

# **CSIR-PGRPE-2012 Programme Brochure**

*(Admission Session : August, 2012)*

## **Integrated MTech-PhD Programme in High Power Microwave Devices and System Engineering 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 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 MTech 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 of the MTech programme provide 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 5.

### **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

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

1. Last date for receipt of on-line application form on AcSIR website : June 23, 2012.
2. Programme registration at CSIR-CEERI, Pilani : August 13, 2012.
3. 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 :  
High Power Microwave Devices and System Engineering**

**Semester-I**

<b>Subject Code</b>	<b>Subject</b>	<b>L-T-P-C</b>
ENG(CEERI) : 2-231	Electromagnetic Theory and Transmission Lines	4-0-0-4
ENG(CEERI) : 2-232	Microwave Communication	2-0-0-2
ENG(CEERI) : 2-233	Numerical Techniques and CAD of Microwave Tubes	4-0-0-4
ENG(CEERI) : 2-235	Lab: Microwave Components Characterization and Tube Processing Techniques	0-0-6-3
ENG(CEERI) : 1-206	Technical Communications	2-0-0-2

**Semester-II**

<b>Subject Code</b>	<b>Subject</b>	<b>L-T-P-C</b>
ENG(CEERI) : 3-231	Slow-wave Devices : Principles and Design	4-0-0-4
ENG(CEERI) : 3-232	Fast-wave Devices : Principles and Design	3-0-0-3
ENG(CEERI) : 2-234	Microwave and Millimeter-wave Tube Technologies	3-0-0-3
ENG(CEERI) : 2-236	Lab: Microwave Devices Characterization and Tube Sub-assembly Fabrication	0-0-6-3
ENG(CEERI) : 3-233	Lab: CAD of Microwave Tubes	0-0-4-2
ENG(CEERI) : 1-206	Project Management	2-0-0-2

**Semester-III**

<b>Subject Code</b>	<b>Subject</b>	<b>L-T-P-C</b>
ENG(CEERI) : 3-234	High Power Microwave Devices, Systems and Applications	3-0-0-3
ENG(CEERI) : 3-23x	Elective-I	2-0-0-2
ENG(CEERI) : 2-098	MTech Dissertation-I	0-7-14-14

**Elective-I**

<b>Subject Code</b>	<b>Subject</b>	<b>L-T-P-C</b>
ENG(CEERI) : 3-235	Electron Emitters and Surface Characterization	2-0-0-2
ENG(CEERI) : 3-236	Plasma-filled Microwave Sources	2-0-0-2
ENG(CEERI) : 3-237	Vacuum Microelectronic Devices	2-0-0-2

**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 : High Power Microwave Devices and Systems Engineering**

### **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) : 2-231 : Electromagnetic Theory and Transmission Lines : 4-0-0-4**

**Course Coordinator: A. K. Sinha**

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.

### **ENG(CEERI) : 2-232 : Microwave Communication : 2-0-0-2**

**Course Coordinator: V. V. P. Singh**

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; PhPHY(CEERI)-noise, intra-pulse and inter-pulse noises and their significance.

### **ENG(CEERI) : 2-233 : Numerical Techniques and CAD of Microwave Tubes : 4-0-0-4**

**Course Coordinator: V. Srivastava**

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.

### **ENG(CEERI) : 2-234 : Microwave and Millimeter-Wave Tube Technology : 3-0-0-3**

**Course Coordinator: R. S. Raju**

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.

**ENG(CEERI) : 2-235 : Microwave Components Characterization and Tube Processing Techniques  
Laboratory : 0-0-6-3**

**Course Coordinator: 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.

**ENG(CEERI) : 2-236 : Microwave Devices Characterization and Tube Sub-assembly Fabrication  
Laboratory : 0-0-6-3**

**Course Coordinator: L. M. Joshi**

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.

**ENG(CEERI) : 3-231 : Slow-wave Devices – Principles and Design : 4-0-0-4**

**Course Coordinator: V. Srivastava and 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.

**ENG(CEERI) : 3-232 : Fast-wave Devices – Principles and Design : 3-0-0-3**

**Course Coordinator: A. K. Sinha**

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.

**ENG(CEERI) : 3-233 : CAD of Microwave Tubes Laboratory : 0-0-4-2**

**Course Coordinator: R. K. Sharma and S. K. 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.

**ENG(CEERI) : 3-234 : High Power Microwave Systems and Applications : 3-0-0-3**

**Course Coordinator: L. M. Joshi**

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.

**ENG(CEERI) : 3-235 : Electron Emitters and Surface Characterization : 2-0-0-2**

**Course Coordinator: 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.

**ENG(CEERI) : 3-236 : Plasma-Filled Microwave Sources : 2-0-0-2**  
**Course Coordinator: Ram Prakash and 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.

**ENG(CEERI) : 3-237 : Vacuum Microelectronic Devices : 2-0-0-2**  
**Course Coordinator: 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.

**MTech Programme : 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	Chief Scientist	Microwave Engineering & Tube Technology
3.	Dr. R. S. Raju	Chief Scientist	Microwave Engineering & Tube Technology
4.	Dr. L. M. Joshi	Chief Scientist	Microwave Engineering & Tube Technology
5.	Sh. R. K. Gupta	Chief Scientist	Microwave Engineering & Tube Technology
6.	Dr. V. V. P. Singh	Chief Scientist	Microwave Engineering & Tube Technology
7.	Sh. O. S. Lamba	Sr. Princ. Sc.	Microwave Engineering & Tube Technology
8.	Dr. A. K. Sinha	Sr. Princ. Sc.	Microwave Engineering & Tube Technology
9.	Dr. R. Ranga Rao	Sr. Princ. Sc.	Microwave Engineering & Tube Technology
10.	Dr. R. K. Sharma	Princ. Sc.	Microwave Engineering & Tube Technology
11.	Dr. S. K. Ghosh	Princ. Sc.	Microwave Engineering & Tube Technology
12.	Dr. Ram Prakash	Sr. Sc.	Plasma Devices
13.	Sh. M. Alaria	Scientist	Microwave Engineering & Tube Technology
14.	Sh. U. N. Pal	Scientist	Plasma Devices
15.	Sh. S. Maurya	Scientist	Microwave Engineering & Tube Technology
16.	Sh. Deepender Kant	Scientist	Microwave Engineering & Tube Technology
17.	Dr. A. Bandhopadhyay	Scientist	Microwave Engineering & Tube Technology
18.	Ms. Mercy Latha	Scientist	Microwave Engineering & Tube Technology
19.	Sh. Niraj Kumar	Scientist	Plasma Devices
20.	Sh. Vishant	Scientist	Microwave Engineering & Tube Technology