One week short term course on

# LASER BASED SPECTROSCOPIC TECHNIQUES IN OPTICAL NANOMATERIAL RESEARCH: THEORY AND HANDS-ON TRAINING

**(18th Dec. 2017 – 23rd Dec. 2017)**

## OVERVIEW

Prof. Alexander Prokhorov led discovery of lasers has given birth of many robust spectroscopic tools for characterization of materials of any phase: solid, liquid, gas or plasma. This new form of spectroscopy has much attracted scientists & technologists and now it has emerged as faithful tool for the understanding of physical, chemical, biological systems and processes. Now, it is possible to get information even from a single molecule with the help of laser based tools. The lasers itself have established its own prestige as a basic tool of science.

The optical nanomaterials world is a lucrative research field and many Indian researchers are involved in it. The lasers and spectroscopic devices, now-a-days, are essential for finding the structural, optical and other properties of materials of any form. Lasers, being strong source of coherent and directional light, when integrated with a spectroscopic device provide much more information about the material under investigation than a conventional spectroscopy can does. Training of a contemporary chemist, physicist, biologist must nowadays certainly include a strong component on spectroscopy. The lasers can efficiently be used for various purposes in many industries such as Coal & Petroleum Mining, Steel industry, mechanical industry, electronics industry etc.

## COURSE OBJECTIVES

The course is designed to provide in depth understanding of lasers and new laser spectroscopy techniques with enough component of experiments on various systems to train participants of the course. Topics of the course are framed in such a manner that it will impart both theory and experiment equally to the young faculty members, Ph. D. students and industry people of wide arena. This course will provide in depth knowledge of luminescence dynamics for achieving lasing action along with the methodologies to start the research on materials for lasers and display devices.

Following are the objectives:

i) To educate faculty members, students and industry persons on new lasers and spectroscopic techniques and how to use them for materials research.
ii) Building confidence and capability in the participants for effective analysis of the results of spectroscopic techniques.
iii) To communicate the need of research on rare-earths based nano-materials for lasers and display devices.
iv) To provide basic understanding of the subject and hands-on training.

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| **Course schedule** | **December, 18-23, 2017**<br>Number of participants for the course will be limited to fifty (50). |
| **You should attend if:** | ✓ You are a B. Tech. / M. Tech. or M. Sc. with broad domain of materials sciences with focus on spectroscopy.<br>✓ You are a Post-doctoral fellow or Ph.D. scholar in Physics, Materials Sciences, Chemistry, Biological science etc.<br>✓ You are a faculty member in academic institution/university.<br>✓ You are a researcher/scientist in industry and interested in learning the scope of lasers and spectroscopy techniques. |
| **Fees** | The participation fees for taking the course is as follows: **Participants from abroad**: **US $200/**<br>**Industry/ Research Organizations**: **Rs. 10,000/**<br>**Academic Institutions: a) Faculty**: **Rs. 6,000/**<br>**b) Student**: **Rs. 3,000/**<br>The above fees include instructional materials, computer use for tutorials and assignments. Accommodation will be on payment basis. |

**Tentative topics of the course:**

**Day 1:**
*Importance of lasers in scientific research*
*Recent advances in laser research, miniaturization and nanolasers*
*Laser Principles: Pulse generation techniques: Q-switching & mode locking*
*Solid State Lasers: Working of Nd: YAG laser, CW and Pulse*
*Applications of Lasers in Earth Sciences, Mining*

**Day 2:**
*Industrial status of optical materials and devices*
*Optical nano-materials synthesis techniques: Physical*
*Luminescence spectroscopy: Steady state & Time resolved*
*Laser non-linear spectroscopy: Z-scanning technique*
*Fluorescence Correlation Spectroscopy (FCS): Single Bio-molecule study*
*Hands-on of Nd:YAG Laser and FCS*

**Day 3:**
*Raman Spectroscopy and Microscopy*
*Surface Enhanced Raman Spectroscopy and sample preparation protocols*
*Dynamical processes in excited states of solids*
*Electron-phonon and ion-ion interaction in solids.*
*Nonradiative multiphonon transitions in optical centers in solids*
*Tutorial on Radiative properties of rare earth ions in solids*
*Hands-on Time resolved photoluminescence spectrophotometer*

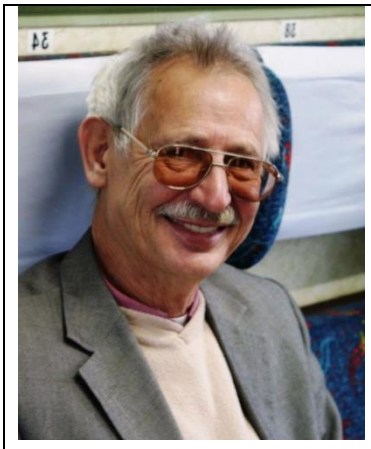
**Day 4:**
*Rare earth ions in materials & nano-crystals*
*Upconversion emission in rare earth nano-materials and their applications*
*Physics and spectroscopy of laser crystals*
*Laser spectroscopic techniques; rare earth emission processes*
*Hands-on upconversion emission*

**Day 5:**
*Density matrix method and its application in laser materials*
*Dynamical processes in excited state: FRET*
*Optical Nanomaterial synthesis routes: Chemical*
*Tutorial on Forster Resonance Energy Transfer (FRET) and density matrix theory*
*Hands-on Physical & Chemical synthesis of luminescent materials*

**Day 6:**
*Emission optimization techniques in optical materials*
*Judd-Ofelt (J-O) theory and its applications in doped laser materials & nano-crystals*
*Present and future of luminescent nanomaterials for solid state lighting*
*Tutorial on Judd-Ofelt (J-O) theory*
*Hands-on Optical characterization techniques*

## The Faculty

No one can be better suited to explain the lasers than a physicist from place where the first laser was invented and this place is undoubtedly associated to the ***Prokhorov General Physics Institute, Russia*** named after **Professor A.M. Prokhorov**, **Nobel Prize winner** on lasers. The foreign faculty who will deliver a series of lectures in this course will be from this institute having legacy in laser research.



**Prof. Konstantin K. Pukhov** is a senior Professor at Department of Laser Materials and Photonics, Prokhorov General Physics Institute, Moscow, Russia. Prof. Pukhov is well known academician and has obtained Ph. D. in Chemical Physics on the topic ***"On the theory of the electron spin-lattice relaxation in solids"***. He has also obtained D. Sc. Degree in Physics on the topic ***"Radiative and nonradiative transitions in optical centers in bulk and nanoscale crystals"***. Prof. Pukhov has long been associated with teaching and research at various institutes of Russia and has also appointed as visiting scientist at overseas institutes of USA, Germany, France, Switzerland etc.

His main fields of interest are Physics of irreversible processes in solids. Solid state spectroscopy of electronic and vibrational transitions of defects in insulating crystals. Optical coherence and quantum optics. Dynamical processes in excited states of solids. Manifestation of electron-phonon and ion-ion interaction in solids. Nonradiative multiphonon transitions in optical centers in solids; nonradiative energy transfer processes; cooperative down-conversion processes. Physics and spectroscopy of laser crystals. Radiative properties of the doped nanocrystals etc.

**Dr. S. K. Sharma** is currently working as an Associate Professor, Department of Applied Physics, Indian Institute of Technology (Indian School of Mines), Dhanbad. Dr. Sharma has obtained Ph.D. from IIT(ISM), Dhanbad and is working on the luminescent materials for display and solar cell devices.

**Dr. Kaushal Kumar** is currently working as an Assistant Professor, Department of Applied Physics, Indian Institute of Technology (Indian School of Mines), Dhanbad. Dr. Kumar has obtained Ph.D. from Banaras Hindu University, Varanasi and is working on the laser spectroscopy of the rare-earth doped materials.

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## Course Coordinators


Dr. S. K. Sharma (**SKS**)
Dr. Kaushal Kumar (**KK**)

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http://www.iitism.ac.in

## Registration Process

### STAGE-1: WEB registration

Please visit **http://www.gian.iitkgp.ac.in/GREGN/** and create login user ID and Password. Fill up blank registration form and do web registration by paying Rs. 500/- on line through NetBanking/ Debit/ Credit Card. Those who have already been paid, need not pay again. Registration to the portal is one time affair and will be valid for lifetime of GIAN. Once registered in the portal, an applicant will be able to apply for any number of GIAN courses as and when necessary.

### STAGE-2: COURSE registration

Log in to the GIAN portal with the user ID and Password created. Click on "Course Registration" option given at the top of the registration form. Select the Course titled "***Laser based spectroscopic techniques in optical nanomaterial research: theory and hands-on training***" from the list and click on "Save" option. Confirm your registration by Clicking on "Confirm Course".

**OR**

Fill the following form and send to the address given. **The last date of registration is 10 December 2017.**

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## Registration Form

**Course: Laser based spectroscopic techniques in optical nanomaterial research: theory and hands-on training**
**(18th Dec. 2017 – 23rd Dec. 2017)**

Name (in block letters): …….....

Qualification: …… Designation:……

Organization:……

Mailing Address:……

……

……Mobile:.....Email:……

Payment: Rs:……DD No.:…… Dt: ……

**DD** in favour of "Registrar, Indian Institute of Technology (ISM), Dhanbad" payable at Canara Bank, Saraidhela Branch (IFSC: CNRB0000986). Bank A/C 0986101009746 **OR** **NEFT/ RTGS** (Please furnish the full details if NEFT/RTGS) Name of A/c Holder UTR NO./Transaction ID Name of Bank & Branch, Date of Payment, Amount.

IIT(ISM) Guest House/Hostel accommodation required: **YES / NO** (on payment basis)

Signature of Applicant:_____

Send filled form to: Dr. K. Kumar, Department of Applied Physics, 5th Floor, Academic Building, IIT(ISM), Dhanbad-820664, JH