graduates with a Bachelor's Degree of minimum three years' duration in Electrical/Electronics/Communication/Information Technology/Computer Science or equivalent
- Students appearing in their final year of graduation may also apply
- Sound background in computing, knowledge of C preferred
- See insert on "Selection and Admission Procedure" for more details

COURSE COMMENCEMENT

The course commences in June / September / January

EVALUATION AND CERTIFICATION

- Periodic evaluation and performance improvement programme
- Module-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
- Active liaison with companies in Infotech Park
- Campus interviews by leading industries in India

CURRICULUM

COMMON FOUNDATION PROGRAMME

- **Self-Management and Leadership**
  This module helps the students to understand one's self and to develop leadership qualities. The student will be taught Yoga of well being, meditation techniques, the Art of Living, self management and leadership, team building, sports, gym and creative arts.

- **Foreign Language**
  This module is designed for students aspiring to learn a foreign language for business communication to avail of global career opportunities.
  English language course will be a pre-requisite for foreign students who do not have adequate proficiency in English.

- **ICT Business Management**
  The course provides students with basic management skills for performing in Information & Communication Technology and a high emphasis on computer usage and office productivity and project management.
  The topics include applying principles of effective communications, time management, interpersonal skills project management, product management, innovation management and finance management.

TRIMESTER I
COMMON CORE PROGRAMME

- **Computer Architecture**
  This module focuses on the study of the hardware structure of computer systems and subsystems. Topics include: processor architecture, parallelism and pipelining, cache and memory organisation, I/O controllers and interconnection structures.

- **Theory of Operating Systems**
  This module covers operating system design concepts with examples from the Linux and Windows operating systems. The topics covered (tentatively) include operating system structures, process and thread management, process synchronisation and communication, memory management, virtual memory, file system, I/O subsystem and device management, communication, protection and security.

- **Database Technologies**

  This module focuses on the theory of database engineering. The module includes topics like file processing, some introductory data structures, the differences between file processing and database processing, fundamental concepts of the relational model, normalisation of data, database integrity issues, database design, SQL and an overview of the functions of a database management system.

- **Data Communication and Networking**

  In this module, the emphasis will be on developing an understanding of the underlying principles of data communications and networking. The student will learn the concepts and terminology of data communications and networking. It covers topics on communication models, network protocols, standards, LANs, WANs, the internet, intranet and networking applications.

TRIMESTER II
ADVANCED TECHNOLOGY PROGRAMME I

- **Analog and Digital Design**

  This module focuses on learning analog components and analog circuit design, digital circuits, combinational logic designs, sequential logic designs and state machine designs.

- **VHDL Hardware Description Language**

  This module focuses on learning syntax, entities, data types, sub-programmes, packages, libraries, structural modeling style, data flow modeling style, behavioral modeling style, sequential and concurrent statements, advanced topics and synthesis issues of VHDL.

- **Verilog Hardware Description Language**

  This module focuses on learning syntax, data types, modules and ports, gate level modeling style, data flow modeling style, behavioral modeling style, switch level modeling style, task and functions, UDPs, advanced topics and synthesis issues of verilog.

- **Theory and Practice on Programmable Devices**

  This module focuses on learning PLD design flow and design implementations, principles of synthesis process, back-end activities like place and route, back annotation and timing simulation of HDL codes.

- **Principles of CMOS VLSI Design**

  This module focuses on learning basic MOS, NMOS, PMOS, CMOS, Bi-CMOS fabrication and electrical properties, CMOS circuits and logic design, MOS transistor processing technology, MOS transistor theory and CMOS gates of digital VLSI design in CMOS technology. Topics include: CMOS devices and circuits, fabrication processes, static and dynamic logic structures, chip layout, simulation and testing, low power techniques, design tools and methodologies and VLSI architecture.

- **Low Power Mixed-Signal VLSI Design**

  This module focuses on the basics of designing mixed analog and digital logic design. The topics to be covered include low voltage, low power analog desgn for mixed analog/digital VLSI systems in CMOS technologies, OpAmps and comparators, sample and hold, switched capacitor filters, applications in baseband wireless communications and integrated sensors.

TRIMESTER III
ADVANCED TECHNOLOGY PROGRAMME II

- **Designing with Micro Controllers**

  The architecture, programming and hardware interfacing of 8-bit and 16 bit micro controllers are discussed. The students will learn how to design systems/products based on 8/16-bit micro controllers. Students will be able to analyze the timing issues involved in designing a micro controller based application.

- **Embedded System Design**

  In this module, embedded system hardware and firmware design will be explored. Issues such as embedded processor selection, hardware/firmware partitioning, glue logic, circuit design, circuit debugging, development tools, firmware architecture, firmware design, and firmware debugging will be discussed.

- **Real-Time Operating Systems**

  This module focuses on the principles of real-time operating systems. The module aims to prepare the students to design and implement real-time application, understand the functionality of a real-time operating system and use RTOS for application development. The topics include operating systems basic concepts, hardware and software features required for real-time systems, process management, scheduling, inter-process communication and synchronisation, memory management, virtual memory and distributed systems.

- **Digital Signal Processing**

  This course provides students with solid foundation on the theory and applications of digital signal processing. Fundamental and advanced mathematical and physical DSP concepts will be discussed. Topics include signals, signal processing, discrete-time signals, systems in time domain, Discrete-Time Fourier Transform (DTFT), DFT, Z-transform, transform analyses of Linear Time Variant (LTI) systems, A/D, D/A converters, digital processing of continuous time signals, digital filter design, FFT, the digital spectral analyses and theory and applications of non-uniformly sampled signals.

- **Introduction to Network Programming**

  This module prepares the students with network programming concepts and developing applications under Linux/Windows environment using sockets. The topics include networking, TCP/IP protocol suite, sockets programming, internet protocols, WAP web programming, security and network programming APIs.

- **Advanced Topics in Embedded System Design**

  This module introduces fundamental concepts in hardware/software co-design of embedded systems, exposing students to the cutting-edge research work and the emerging trends in related topics and provide students with research experience in embedded system design and analysis. The main topics include system modeling, performance and power/energy analysis and estimation, system-level partitioning, synthesis and interfacing, co-simulation and emulation. Research papers with significant impacts on the above topics are studied in detail. Class discussions, participation and research project are integral parts of this module.

TRIMESTER IV
RESEARCH PROGRAMME

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

The Institute reserves the rights to change / revise the course contents as per the prevailing market conditions and technological advances.

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

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Master of Science Program in Advanced Information Technology (MSP-AIT)

with specialization in

Micro Electronics & VLSI Design

An autonomous full-time residential Masters Program (18 months)

"Instead of shrinking the dimensions of Si devices or perfecting exotic compound Semiconductor technologies, lets make best use of both these technologies" — **Prof. Serge Luryi**

Ever since the invention of the transistor and especially after the advent of integrated circuits, semiconductor devices have kept expanding their role in our lives. Highly integrated transistor circuits entertain us, keep track of our money, make our home appliances smart and keep us connected to our beloved ones. New applications are emerging in the areas of networking and communication, control and automation, manufacturing, automobile and transportation, power controls, E-learning, medicine, signal processing and system securities. For many years the celebrated silicon technology has known a virtually one-dimensional path of development: reducing the minimal size of lithographic features. But, beyond CMOS, after 2010 to 2014, there will be new material challenges hence new approaches will be needed to develop devices with new processes using new materials. Hence, new architectures and new circuits will be the key to success. It is anticipated that future VLSI chips will have "chessboard" architecture. "Active Packaging" is going to play important role in designing such architectures. International R&D spending in the semiconductor industry has reached a record $20 billion in 2004 from $14.2billion in 2001. The Philips, STMicroelectronics and Motorola alliance has opened a joint R&D center in France, dedicated to the future generation of nanoelectronics and semiconductor manufacturing on 300mm silicon wafers. Huge investments, by the three partners and other leading semiconductor companies, in the facility and planning, will create a number of job opportunities in the region and worldwide. This has increased the need to focus on core competencies, which lead to advanced specialization in VLSI design service market. VLSI Design is coming up very strongly on the Indian horizons, due to less initial investment cost. IC designing, IP and EDA services constitute a big chunk of the Indian semiconductor sector. With all the leading IC design companies opening their design centers in India, there are many job opportunities emerging out in the field of microelectronics and VLSI design. According to one survey done by TCS and IIT Mumbai, there is a demand of around 2500 master's level candidates per year in India to meet the challenges raised by state-of-the-art system-on-chip design for emerging applications. Companies with skills in analog, mixed signal and RF domains are comparatively less in number to the skills available in digital domain. A gap exists between demand and supply of skilled manpower in this area. Identifying this huge gap and studying the reasons for this gap, I²IT has decided to come-up with a unique program that can address all the issues in the field of microelectronics and VLSI design.

THE PROGRAM

It is a fact that we are at the turning point in the evolution of the giant semiconductor and VLSI design industry. The program is exactly designed to meet all the challenges in VLSI market. This four trimester, 18 months program of 60 Credits is designed to equip students to understand and accept; design, development and testing responsibilities in integrated circuit design. The bridge courses ensure that every student attains the level of competency for further learning. The foundation courses give students a broad background in fundamentals with preliminary system design knowledge. Core and advanced courses provide further in depth knowledge including: Fabrication technology, ASIC modeling, Layout synthesis, ASIC Design Flow, Testing and a mini project using basic VLSI design tools. Specialization courses and main project focus on implementation of VLSI design flow using state-of-the art CAD tools in low power, mixed signal and RF IC design.

PROGRAM STRUCTURE

- Successful completion requires 60 credits.
- To bridge the gap between theory and practice project work worth 12 credits in the last trimester.
- The entire curriculum is distributed over six levels, which are aimed at transcending the students' level of understanding for corporate readiness. The levels respectively are, Bridge, Foundation, Core, Advanced, Electives and Project.

- The student has to carryout ONE mini project in specified trimester to consolidate the technical knowledge in the selected specialization stream.
- Students are required to take "Two" electives from the Elective Courses.

PROGRAM PEDAGOGY

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

DISTINCTIVE FEATURES

- Well-structured theory and laboratory sessions to gain experience of practical situations in chip design for various applications.
- Collaboration with leading institutes and industry for FAB house exposure and curriculum updating to keep pace with industrial needs and requirements.
- Working with the latest VLSI CAD tools such as CADENCE suit, Mentor Graphics FPGA Advantage, Xilinx Web-Pack ISE, Model-Sim, Magic and Altera tools.
- An option to work on projects which require working with faculty members and students from other streams such as Advanced

software technologies, embedded systems, Network Technology and management.

- Expert lectures, seminars and case studies by leading experts from industry.

ELIGIBILITY

- *Graduates with a Bachelor's Degree (with minimum 50 percent marks) of at least four years' duration in Electrical/Electronics/ Communication/Information Technology/Computer Science or equivalent*
- Basic knowledge of Digital and Analog systems
- See insert on 'Selection and Admission Procedure' for more details

PROGRAM COMMENCEMENT

The program commences in June / September / January

EVALUATION AND CERTIFICATION

- Continuous evaluation and performance improvement program
- Course-wise Credits
- Balanced assessment based on internal, laboratory and final theory examination 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

CURRICULUM

BASIC COURSES

- **COM001: LIFE SKILLS DEVELOPMENT**

  This basic course prepares students for the rigours 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 course 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 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 entrance examination and interview as part of selection process. Depending on the performance, students will be advised to undergo the bridge course
- Duration of the bridge courses is 4 weeks prior to the beginning of the academic term
- **AST 001: 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. 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.

- **MV001: INTRODUCTION TO CIRCUIT THEORY**

  The course covers KCL, KVL, Ohms law, Thevinins and Norton's theorem, energy & power relationships, time domain and frequency domain analysis of RLC circuits, steady state and transient response analysis. It also covers, transmission line theory and concepts, passive filter design, lab experiments using circuit simulation tool.

- **MV002: ELECTRONIC DEVICE PHYSICS AND MODELING**

  This course focuses on P-N junction, metal semiconductor junctions, Ohmic and Schottky contacts, BJT, FET, small signal models and piecewise analysis of nonlinear circuits, analysis and design of basic single stage transistor amplifiers. The course also addresses issues in formulation of circuit equations, equivalent circuits, bias stabilization techniques, gain bandwidth product and frequency response, power analysis, introduction to operational amplifier based circuits, lab experiments using circuit simulation tool.

- **MV003: INTRODUCTION TO LOGIC DESIGN**

  This course covers binary, non binary systems, Boolean algebra, digital design techniques, logic gates, combinational circuits, K maps, flip-flops, sequential circuits and state machine theory, preliminary timing analysis, digital circuit building blocks such as multiplexers, decoders, counters. The course further covers PLA, PAL, SPLD, Various logic families, I/O standards, Bipolar based logic; ECL, BiCMOS, Memory; SRAM, DRAM, EEPROM, I/O circuits and interfacing between different logic families.

FOUNDATION COURSES

- **MV501: OVERVIEW OF MICROELECTRONICS TECHNOLOGY AND APPLICATION ORIENTED SEMINARS (1 Credit T=0, L=1)**

  Experts from industry and academia provide an introduction to advances and possibilities in the advanced technology. Students are given a bird's eye view of multiple technological frontiers from the field of microelectronics and VLSI Design technology.

- **MV502: ANALOG IC DESIGN (3 Credits T=2, L=1)**

  This course gives a review of integrated circuit fabrication technologies, BJT and MOS transistor models, multi transistor amplifier, feed back theory and application of feedback amplifiers, stability consideration, pole-zero cancellation, root locus techniques in feedback amplifiers, detailed analysis and design of integrated operational amplifiers, power amplifiers, voltage references, voltage regulators, rectifiers, oscillators, multipliers, mixers, phase detectors, phase locked loops, simulation using SPICE.

- **MV503: DIGITAL IC DESIGN (3 Credits T=2, L=1)**

  This course covers the IC fabrication overview, design and analysis of static CMOS inverter, long channel I-V characteristics including velocity saturation, mobility degradation, hot carriers gate depletion, short channel effects, scaling strategies, complex combinational logic gates, dynamic logic families, pass transistor logic, ratioed logic, sequential elements (latches, flip-flops), complete circuit analysis for speed space and power using basic MOSFET model and interconnects effects, fast adder, multipliers and barrel shifter circuits, use of CAD tool for MOSFET based circuit simulation (SPICE).

- **MV504: LOGIC SYNTHESIS AND OPTIMIZATION (3 Credits T=2, L=1)**

  This course covers the advanced design of logic circuits, technology constraints, theoretical foundation, computer aided design algorithms, two level and multilevel optimization of combinational circuits. Further it covers optimization of state machines, high level synthesis technique: modeling, scheduling and binding, CPLD, FPGA, synthesis and optimization for PLD architectures, introduction to verification and testing concepts.

- **ESD502: MICROCOMPUTER BASED SYSTEM DESIGN** (3 Credits T=2, L=1)

  This course introduces the 8-bit/16-bit-bit micro controllers, RISC/CISC and Harvard/ Princeton architectures, timers/ counters. It also covers interfacing with UART, SPI, PWM, WDT, input capture, output compare modes, I2C, CAN, interfacing LED, switches, ADC, DAC, LCD, RTC, interfacing analog circuits, FPAA and FPGA, hardware-software co-design issues, emerging bus standards (USB, Compact PCI), types of memories, programming in assembly and C (GNU Tools).

- **ESD503: DIGITAL SIGNAL PROCESSING.**(3 Credits T=2, L=1)

  This course covers discrete–time signals and systems, system characterization in time and frequency domains, discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, A/D, D/A converter. It also covers basic concepts in digital signal processing of continuous time signals, digital filter design (FIR and IIR), digital spectral analyses of signals, application of non-uniformly sampled signals. This module also includes software implementation of DSP algorithms.

CORE COURSES

- **MV601: MICROCOMPUTER ARCHITECTURE** (3 Credits T=3, L=0)

  This course introduces the basic concepts of computer architecture and organization, computer evolution, design methodology, performance evaluation, elementary queuing models, hardware and micro programmed control, nano-programming, memory hierarchies, virtual Memory, cache design, input-output architectures, interrupts and DMA, I/O processors, parallel processing, pipelined processors, multiprocessors, case study of advanced 32- / 64-bit processor architectures, VLIW processors, instruction scheduling, compiler issues, Floating-point math using IEEE 754 standard.

- **MV602: MICROELECTRONICS FABRICATION TECHNOLOGY** (3 Credits T=3, L=0)

  The course addresses the issues in processing of silicon for manufacture of VLSI. It covers fundamentals of materials processing like phase diagrams, nucleation and growth. It also covers principles and manufacturing practices of VLSI fabrication processes like crystal growth, epitaxy and CVD, diffusion, ion implantation, oxidation, deposition of thin film, nitrides and silicides, lithography and etching, MOS fabrication, interconnects, contacts and dielectrics, IC process integration, IC packaging, reliability, yield and MEMS fabrication.

- **MV603: ASIC MODELING AND FORMAL VERIFICATION** (3 Credits T=2, L=1)

  This course focuses on design specification v/s implementation, design errors, introduction to VHDL and Verilog, analog HDL, System C, simulation v/s symbolic verification techniques, functional verification of combinational and sequential circuits, path delays, path sensitization, software verification, BDD techniques and abstraction.

- **MV604: LAYOUT SYNTHESIS AND OPTIMIZATION** (3 Credits T=2, L=1)

  This course covers theory of circuit layout partitioning and placement algorithms, routing algorithms, simulated annealing and other optimization techniques and their applications in CAD, layout transformation and compaction, fault repair algorithms for RAMs and PLAs, hardware synthesis from behavioral modeling, artificial intelligence based CAD.

- **MV605: PCB DESIGN TECHNOLOGY** (1 Credit T=0, L=1)

  This course focuses on lay-out planning, general rules, design rules for digital circuit, high frequency PCB design, analog and mixed signal PCB design, PCBs in power and microwave applications, PCB fabrication process, PCB technology trends, multi-layer boards, CAD tool for PCB artwork and layout, soldering and assembly techniques.

- **ESD606: TECHNOLOGY & IP MANAGEMENT** (1 Credit)

  This course introduces the Indian and global IP practices, specific focus on embedded software, case studies from different application disciplines.

ADVANCED COURSES

- **MV701: 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 theoretic 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.

- **MV702: ASIC DESIGN FLOW AND CAD FOR VLSI** (3 Credits T=1, L=2)

  This course introduces the algorithms and techniques underlying today's integrated design approaches, rapid implementation of VLSI circuits, aspects of modern design flow: specification to GDS-II tape out, design entry tools, synthesis tools, logic optimization tools, logic and circuit simulation tools, timing verification of combinational and sequential circuits, clock schedule optimization, physical design, layout, design rule checking, design flows for the microelectronics industry, ASIC and SOC design concepts.

- **MV703: TESTING AND DESIGN FOR TESTABILITY** (2 Credits T=1, L=1)

  This course focuses on logic simulation, fault sources and models, fault simulation, testing process, combinational and sequential circuit testing, testing for stuck at fault, fault simulation, functional testing, D-algorithm and PODEM, design for testability, compression techniques, BIST, self testing circuits and systems, memory and processor testing, automatic test pattern generation, boundary scan testing (JTAG).

- **MV704: MICROELECTRONICS & VLSI DESIGN STATE-OF-THE-ART AND FUTURE PERSPECTIVE** (1 Credit T=0, L=1)

  The course summarizes and links all the courses studied in the program.

ELECTIVES

The student has to select TWO ELECTIVES from the given list of elective courses or Suitable Courses from other departments.

- **MV801: LOW POWER IC DESIGN** (3 Credits T=2, L=1)

  This course introduces the low power CMOS VLSI design, power dissipation in CMOS FET devices, power estimation, synthesis for low power, design and test of low voltage CMOS circuits, low power static RAM architectures, low energy computing using energy recovery techniques, low voltage circuit techniques using floating gate transistors, low voltage CMOS operational amplifiers, threshold voltage scaling and control, lightly doped drain structures, multiple threshold CMOS (MTCMOS), substrate bias controlled variable threshold CMOS, silicon on insulator based technologies, adaptive power supply systems, adiabatic logic circuits, power analysis techniques, power optimization techniques, etc.

- **MV802: MIXED SIGNAL IC DESIGN** (3 Credits T=2, L=1)

  This course introduces the aspects of integrating both analog and digital CMOS components onto the same integrated circuit, representation of signals in the analog and digital domains, sample and hold, Nyquist theorem, constraints such as maximum signal handling capability, electronic noise, frequency limitations, mixed signal layout issues. The course also covers different types of filters, switched capacitor circuits, various data converters, various types of comparators.

- **MV803: RF IC DESIGN** (3 Credits T=2, L=1)

  This course introduces the techniques employed in designing Radio Frequency Integrated Circuits used in wireless communication and

mobile applications. Introduction to RF circuit design, amplifier at GHz frequencies, transceiver architectures, short channel transistor model, passive component models, MOS and bipolar technology, LNA, mixers, VCO's, frequency synthesizers, power amplifiers and base band circuits.

- **MV804: MEMS (3 Credits T=3, L=0)**

  The course will describe the principles, fabrication techniques and applications of micro electro-mechanical systems. Topics covered will be: Silicon micro-machining, wet and dry etching technologies for semiconductors including planer thin-film processing, wafer bonding, metals and insulators, advanced lithography, principles of MEMS design and their application to a variety of Microsystems, fabrication of micro-sensors, micro-actuators, micro-mechanical resonators, optical switches, micro-pumps, transduction mechanism and modeling in different energy domains, computer aided design for MEMS layout, fabrication and analysis.

- **MV805: NANO TECHNOLOGY (3 Credits T=3, L=0)**

  The course will discuss the science and technology of fabrication and application of nano-materials, nano-devices and nano-systems. Topics covered will be: Properties of materials with nanometer dimensions, quantum wells, quantum wires and quantum dots, scanning probe microscopy (SPM), scanning tunneling mode (STM), carbon nanotubes, nanoscale materials synthesis, positional assembly and self assembly, nanolithography, nanoscale devices, bottom up nano-fabrication of systems, applications in information technology and biology and ethical issues.

- **MV806: COMPOUND SEMICONDUCTOR DEVICES (3 Credits T=3 ,L=0)**

  This course will describe the physics, modeling, application and technology of compound semiconductor devices (primarily III-Vs) for use in electronics, optoelectronic, photonic devices and integrated circuits. Topics covered will be properties of compound semiconductors, heterojunctions, quantum structures, strained layers, band gap engineering, liquid phase epitaxy and molecular beam epitaxy, III-V semiconductor IC fabrication, metal-semiconductor field effect transistors (MESFETs); heterojunction field effect transistors (HFETs), quasi-ballistic transistor concepts and bipolar transistors (HBTs); photodiodes, laser diodes, and other optoelectronic devices

PROJECT

- **MV902: PROJECT (15 Credits)**

  Students in this course should 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, which 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 deliver 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 : 60

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