# AcSIR-IMP-2015 Programme Brochure

*(Admission Session : August, 2015)*

## Integrated MTech-PhD Programme
## in
## Advanced Electronic Systems
## at
## CSIR-CEERI, Pilani

The integrated MTech-PhD programme has two segments:

1. MTech programme of 2 years duration spread over 4 semesters.
2. PhD programme of 3 years duration after the successful completion of the MTech programme. Continuation into the PhD programme will be decided on case-by-case basis.

This full-time programme aims to provide in-depth exposure to the engineering concepts, research methodology and hands-on experience on advanced real-life R&D projects in different application areas such as Process Control Instrumentation, Digital Signal and Image Processing, Embedded Systems, and Power Electronics. Students completing this integrated programme will be fully research-enabled and industry-ready.

Modern electronic systems engineering requires designers and users to understand various paradigm changes in the development of electronic systems. From the earlier period of designing electronic systems with discrete devices and few ICs; the technology, with enhanced power of computation and speed, has advanced to electronic system design based on the use of sensors, FPGAs, ASICs, processors, DSPs and microcontrollers with real-time operating systems for various applications such as image processing, smart instrumentation, wireless sensor networking, communications, power electronics and drives, and process control instrumentation. With the advent of powerful system specification, modeling, design and simulation tools, the time taken from concept to implementation has been considerably reduced. This has also been accompanied with increase in functional complexity.

The programme offers a unique opportunity to electronics, instrumentation, electrical, computer and other engineers to understand the nuances of advanced electronic systems and embedded systems as well as to have hands-on experience on the development of such systems.

The first and second semesters of the first year of the programme focus on the study of core and advance-level courses with associated laboratories related to understanding of the principles of electronic system design with emphasis on the use of modern tools in modeling, simulation, design and testing of electronic systems.

The third and fourth semesters of the programme give the opportunity to the candidates to effectively utilize the knowledge acquired through the courses towards advanced R&D project work and dissertation in their areas of interest.

The laboratory facilities and research expertise of the scientists acting as faculty and mentors further adds to the programme's uniqueness.

The medium of instruction and evaluation is English.

**Number of Seats in the Programme**

The total number of seats available is 6.

**Admission Process and Eligibility for Admission**

Please see the AcSIR website at **http://acsir.res.in/** for on-line submission of the admission form and details of eligibility.

**Fellowship**

Fellowship amount will depend on selection as a JRF (NET-Engg-JRF or GATE-JRF).

**Programme Fee Structure**

1. One-time Admission Fee (non-refundable) : Rs. 4,000.
2. One-time Security Deposit (refundable) : Rs. 6,000.
3. Semester Fees (non-refundable) : Rs. 24,000.

Students wanting to withdraw from the programme after deposit of fees and security amount will need to apply in writing for refund. If such an application is made before 7 days to the start of first semester session at CSIR-CEERI, refund of fees/other charges will be made after deducting the admission fee amount of Rs. 4,000.

No refund of fees / other charges will be made if the student leaves after joining the programme except for the security deposit / caution money amount of Rs. 6,000.

Total amount of Rs. 34,000 needs to deposited at the time of admission. Subsequently, only the semester fees of Rs. 24,000 needs to be deposited before the start of every semester for the duration of the MTech programme. The tuition fees during PhD programme is Rs. 1,000 per month.

For NEFT bank transfer, please transfer the amount to the bank account number **61033385318** of "Director, CSIR-CEERI" at SBBJ, Pilani **(IFSC code SBBJ0010398)** with appropriate narration statement. *This is the preferred mode of transaction for the depositing the amount.*

In case of Demand Draft, please get it issued in favour of "Director, CSIR-CEERI" payable at Pilani and post it by speed post or registered letter to "Director, CSIR-CEERI, Pilani – 333 031" with your name written in pencil on the reverse side of the demand draft.

**Important Dates**

All important dates will be announced on AcSIR website at **http://acsir.res.in/**.

The detailed academic programme calendar will be made available before the start of each semester.

**Please visit the AcSIR website at http://acsir.res.in/ for more information. You should also periodically visit CSIR-CEERI's website link for AcSIR-IMP-2015 at http://www.ceeri.res.in/ for updates and news about this programme.**

## MTech Programme : Semester-wise Scheme : Advanced Electronic Systems

**Semester-I**

| Subject Code | Subject | L-T-P-C |
|---|---|---|
| ENG(CEERI) : 2-208 | Process Control Techniques and Platforms | 2-0-0-2 |
| ENG(CEERI) : 2-209 | Digital Systems Engineering | 2-0-0-2 |
| ENG(CEERI) : 2-210 | Intelligent Instrumentation | 2-0-0-2 |
| ENG(CEERI) : 2-212 | Signal and Image Processing-I | 2-0-0-2 |
| ENG(CEERI) : 2-213 | Power Electronics | 2-0-0-2 |
| ENG(CEERI) : 2-215 | Lab: Process Control Techniques and Platforms | 0-0-2-1 |
| ENG(CEERI) : 2-216 | Lab: Digital Systems Engineering | 0-0-2-1 |
| ENG(CEERI) : 2-217 | Lab: Intelligent Instrumentation | 0-0-2-1 |
| ENG(CEERI) : 2-219 | Lab: Signal and Image Processing-I | 0-0-2-1 |
| ENG(CEERI) : 2-220 | Lab: Power Electronics | 0-0-2-1 |
| ENG(CEERI) : 1-206 | Technical Communication | 2-0-0-2 |

**Semester-II**

| Subject Code | Subject | L-T-P-C |
|---|---|---|
| ENG(CEERI) : 2-211 | Real-time Embedded System Design | 3-0-0-3 |
| ENG(CEERI) : 3-208 | Advances in Process Control | 2-0-0-2 |
| ENG(CEERI) : 3-209 | Signal and Image Processing-II | 2-0-0-2 |
| ENG(CEERI) : 3-210 | Applications of Power Electronics | 2-0-0-2 |
| ENG(CEERI) : 2-218 | Lab: Real-time Embedded System Design | 0-0-4-2 |
| ENG(CEERI) : 3-238 | Lab: Advances in Process Control | 0-0-2-1 |
| ENG(CEERI) : 3-239 | Lab: Signal and Image Processing-II | 0-0-2-1 |
| ENG(CEERI) : 3-240 | Lab: Applications of Power Electronics | 0-0-2-1 |
| ENG(CEERI) : 2-206 | Project Management | 2-0-0-2 |

**Semester-III**

| Subject Code | Subject | L-T-P-C |
|---|---|---|
| ENG(CEERI) : 2-223 | CMOS Digital VLSI Design | 3-0-0-3 |
| ENG(CEERI) : 2-226 | Lab: CMOS-based Physical Design | 0-0-4-2 |
| ENG(CEERI) : 2-098 | MTech Dissertation-I | 0-7-14-14 |

**Semester-IV**

| Subject Code | Subject | L-T-P-C |
|---|---|---|
| ENG(CEERI) : 2-099 | MTech Dissertation-II | 0-9-18-18 |

# MTech Programme : Brief Course Descriptions : Advanced Electronic Systems

**ENG(CEERI) : 1-206 : Technical Communication : 2-0-0-2**

Role and importance of technical communication; Effective written and oral communication; Ethical issues; Technical report writing; Technical / R&D proposals; Research paper writing; Letter writing and official correspondence; Emails; Oral communication in meetings and group discussions; Oral presentations; Use of modern aids.

**ENG(CEERI) : 2-206 : Project Management : 2-0-0-2**

Introduction and overview; Project formulation, evaluation and initiation; Project planning and scheduling; Risk management; Project execution and implementation; Project monitoring and control; Project closure; Project documentation; Leadership and teamwork issues; Complex projects; Advances and trends.

**ENG(CEERI) : 2-208 : Process Control Techniques and Platforms : 2-0-0-2**

Introduction to embedded systems for process control; 8- and 16-bit PIC microcontroller architecture, programming, I/O, Timer and interfaces, dsPIC architecture overview; ARM processor architecture and programming model; Functional Analysis : fundamental and common non-linearities; Phase plane analysis, limit cycles and linearization; Stability concept, methods, disturbances and analysis; P, PI, PID control analysis, design, implementation, comparison and applications;

**ENG(CEERI) : 2-209 : Digital Systems Engineering : 2-0-0-2**

Overview of digital system specification, modeling and design methodologies; Timed, Untimed and Synchronous models of computation; Modeling of computation and memory interfaces; Basic concepts of system design specification, modeling and simulation using VHDL (or using SystemC); Transaction level modeling (TLM) based methodologies; Trends in digital systems design.

**ENG(CEERI) : 2-210 : Intelligent Instrumentation : 2-0-0-2**

Sensor characteristics and terminology; Sensing techniques for temperature and humidity; Data conversion; Intelligent sensor systems structure and characteristics; Modeling of sensors and strain gauges; Temperature compensation, linearization and calibration; Mutli-sensor systems; Introduction to soft-computing techniques; Foundations of fuzzy approaches, fuzzy relations, fuzzy modeling, fuzzy-rules based systems; Introduction to statistical pattern recognition, dimensionality reduction and classification; Future trends in intelligent sensor systems.

**ENG(CEERI) : 2-211 : Real-time Embedded System Design : 3-0-0-3**

Fundamentals of FPGA-based embedded system design, FPGA architectures and design tools; Designing soft processors with FPGAs; Power/energy efficient embedded system design; Real-time programming and communication; Concurrent programming, synchronization and communication; Scheduling of uni-processor and multi-processors; Real-time operating systems (RTOS) organization, concepts of kernel design, RTOS scheduling; Case studies of an example RTOS and an embedded OS; Other system-level design considerations; Trends in embedded system design.

**ENG(CEERI) : 2-212 : Signal and Image Processing-I** : **2-0-0-2**

Linear time-invariant (LTI) discrete-time Systems (DTS) in time domain and transform domain; Discrete-time Fourier transform (DTFT), discrete Fourier transform (DFT), Z-transform; Transform analysis of LTI system : inverse system, all-pass system, minimum phase system, linear phase system; Image sensor models; Image representations and properties; Noise models, image de-noising; image pre-processing; Segmentation; Morphological image processing : basic concepts; Edge detection algorithms; Histogram, histogram equalization and its applications; Motion detection algorithm; Applications of edge detection, face detection and motion detection.

**ENG(CEERI) : 2-213 : Power Electronics : 2-0-0-2**

Introduction to power electronics; Power semiconductor devices, switching characteristics, driver circuits, loss and cooling requirements; AC-DC and DC-DC converters – steady-state analysis, modeling and simulation, converter transfer function; I/O filter design and analysis; Voltage-mode and current-mode control of converters; Basic magnetic theory, Inductor and transformer design.

**ENG(CEERI) : 2-215 : Process Control Techniques and Platforms Laboratory : 0-0-2-1**

Laboratory practices and safety considerations; Assembling/populating PCBs for process control applications; PIC and dsPIC platform programming exercises; Monitoring of process parameters in a RO plant; Control of actuators, valves and pumps in a RO plant; Flow monitoring and control for e-nose applications; Data analysis using e-nose and GC/MS system.

**ENG(CEERI) : 2-216 : Digital Systems Engineering Laboratory : 0-0-2-1**

Laboratory practices and safety considerations; Understanding Xilinx FPGA architecture; Designing with Xilinx FPGAs using Xilinx EDK, Core Generator; Architecture wizard and doing pin assignments; Using Xilinx ChipScope; Design of DSP sub-blocks using SysGen; Designing system blocks using synthesis tools.

**ENG(CEERI) : 2-217 : Intelligent Instrumentation Laboratory : 0-0-2-1**

Laboratory practices and safety considerations; Data acquisition (DAQ) techniques; LabView-based virtual instrument and GUI design; Analog and digital I/O; File I/O; Integration of sensor, DAQ and GUI modules; Experiments with modeling and use of sensors and strain gauges; Implementation of fuzzy systems and algorithms; Time series forecasting.

**ENG(CEERI) : 2-218 : Real-time Embedded System Design Laboratory : 0-0-4-2**

Laboratory practices and safety considerations; Basic steps and flow of embedded hardware design; Developing a PowerPC and/or MicroBlaze based embedded system by using Xilinx EDK; Adding a processor system to a FPGA design; Adding IP block to a hardware design; Bus interface and memory considerations; System simulation with RTOS support; Multi-processor system design and implementation.

**ENG(CEERI) : 2-219 : Signal and Image Processing-I Laboratory : 0-0-2-1**

Laboratory practices and safety considerations; MATLAB experiments on LTI DT systems and their analysis in the transform domain with special focus on inverse system, linear phase system, all-pass system and minimum system analysis; MATLAB experiments on various color models, image pre-processing, de-noising, segmentation and morphological image processing.; Experiments on histogram equalization and edge detection algorithms.

**ENG(CEERI) : 2-220 : Power Electronics Laboratory : 0-0-2-1**

Laboratory practices and safety considerations; Familiarization with power electronic devices and components, PCB design aspects; IGBT / Power MOSFET gate charge and switching times measurement; Estimating device loss; Design of gate driver circuit; Experiments with PWM controllers for buck and boost operations; Simulation of DC-DC converter using MATLAB and SPICE; Building forward and flyback controller for DC-DC conversion.

**ENG(CEERI) : 2-223 : CMOS Digital VLSI Design : 3-0-0-3**

MOS Capacitor: energy-band diagram, C-V curve, accumulation, depletion and inversion regions; MOS transistor: threshold voltage computation, body effect, channel length modulation, current equation; NMOS/ pseudo-NMOS/CMOS inverters and their analysis, static and switching characteristics; CMOS processing technology, layout design rules and technology interfaces, layer properties, parasitic and delay estimation; Layout of CMOS inverter and basic gates; CMOS latch-up; Combinational MOS logic circuits; Pass transistor

and transmission gate based logic circuits; Dynamic logic circuits; Sequential logic circuits; Latches, D F/F; Clocking issues; Programmable Logic, PLA/PLD, memories; VLSI subsystem design strategies: structure, hierarchy, regularity, modularity; Various adder architectures: ripple carry adder, carry look-ahead adder, carry select adder, carry save adder; Booth multiplier, array multiplier; Shift register; Parity generator; Barrel shifter; State machines and controller design; Trends in VLSI design.

**ENG(CEERI) : 2-226 : CMOS-based Physical Design Laboratory : 0-0-4-2**

Laboratory practices and safety considerations; Overview of the laboratory toolset environment; Schematic editor; SPICE/Spectre simulation; Layout editor; Extraction, DRC and LVS tools; Transfer and output characteristics of NMOS transistor, parameter variations; CMOS inverter design and layout; Layout versus schematic (LVS), circuit simulation and layout of basic gates, D latch, D flip-flop, and adders; VLSI subsystem design mini-project.

**ENG(CEERI) : 3-208 : Advances in Process Control : 2-0-0-2**

Review of control system concepts; Issues in advanced process control design; State variable representation of continuous and discrete time systems; Concepts of observability and controllability; Design and analysis of SISO/MIMO feedback and feed-forward control systems; Steady state optimization, linear quadratic regulator control, stability using Lyapunov technique; Process applications of optimal control, adaptive control, model reference adaptive control; System analysis and design, process/plant uncertainty and robustness, sliding mode and robust control; Typical applications and case studies.

**ENG(CEERI) : 3-209 : Signal and Image Processing-II : 2-0-0-2**

Continuous wavelet transform (CWT) and time-frequency resolution; Multi-resolution analysis and discrete wavelet transform (DWT); Fundamentals of multi-rate signal processing and perfect reconstruction; Spatial/2-D convolution and 2-D DWT; Applications of DWT; Image compression. Image registration, image restoration; Circular Hough transform and its applications; Hidden Markov model (HMM), support vector machine (SVM); Principle component analysis (PCA) and its application for gesture recognition; Introduction to neural networks and their application for human gesture recognition; Feature detection, scale-invariant feature transform.

**ENG(CEERI) : 3-210 : Applications of Power Electronics : 2-0-0-2**

Design and applications of buck, boost, half-bridge and full-bridge converters; Soft switching conversion techniques; Single-phase and three-phase DC-AC converters; PWM techniques for inverters; Design of single-phase inverters for UPS and photovoltaic applications; Design and applications of DC and AC drives; Unity power factor conversion techniques and their applications.

**ENG(CEERI) : 3-238 : Advances in Process Control Laboratory : 0-0-2-1**

Laboratory practices and safety considerations; MATLAB exercises for control system design; LabView exercises for control system design; PID control design and simulation of inverted pendulum; Case studies – Design and simulation of motion control algorithms, Design and simulation of optimal controls for a MIMO process, Adaptive/robust controller design and simulation.

**ENG(CEERI) : 3-239 : Signal and Image Processing-II Laboratory : 0-0-2-1**

Laboratory practices and safety considerations; MATLAB experiments on DWT and multi-rate signal processing; A mini-project on DWT-based application, motion detection algorithm and circular Hough transform, feature detection, scale-invariant feature transform, *etc.*

**ENG(CEERI) : 3-240 : Applications of Power Electronics Laboratory : 0-0-2-1**

Laboratory practices and safety considerations; Design and experiments with half-bridge and full-bridge converters; PWM generation and control of single-phase and 3-phase inverter; Experiments with DC and AC motor drives; Mini-project.

## List of Faculty Members : Advanced Electronic Systems

| S. No. | Name | Designation | Discipline |
|---|---|---|---|
| 1. | Dr. Chandra Shekhar | Director | Microelectronics/VLSI System Design |
| 2. | Sh. Rahul Varma | Chief Scientist | Power Electronics and AC/DC Drives |
| 3. | Sh. Raj Singh | Chief Scientist | Microelectronics/VLSI System Design |
| 4. | Dr. P. Bhanu Prasad | Chief Scientist | Electronic Instrumentation/Embedded Systems |
| 5. | Dr. S. A. Akbar | Chief Scientist | Control Systems |
| 6. | Dr. J. L. Raheja | Sr. Princ. Sc. | Image Processing |
| 7. | Dr. S. S. Sadistap | Sr. Princ. Sc. | Process Control/Electronic Instrumentation |
| 8. | Dr. P. C. Panchariya | Sr. Princ. Sc. | Electronic Instrumentation/Embedded Systems |
| 9. | Dr. A. Karmakar | Princ. Sc. | Signal Processing/VLSI Design |
| 10. | Dr. K. Solomon Raju | Princ. Sc. | Digital Systems Engineering/Embedded Systems |
| 11. | Sh. Santosh Kumar | Sr. Scientist | Electronic Instrumentation |
| 12. | Sh. A. K. Dhakar | Sr. Scientist | Power Electronics and AC/DC Drives |
| 13. | Sh. Saikrishna V. | Scientist | Process Control/Electronic Instrumentation |
| 14. | Sh. Pramod Tanwar | Scientist | Digital Systems/Embedded Systems |
| 15. | Dr. B. A. Botre | Scientist | Instrumentation/Embedded Systems |
| 16. | Ms. Chitra Gautam | Scientist | Process Control/Electronic Instrumentation |
| 17. | Sh. Brijendra Verma | Scientist | Power Electronics and AC/DC Drives |
| 18. | Sh. Sachin Devassy | Scientist | Power Electronics and AC/DC Drives |
| 19. | Sh. Dhiraj Sangwan | Scientist | Image Processing |
| 20. | Dr. A. S. V. Sarma | Chief Scientist | Electronic Instrumentation *(Chennai Centre)* |