

# **CSIR-PGRPE-2011 Programme Brochure**

*(2011-2013)*

## **Two-year Post-Graduate Research Programme in Engineering (PGRPE) in High Power Microwave Devices and System Engineering at CSIR-CEERI, Pilani**

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 aspects of microwave devices and its system engineering. Students completing this two-year programme will be fully research-enabled and industry-ready.

The first semester of the programme focuses on core subjects and associated laboratories related to microwave communications and components.

The second and third semesters offer courses related to slow-wave and fast-wave devices, CAD techniques used for the design of microwave tubes, specialized tubes and their applications as well as fabrication technologies used for microwave tubes.

The third and fourth semesters 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.

In addition, on successful completion of the programme with distinction, the candidates may be considered by CSIR for absorption as Scientists in PB-3 of the Government of India (Scale of Rs. 15600/- to 39100/- with Grade Pay of Rs. 6600/- plus other allowances as applicable).

The medium of instruction and evaluation is English.

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

The total number of seats available is 8.

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

Please see the CSIR-PGRPE-2011 website at <http://pgrpe.csio.res.in/> for announcement and on-line submission of the admission form and details of eligibility.

### **Fellowship**

Fellowship amount of **Rs. 25,000 per month** will be awarded to selected candidates during the two-year programme. The selected candidates will be designated as "Scientist Trainee" under the CSIR QHS scheme.

## 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 on or before July 31, 2011 at 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 NEFT bank transfer, please transfer the amount to the saving account number 61033385318 of “Director, CEERI” at SBBJ, Pilani (IFSC code SBBJ0010398) with appropriate narration statement.

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

## Important Dates

1. Last date for receipt of on-line application form on CSIR-PGRPE website : May 23, 2011.
2. Programme registration at CSIR-CEERI, Pilani : August 08-09, 2011.
3. Start of first semester at CSIR-CEERI, Pilani : August 09, 2011.

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

**Please visit the CSIR-PGRPE-2011 website at <http://pgrpe.csio.res.in/> for more information. You should also periodically visit CEERI's website link for CSIR-PGRPE-2011 at <http://www.ceeri.res.in/> for updates and news about this programme.**

## Semester-wise Scheme : High Power Microwave Devices and System Engineering

### Semester-I

Subject Code	Subject	Credits
MDSE 501	Electromagnetic Theory and Transmission Lines	4
MDSE 502	Microwave Communication	2
MDSE 601	Numerical Techniques and Computer Aided Design of Microwave Tubes	4
MDSE 611	Lab: Microwave Component Characterization and Tube Processing Techniques	3
MDSE 551	Technical Communications	2
MDSE 552	Research Methodology	1

### Semester-II

Subject Code	Subject	Credits
MDSE 602	Slow-wave Devices : Principles and Design	4
MDSE 603	Fast-wave Devices : Principles and Design	3
MDSE 604	Microwave and Millimeter-wave Tube Technologies	3
MDSE 612	Lab: Microwave Devices Characterization and Tube Sub-assembly Fabrication	3
MDSE 613	Lab: CAD of Microwave Tubes	2
MDSE 651	Project Management	2

### Semester-III

Subject Code	Subject	Credits
MDSE 631	High Power Microwave Devices, Systems and Applications	3
MDSE 63x	Elective-I	2
MDSE 661	Project Work and Seminar	14

### Elective-I

Subject Code	Subject	Credits
MDSE 632	Electron Emitters and Surface Characterization	2
MDSE 633	Plasma-filled Microwave Sources	2
MDSE 634	Vacuum Microelectronic Devices	2

### Semester-IV

Subject Code	Subject	Credits
MDSE 671	Dissertation Seminar and Viva-voce	4
MDSE 672	Dissertation Report	14

## **Brief Course Descriptions : High Power Microwave Devices and Systems Engineering**

### **MDSE 501 : Electromagnetic Theory and Transmission Lines (4-0-0-4) 4 Credits**

**Faculty Coordinators : Dr. A. K. Sinha; (Dr. S. N. Joshi)**

Maxwell's equations; Wave equations and their solutions; Boundary Conditions and their applications; Electromagnetic energy and power flow; Poynting theorem. Transmission lines; Wave-guide and coaxial components. Scattering matrix representation; Propagation of electromagnetic waves through homogeneous, inhomogeneous, and anisotropic media. Surface resistance and RF resistance. Ferrite devices. Waveguides and resonators. Characteristic and interaction impedances. Quality factors (loss and diffractive). Impedance Matching. Measurement of "Q", power, noise figure, S-parameters, dielectric constant and loss tangent, dispersion and impedance characteristics, and loss parameters.

### **MDSE 502 : Microwave Communication (2-0-0-2) 2 Credits**

**Faculty Coordinators : Dr. V. V. P. Singh; Dr. R. K. Sharma**

Ground/surface wave, space-wave, and sky-wave modes of communication; Tropo-sphereic Communication; Line of sight communication and system performance; Active and passive repeaters and their design; Analog and digital communication; Mobile communication; Satellite communication system; Earth station design criteria and direct reception system; Satellite transponders and their design criteria; Phase noise, intra-pulse and inter-pulse noises and their significance.

### **MDSE 601 : Numerical Techniques and Computer Aided Design of Microwave Tubes**

**(4-0-0-4) 4 Credits**

**Faculty Coordinators : Dr. V. Srivastava; Dr. A. K. Sinha**

Numerical solution of linear and non-linear differential equations of higher orders; Analytical and numerical techniques to the solution of electromagnetic field problems; Numerical techniques for the electrical, thermal, and structural design of slow-wave and fast-wave microwave tubes; Spent beam analysis for efficiency enhancement; Special focusing techniques for multi-beam electron guns; PIC simulation techniques; Finite difference and finite element techniques; Method of moments applied to microwave devices.

### **MDSE 611 : Microwave Component Characterization and Tube Processing Techniques**

**Laboratory (0-0-6-3) 3 Credits**

**Faculty Coordinator : Sh. O. S. Lamba**

Laboratory practices and safety considerations; Scattering parameters; Measurement of impedance and characterization of cavities; Dispersion and impedance characterization of RF structures; RF loss measurements; UHV techniques; Heat treatment in protective atmosphere; Ceramic-to-metal sealing techniques; Chemical processing of components.

### **MDSE 551 : Technical Communications (2-1-0-2) 2 Credits (Same as AES 551 and ASE 551)**

**Faculty Coordinator : Sh. 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.

### **MDSE 552 : Research Methodology (1-1-0-1) 1 Credit (Same as AES 552 and ASE 552)**

**Faculty Coordinator : Sh. Raj Singh**

Introduction, terminology, and scientific methods; Types of research; Research process and steps; Identifying a research problem; Literature survey, appreciation of existing literature, identification of knowledge gaps; Conception of novel approach to solve the problem; Role of theory, modeling, and simulation; Design of experiments, testing and characterization strategies; Quantitative methods and data analysis; Qualitative analysis; Communicating research results; Ethics in research.

**MDSE 602 : Slow-wave Devices: Principles and Design (4-0-0-4) 4 Credits**  
**Faculty Coordinators : Dr. V. Srivastava; Dr. L. M. Joshi**

Classification and high frequency limitations of conventional electron tubes. Formation and confinement of an electron beam. Slow-wave structures, couplers and RF windows. Beam-wave interaction mechanism. Spent beam collection. Efficiency enhancement by phase velocity tapering and multi-stage depressed collection. Different types of devices, their operation, and characteristics, High power and wide bandwidth issues. Future trends.

**MDSE 603 : Fast-wave Devices: Principles and Design (3-0-0-3) 3 Credits**  
**Faculty Coordinators : Dr. A. K. Sinha; Sh. M. Alaria**

Merits of fast-wave devices over slow-wave devices. Operating principle of a gyrotron and design of its components: magnetron injection gun, beam tunnel, RF interaction cavity, magnetic field, non-linear taper, RF window, mode converter and collector. Beam-wave interaction and mode selection criteria. Other fast-wave devices: gyro-TWT, gyro-klystron, peniotron and FEL. Applications of gyro-devices and future trends. High Power Microwave (HPM) Devices.

**MDSE 604 : Microwave and Millimeter-Wave Tube Technology (3-0-0-3) 3 Credits**  
**Faculty Coordinators : Dr. R. S. Raju; Sh. R. K. Gupta**

Fundamentals of vacuum technology. Vacuum generation and measurement, and leak detection. Ultra-high vacuum techniques. Surface physics and analysis in relation to electron Emitters. Electron-tube grade materials and their characteristics. Chemical processing. Heat treatment and special techniques: brazing, sintering, sputtering, TIG/electron beam/laser welding, glass-to-metal and ceramic-to-metal sealing, loss coating, and helix fitting. Vacuum processing of integrated devices. Design of tools, jigs, and fixtures. Engineering/mechanical design of components. Special machining techniques.

**MDSE 612 : Microwave Device Characterization and Tube Sub-assembly Fabrication Laboratory (0-0-6-3) 3 Credits**  
**Faculty Coordinators : Dr. L. M. Joshi; Sh. S. Maurya**

Laboratory practices and safety considerations; Device characterization using spectrum analyzer, scalar/vector analyzer; Break-down tests; X-ray radiography; Cathode characterization using Auger and Thermal emission microscope; Hot RF characterization of devices; Metal-to-metal brazing techniques; Leak detection; TIG/laser welding; Vacuum processing of devices; Cathode fabrication.

**MDSE 613 : CAD of Microwave Tubes Laboratory (0-0-4-2) 2 Credits**  
**Faculty Coordinators : Dr. R. K. Sharma; Dr. Sanjay Ghosh**

Laboratory practices and safety considerations; Components design : electron guns, slow-wave structures, fast-wave structures, RF cavities, RF windows, collectors; Electron beam and RF wave interaction simulation; Thermal and structural design and simulation; CAD of complete tube; Computer aided engineering drawing.

**MDSE 651 : Project Management (2-1-0-2) 2 Credits (Same as AES 651 and ASE 651)**  
**Faculty Coordinator : Sh. Raj Singh**

Introduction; Project formulation, evaluation and initiation; Project planning and scheduling; Resource allocation; Time management; Risk management; Project implementation; Project monitoring and control; Project closure; Project documentation; Complex projects; Advances and trends.

**MDSE 631 : High Power Microwave Systems and Applications (3-0-0-3) 3 Credits**  
**Faculty Coordinators : Dr. L. M. Joshi; Dr. V. V. P. Singh**

Special EW (Radar, ECM, ECCM) systems and their requirements in respect of microwave and millimeter wave devices; Types of jamming; Linear accelerators, Microtrons, Synchrotrons, Plasma heating systems, Proton accelerators, and Thermonuclear reactors; Other applications like imaging, spectroscopy, biomedical, industrial heating, electronic power conditioners, and modulators.

**MDSE 632 : Electron Emitters and Surface Characterization (2-0-0-2) 2 Credits****Faculty Coordinator : Dr. R. S. Raju**

Physics of electron emission, emission equation; Temperature limited and space-charge limited emission; Methods of determining work function; Oxide coated cathodes, Dispenser cathodes, Field emitters, Explosive emission cathodes, Secondary emitters; Fabrication and characterization of cathodes; Life testing and surface analysis techniques; Nano-cathodes.

**MDSE 633 : Plasma-Filled Microwave Sources (2-0-0-2) 2 Credits****Faculty Coordinator : Sh. U. N. Pal**

Plasma and its physical parameters; Saha equation and its relevance; Motion of charged particles in static and slowly varying electric and magnetic fields; Motion of relativistic charged particles; Types of gaseous discharge; Hollow-cathode discharge and other kinds of low-pressure discharges; General features of electrons emission, control and extraction of electrons and ions from plasma in DC and pulsed mode conditions; Plasma sources for axially symmetric electron beams; Plasma cathode electron gun (PCE-gun); Advantages of plasma filling in high power microwave devices; Operating principles, characteristics, and applications of different types of plasma-filled devices including the pasotron.

**MDSE 634 : Vacuum Microelectronic Devices (2-0-0-2) 2 Credits****Faculty Coordinators : Dr. V. Srivastava; Dr. R. K. Sharma**

Basic semiconductor technologies like reactive ion etching, photo-lithography, oxidation, CVD, sputtering, LIGA; MEMS technologies; Design considerations in vacuum microelectronic devices; Photonic band-gap structures, folded wave guide and ladder structures; Tera Hertz devices including reflex klystrons; Micro-fabricated devices like TWT and klystrino; Combination of vacuum and semiconductor technologies in microwave devices, including microwave power module and their applications.

**List of Faculty Members : High Power Microwave Devices and System Engineering**

<b>S. No.</b>	<b>Name</b>	<b>Designation</b>	<b>Discipline</b>
1.	Dr. S. N. Joshi	Ex-Scientist G	Microwave Engineering & Tube Technology
2.	Dr. V. Srivastava	Scientist G	Microwave Engineering & Tube Technology
3.	Dr. R. S. Raju	Scientist G	Microwave Engineering & Tube Technology
4.	Dr. L. M. Joshi	Scientist G	Microwave Engineering & Tube Technology
5.	Sh. R. K. Gupta	Scientist G	Microwave Engineering & Tube Technology
6.	Dr. V. V. P. Singh	Scientist F	Microwave Engineering & Tube Technology
7.	Sh. O. S. Lamba	Scientist F	Microwave Engineering & Tube Technology
8.	Dr. A. K. Sinha	Scientist F	Microwave Engineering & Tube Technology
9.	Dr. R. Ranga Rao	Scientist F	Microwave Engineering & Tube Technology
10.	Dr. R. K. Sharma	Scientist E-II	Microwave Engineering & Tube Technology
11.	Dr. Sanjay Ghosh	Scientist E-II	Microwave Engineering & Tube Technology
12.	Sh. M. Alaria	Scientist C	Microwave Engineering & Tube Technology
13.	Sh. U. N. Pal	Scientist C	Plasma Devices
14.	Sh. S. Maurya	Scientist C	Microwave Engineering & Tube Technology
15.	Dr. A. Bandhopadhyay	Scientist C	Microwave Engineering & Tube Technology
16.	Sh. S. Raghunath	Ex-Scientist G	Communications Engineering