

# CSIR-PGRPE-2012 Programme Brochure

*(Admission Session : August, 2012)*

## **Integrated MTech-PhD Programme in Advanced Semiconductor Electronics 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 programme aims to provide in-depth exposure to the engineering concepts, scientific principles, research methodology and hands-on experience on advanced real-life R&D projects in different specializations of semiconductor electronics. Students completing this two-year programme will be fully research-enabled and industry-ready.

The first semester of the MTech programme focuses on core subjects and associated laboratories related to semiconductor electronics.

The second and third semesters of the programme offer elective courses for specialization in the areas of :

- MEMS and Microsensors.
- Nanoelectronics.
- VLSI Design.
- Optoelectronics and Photonics.

The third and fourth semesters of the MTech programme then 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 specialization areas.

The medium of instruction and evaluation is English.

### **Number of Seats in the Programme**

The total number of seats available is 9.

The allotment of specializations will be done based on the candidate's performance and preference at the end of the first semester.

### **Admission Process and Eligibility for Admission**

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

### **Fellowship**

Fellowship amount will depend on selection as TS (Trainee Scientist) or as a Sponsored Candidate.

## Programme Fee Structure

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|--|---------------|
| 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 on or before August 10, 2012 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 be 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.

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

- Last date for receipt of on-line application form on AcSIR website : June 23, 2012.
- Programme registration at CSIR-CEERI, Pilani : August 13, 2012.
- Start of first semester at CSIR-CEERI, Pilani : August 14, 2012.

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/> and <http://acsir-imp.csio.res.in/> for more information. You should also periodically visit CSIR-CEERI's website link for CSIR-PGRPE-2012 at <http://www.ceeri.res.in/> for updates and news about this programme.

## MTech Programme : Semester-wise Scheme : Advanced Semiconductor Electronics

### Semester-I

Subject Code	Subject	L-T-P-C
ENG(CEERI) : 2-221	Physics of Semiconductor Materials and Devices	4-0-0-4
ENG(CEERI) : 2-222	Unit Processes in Semiconductor Technologies	3-0-0-3
ENG(CEERI) : 2-223	CMOS Digital VLSI Design	3-0-0-3
ENG(CEERI) : 2-225	Lab: Semiconductor Processing Technologies	0-0-4-2
ENG(CEERI) : 2-226	Lab: CMOS-based Physical Design	0-0-4-2
ENG(CEERI) : 1-206	Technical Communications	2-0-0-2

### Semester-II

Subject Code	Subject	L-T-P-C
ENG(CEERI) : 2-224	Characterization Techniques for Semiconductor Materials, Technologies and Devices	3-0-0-3
ENG(CEERI) : 2-227	Lab: Characterization and Measurement Techniques	0-0-4-2
ENG(CEERI) : 3-211 / 3-213 / 3-215 / 3-217	Elective-I	0-0-4-2
ENG(CEERI) : 3-212 / 3-214 / 3-216 / 3-218	Elective-II	3-0-0-3
ENG(CEERI) : 3-221 / 3-223 / 3-225 / 3-227	Lab/Seminar: Elective-I Related	0-0-4-2
ENG(CEERI) : 3-222 / 3-224 / 2-228 / 3-228	Lab/Seminar: Elective-II Related	0-0-4-2
ENG(CEERI) : 2-206	Project Management	2-0-0-2

### MEMS and Microsensors (Elective-I and Elective-II)

Subject Code	Subject	L-T-P-C
ENG(CEERI) : 3-211	MEMS Technology, LTCC and Packaging	3-0-0-3
ENG(CEERI) : 3-212	Physics and Design of MEMS and Microsensors	3-0-0-3
ENG(CEERI) : 3-221	Lab: MEMS Technology, LTCC and Packaging	0-0-4-2
ENG(CEERI) : 3-222	Lab: Design of MEMS and Microsensors	0-0-4-2

### Nanoelectronics (Elective-I and Elective-II)

Subject Code	Subject	L-T-P-C
ENG(CEERI) : 3-213	Nanoelectronic Devices and Technologies	3-0-0-3
ENG(CEERI) : 3-214	Advanced VLSI Technologies and Devices	3-0-0-3
ENG(CEERI) : 3-223	Lab: Nanoelectronic Technologies	0-0-4-2
ENG(CEERI) : 3-224	Lab: Study and Seminar on Advanced VLSI Technologies	0-0-4-2

### VLSI Design (Elective-I and Elective-II)

Subject Code	Subject	L-T-P-C
ENG(CEERI) : 3-215	CMOS Analog Design	3-0-0-3
ENG(CEERI) : 3-216	Advanced VLSI System Architectures	3-0-0-3
ENG(CEERI) : 3-225	Lab: CMOS Analog Design	0-0-4-2
ENG(CEERI) : 2-228	Lab: HDL-based Digital Design	0-0-4-2

### Optoelectronics and Photonics (Elective-I and Elective-II)

Subject Code	Subject	L-T-P-C
ENG(CEERI) : 3-217	Optoelectronic Materials, Devices and Technologies	3-0-0-3
ENG(CEERI) : 3-218	Photonic Materials, Devices and Technologies	3-0-0-3
ENG(CEERI) : 3-226	Lab: Optoelectronic Devices and Technologies	0-0-4-2
ENG(CEERI) : 3-227	Lab: Photonic Devices and Technologies	0-0-4-2

**Semester-III**

<b>Subject Code</b>	<b>Subject</b>	<b>L-T-P-C</b>
ENG(CEERI) : 3-002	Advanced Self-study on Special Topic	0-2-4-4
ENG(CEERI) : 2-098	MTech Dissertation-I	0-7-14-14

**Semester-IV**

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

## **MTech Programme : Brief Course Descriptions : Advanced Semiconductor Electronics**

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

**Course Coordinator : Raj Singh**

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**

**Course Coordinator : Raj Singh**

Introduction; 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) : 2-221 : Physics of Semiconductor Materials and Devices : 4-0-0-4**

**Course Coordinators : J. Akhtar and S. C. Bose**

Semiconductors; Inorganic and organic, single crystalline, polycrystalline, porous, amorphous crystal structures, and material properties; Si, GaAs, GaN, SiC; Energy band diagrams; Dielectric constant, permeability, permittivity, sheet resistance, resistivity, mobility, thermal conductivity and heat dissipation; Piezo-resistive and piezo-electric effects; Defects, dislocations and micro-plasma, phonon dynamics, ion-solid interactions; Electron transport in semiconductors, minority carrier life time, avalanche breakdown phenomena, Hall effect; Theory of p-n junction, Schottky barrier, MOSFETs and MESFETs, IMPATTs and BARRITTs; Hetro-structures, strained semiconductors; Photovoltaics and solar cell; Solid state sensors and transducers; MOS analysis.

### **ENG(CEERI) : 2-222 : Unit Processes in Semiconductor Technologies : 3-0-0-3**

**Course Coordinator : G. Eranna**

Crystal growth techniques, wafer preparation and shaping, chemical cleaning, thermal oxidation, photolithography, chemical etching (wet and dry), chemical vapor deposition techniques, thermal diffusion, ion implantation, metalization, chemical mechanical polishing, rapid thermal processing.

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

**Course Coordinator : A. Karmakar**

Introduction to MOSFET from designer's viewpoint; MOS inverter : static and switching characteristics; MOS capacitor; Layers in VLSI design; Design rules and technology interface; Stick diagrams and Layout design; Propagation delay, Fan-out consideration; CMOS Latch-up; Scaling; Combinational MOS logic circuits : pass-transistors/transmission gates, primitive logic gates, complex logic gates; Sequential MOS logic circuits : latches and flip-flops; Dynamic logic circuits; Clocking issues; CMOS subsystem design.

### **ENG(CEERI) : 2-224 : Characterization Techniques for Semiconductor Materials, Technology and Devices : 3-0-0-3**

**Course Coordinator : K. J. Rangra and G. Eranna**

Resistivity, Contact resistance, barrier height, carrier and doping concentration, mobility and carrier life time measurement techniques; Test structures for technology characterization; Analysis of surfaces, interfaces, thin films and devices; E-beam based techniques, Scanning Electron Microscopy and allied techniques; Material analysis techniques; Scanning probe Techniques; Ion-beam based techniques; Interferometry based techniques for materials and device characterization; Optical characterization.

**ENG(CEERI) : 2-225 : Semiconductor Processing Technologies Laboratory : 0-0-4-2**  
**Course Coordinator : G. Eranna**

Laboratory practices and safety considerations; Wafer preparation and shaping; Chemical cleaning; Thermal oxidation, photo-lithography; Wet chemical etching; Dry etching; Chemical vapor deposition; Thermal diffusion; Ion implantation; Metalization.

**ENG(CEERI) : 2-226 : CMOS-based Physical Design Laboratory : 0-0-4-2**  
**Course Coordinator : A. Karmakar**

Laboratory practices and safety considerations; SPICE simulation; Schematic editor, Layout editor, DRC, LVS; Transfer and output characteristics NMOS transistor, parameter variations; CMOS inverter design, inverter threshold, noise margin, propagation delay; Layout of CMOS inverter, n-well design rules, LVS, static and transient characteristics, DRC; 2-input NAND/NOR gate; D latch and flip-flop; Post-extract simulation.

**ENG(CEERI) : 2-227 : Semiconductors Related Characterization and Measurement Techniques Laboratory : 0-0-4-2**  
**Course Coordinator : K. J. Rangra and G. Eranna**

Laboratory practices and safety considerations; IV and CV Measurements; Resistivity, thickness, thin-film surface and bulk defects; grain size measurement; AFM/STM surface analysis; Stress and deformation measurements; Measurement of sheet resistance, junction depth, carrier mobility, doping profile estimation, minority carrier life-time measurement; Model parameter extraction experiments.

**ENG(CEERI) : 2-228 : HDL-based Digital Design Laboratory : 0-0-4-2**  
**Course Coordinator : A. S. Mandal**

Laboratory practices and safety considerations; Introduction to HDLs; Simulation of behavioral, Architecture/RTL, data-flow and structural HDL code; Sub-system design using HDL : various adder architectures, BCD arithmetic, various counters, traffic-light controller, *etc.*; Mini-project. (*SystemC, VHDL and/or SystemVerilog will be used as the HDL for the laboratory.*)

**ENG(CEERI) : 3-002 : Advanced Self-study (Special Topic) : 0-2-4-4**  
**Course Coordinator : Senior Scientists**

This will involve readings from published literature or books about new frontiers on a specific topic related to the field of electronics under guidance of senior scientist(s). A report needs to be submitted and a seminar on the special topic needs to be presented.

**ENG(CEERI) : 3-211 : MEMS Technology, LTCC and Packaging : 3-0-0-3**  
**Course Coordinator : B. D. Pant and P. K. Khanna**

Review of Silicon crystal and unit processes; Processing steps for MEMS device fabrication; photo-lithography and backside mask alignment; Surface and bulk micro-machining techniques; Deep reactive ion etching; LIGA process; Wafer-level bonding and packaging techniques; LTCC technology, materials, LTCC process steps, bonding and packaging; Testing and characterization of technology; Reliability and residual stress issues.

**ENG(CEERI) : 3-212 : Physics and Design of MEMS and Microsensors : 3-0-0-3**  
**Course Coordinator : Ram Gopal and K. J. Rangra**

Overview of Microsensors; Mechanical properties of materials and essentials of structural mechanics; Electro-mechanical, magneto-mechanical and piezo-based sensing; Structural elements for MEMS and microsensors (Beams, plates, cantilevers, bridges and diaphragms); Electrostatic sensing and actuation (parallel plate and torsional structures, time domain analysis); Micro-fluidics; Scaling laws and miniaturization; Micro-system design principles; MEMS simulation and design Tools; RF MEMS; Reliability issues in microsensors; Examples and applications of MEMS microsensors.

**ENG(CEERI) : 3-213 : Nanoelectronic Devices and Technologies : 3-0-0-3**  
**Course Coordinator : Anil Kumar**

Low-dimensional structures (Quantum well, quantum wire, quantum dot, quantum confinement); Confinement energy level, band-gap enhancement, absorption-emission spectra, blue shift, luminescence; Nanoelectronic Devices (Single electron box, Coulomb blockade, single electron transistor, pump, turnstile, trap, memory); Simulation, Modeling of single electron devices and applications; Technology for fabrication of nanostructures and nanoelectronic devices; Next generation lithography techniques; Characterization of nanoscale materials and nanodevices.

**ENG(CEERI) : 3-214 : Advanced VLSI Technologies and Devices : 3-0-0-3**  
**Course Coordinator : G. Eranna and W. R. Taube**

Overview of VLSI technology; Effect of scaling on MOS devices and interconnections; Hot electron degradations and drain engineering structures; Process and material requirements for VLSI devices; Advanced thin-film deposition and VLSI process techniques; High-k dielectric and low-k dielectric materials; Process integration of high-k metal gate for nanoscale CMOS technology; Device characterization, failure diagnosis and reliability measurements; Carrier transport mechanisms, velocity saturation, ballistic transport; Nanoscale MOSFET, FinFET and Multi-gate FET; Emerging materials and future devices.

**ENG(CEERI) : 3-215 : CMOS Analog Design : 3-0-0-3**  
**Course Coordinator : S. C. Bose**

Basic concepts of transistors and diodes, their modeling, large-signal and small signal analysis, CMOS technology, clock feed-through; Reference sources : bias circuits, band-gap reference circuit, cascode current mirror; Single-stage amplifier, common source amplifier, drain and gate amplifier, differential amplifier; Operational amplifier; Comparators; Switched-capacitor circuits; Introduction to data converters; Issues of analog layout and device noise.

**ENG(CEERI) : 3-216 : Advanced VLSI System Architectures : 3-0-0-3**  
**Course Coordinator : A. S. Mandal**

Introduction and review of basic computer architectures, CISC and RISC processors; Pipelining, hazards, exception handling, optimization techniques, synchronous and asynchronous pipelining; Memory organization, caches, virtual memory, memory management; Arithmetic circuits, algorithms and architectures for high-radix adders, multipliers, sine-cosine and exponential computation; Instruction-level parallelism, super-scalar, super-pipelined and VLIW architectures, array and vector processors; Multiprocessor architectures and parallel architectures, synchronization, memory consistency; DSP architectures; Performance improvement techniques; ASIP; Low-power architectures; Fault-tolerant architectures; Case-study on Algorithm-to-Architecture; Future trends.

**ENG(CEERI) : 3-217: Optoelectronic Materials, Devices and Technologies : 3-0-0-3**  
**Course Coordinator : C. Dhanvantri**

Optoelectronic Materials; Growth of Epitaxial materials; Characterization of Epitaxial Materials; Optoelectronic Devices (Light Emitting Diodes, Semiconductor Lasers, UV, Visible and IR Photo-detectors and Receivers, Solar Cells); Compound semiconductors and advanced electronic devices; Compound Semiconductor Technologies; Packaging of compound semiconductor components; Applications and trends.

**ENG(CEERI) : 3-218 : Photonic Materials, Devices and Technologies : 3-0-0-3**  
**Course Coordinator : S. Pal**

Introduction to Photonics; Basic photonic components and their technologies; Propagation of Electromagnetic waves; Optical waveguides and optical fibers; Principle of optical fiber communications, Transmission capacity, Dispersion and losses in optical fiber; Coupled mode theory in guided wave systems; Materials and fabrication technologies; Types of waveguides; Basic photonics devices and components; Optical sensors and sensing techniques; Optical MEMS; Fiber gratings and waveguide gratings; Photonic crystal based waveguides and devices; Packaging of photonic devices; Applications of photonic devices; Recent trends.

**ENG(CEERI) : 3-221 : MEMS Technology, LTCC and Packaging Laboratory : 0-0-4-2**  
**Course Coordinator : B. D. Pant and P. K. Khanna**

Laboratory practices and safety considerations;; Wafer cleaning; Lithography : front and backside alignment; Bulk micro-machining; DRIE process; LPCVD; Metalization; Wafer bonding; Surface planarization; Wafer dicing; LTCC process; Packaging.

**ENG(CEERI) : 3-222 : Design of MEMS and Microsensors Laboratory : 0-0-4-2**  
**Course Coordinator : Ram Gopal and K. J. Rangra**

Laboratory practices and safety considerations; MEMS design tools; Design of pressure sensors of various types; Design of gas sensors of various types; Acoustic, Ultrasonic, micro-resonator, ISFET; RF MEMS design and simulation.

**ENG(CEERI) : 3-223 : Nanoelectronic Technologies Laboratory : 0-0-4-2**  
**Course Coordinator : Anil Kumar**

Laboratory practices and safety considerations; Fabrication of metal thin films by sputtering/e-beam/resistive-heating and measurement of film thickness by making steps using wet etching; Experiments on growth of Silicon nanoparticles and their optical characterization; Experiments with nanolithography and nanopatterning; Simulation of single electron devices using SIMON; Simulation of inverter circuit using SET in SIMON; Operation of AFM/STM; Analysis of AFM/STM images; Study of annealing effect on roughness/grain size of metal films by AFM/STM imaging and analysis.

**ENG(CEERI) : 3-224 : Study and Seminar on Advanced VLSI Technologies : 0-0-4-2**  
**Course Coordinator : G. Eranna and W. R. Taube**

This will involve literature search, review and study of current research on materials, process methodologies and simulations, and novel applications related to advanced VLSI technologies and nanoelectronics. Simulation studies and experiments may also be carried out, where possible. A study report is to be submitted and a seminar is to be given.

**ENG(CEERI) : 3-225 : CMOS Analog Design Laboratory : 0-0-4-2**  
**Course Coordinator : S. C. Bose**

Laboratory practices and safety considerations; I-V characteristics of MOSFET, estimation of early voltage; Clock feed-through and its minimization; Bias generation architecture simulation; Band-gap reference circuit simulation; Design and simulation of various amplifiers; Design and simulation of 2-stage CMOS operational amplifier; Layout of analog circuits.

**ENG(CEERI):3-227 : Optoelectronic Devices and Technologies Laboratory : 0-0-4-2**  
**Course Coordinator : C. Dhanvantri**

Laboratory practices and safety considerations; Lift-off process for Ohmic Contact on GaAs substrate; TLM measurements for specific contact resistance; RIE process for GaAs etching; LI Characteristics of 980 nm Laser Diode; Transistor characteristics of GaAs Power MESFET; LED Characteristics; Photoluminescence characterization of GaN epitaxial material; Characterization of PIN-FET receiver module.

**ENG(CEERI) : 3-228 : Photonic Devices and Technologies Laboratory : 0-0-4-2**  
**Course Coordinator : S. Pal**

Laboratory practices and safety considerations; Measurement of refractive index and thickness of planar waveguides; Propagation loss measurement of planar waveguides; Design of 1x2 and 1x4 optical power splitter; Measurement of insertion loss, uniformity and polarization-dependent loss of a packaged 1x8 optical splitter at C+L band region; Design and simulation of Bragg gratings; Waveguide patterning by photolithography; Testing of MUX/DEMUX by DWDM test set-up; Chip-level testing: alignment of DUT (in a diced chip) to the source and the detector with x-y-z alignment stages.

## MTEch Programme : List of Faculty Members : Advanced Semiconductor Electronics

S. No.	Name	Designation	Discipline
1.	Dr. Chandra Shekhar	Director	Microelectronics/VLSI Design
2.	Sh. Raj Singh	Chief Scientist	Microelectronics/VLSI Design
3.	Dr. A. S. Mandal	Sr. Princ. Sc.	Microelectronics/VLSI Design
4.	Dr. S. C. Bose	Sr. Princ. Sc.	Microelectronics/VLSI Design
5.	Dr. A. Karmakar	Princ. Sc.	Microelectronics/VLSI Design
6.	Sh. Ravi Saini	Scientist	Microelectronics/Digital Design
7.	Sh. Anil Kumar Saini	Scientist	Microelectronics/Analog Design
8.	Sh. Jai Gopal Pandey	Scientist	Microelectronics/Digital Design
9.	Sh. G. Rajahari	Scientist	Microelectronics/Analog Design
10.	Sh. Sanjay Singh	Scientist	Microelectronics/Digital Design
11.	Dr. V. K. Khanna	Chief Scientist	MEMS/IC Technology
12.	Sh. B. D. Pant	Chief Scientist	MEMS Technology
13.	Dr. Ram Gopal	Sr. Princ. Sc.	MEMS Technology/Devices
14.	Dr. K. J. Rangra	Sr. Princ. Sc.	MEMS Devices/Design
15.	Dr. Ajay Agarwal	Princ. Sc.	MEMS Technology/Devices
16.	Dr. Rishi Sharma	Scientist	MEMS Technology/Devices
17.	Dr. R. Mukhiya	Scientist	MEMS Technology/Devices
18.	Dr. P. K. Khanna	Sr. Princ. Sc.	LTCC Technology/Packaging
19.	Dr. Nikhil Suri	Scientist	LTCC Technology
20.	Dr. J. Akhtar	Chief Scientist	Semiconductor Devices
21.	Sh. Jitendra Singh	Scientist	IC Technology/Devices
22.	Sh. Anil Kumar	Chief Scientist	Nanoelectronics Technology
23.	Sh. William Taube	Scientist	Nanoelectronics/Nanodevices
24.	Dr. G. Eranna	Sr. Princ. Sc.	IC Technology
25.	Dr. C. Dhanvantri	Sr. Princ. Sc.	Optoelectronics/Photonics
26.	Dr. Suchandan Pal	Princ. Sc.	Optoelectronics/Photonics
27.	Dr. Bala Pesala	Senior Scientist	Optoelectronics/Photonics