



# TIFAC-CORE IN



# FIBER OPTICS AND OPTICAL COMMUNICATION



**DELHI TECHNOLOGICAL UNIVERSITY**

*(Formerly Delhi College of Engineering)*

Bawana Road, Delhi-110042



## INTRODUCTION

TIFAC (Technology Information Forecasting & Assessment Council)

TIFAC is an autonomous society under the Department of Science and Technology, Government of India. It keeps technology watch on global trends and formulates preferred technology options for India.

## MISSION REACH

Today's liberalized economic order is witnessing silent competitions for sustenance and excellence in almost every sector of the economy. Focusing on such competition-both national and global levels, TIFAC launched Mission **REACH (Relevance and Excellence in ACHieving new heights in educational institutions)** in the year 2000 - a mission embedded in Technology Vision - 2020, Government of India. Under the Mission REACH program, institutions of proven potential are being selected for creating **Centers Of Relevance and Excellence (CORE)**.

These TIFAC-COREs are mandated for excelling in focused areas. The prime objective of establishing the COREs is to mobilize human resources of international standards by imparting quality education and involving them in frontier research in diverse disciplines that are of immediate and high relevance to the Indian industry and the society. These COREs will leverage the synergy of a triangular linkage among educational institutions, government and industries or user organizations to create world class centers which will be the leaders in their respective fields. Through these centers, technology generation and skill upgradation of work force is to be done on a continuous basis. One such TIFAC-CORE in the area of **Fiber Optics & Optical Communication has been established in Delhi College of Engineering, Delhi, now transformed into Delhi Technological University, Delhi.**



Experimental Setup on Electro-Optic Effect



Entrance of Delhi Technological University (Formerly Delhi College of Engineering, DTU Campus)



## DELHI TECHNOLOGICAL UNIVERSITY (Formerly Delhi College of Engineering-DCE)

**Delhi Technological University, Formerly Delhi College of Engineering-DCE, Delhi** is a premier engineering & technology institute established in 1941, has been imparting education in various field of Engineering and Applied Sciences at Under Graduate, Post Graduate & Ph.D. (Doctoral) Levels.

The graduates of this institution are in demand in industries & scientific organizations within the country and abroad. This institute is consistently ranked as one of the top 10 institutions in the country. DTU formerly DCE today imparts education and training in 14 branches of engineering at Under Graduate level with an intake of 910, 4 branches of B.Tech. (Evening Program) degree are being run with an intake of 120. Full-time and part-time Post Graduate education is given in 18 specialized fields of science, engineering & technology management with an intake of 340. In our Ph.D. program 75 scholarships are offered to students selected through a common interview.

In addition, sponsored research and development activities are also supported by Government funding agencies and Industries in large number of areas of mutual interest. The key to success is our emphasis on quality research and innovative design in technical education.

TIFAC-CORE in the area of **Fiber Optics & Optical Communication** has been established in **Delhi Technological University (Delhi College of Engineering), Delhi** for which an agreement was signed between TIFAC & DCE on July 6, 2004. The activities of this TIFAC-CORE at DCE is supported by TIFAC/DST, Govt. of NCT of Delhi and partners from industries under Mission REACH Program, Technology Vision-2020, Govt. of India.

Detailed informations about **DTU (formerly DCE)**, Delhi is available at its official websites **[www.dce.edu](http://www.dce.edu)** and **[www.dce.ac.in](http://www.dce.ac.in)**



Agreement Signing Ceremony at Vigyan Bhawan, Delhi in presence of Dr. R. Chidambaram, Chairman-TIFAC & PSA and Prof. V. S. Ramamurthy, Secretary-DST, Govt. of India



Visit of Sh. B. L. Joshi, Hon. Lt. Governor-GNCTD at TIFAC-CORE @ DCE Exhibition



Experiments on High Voltage Measurement



Prof. D. Goldar, Principal, DCE with Prof. G. Atkinson, Scientific Advisor-USA



Dr. D.P.S. Seth, Chairman-RMC alongwith co-ordinators of TIFAC-CORE @ DCE



## VISION

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"To establish a world class knowledge centre providing education in the area of **Fiber Optics and Optical Communication System** that promotes research and development leading to innovative applications of Fiber Optics, fostering institute-industry linkages and entrepreneurial culture encompassing all aspects of interaction of light and matter for the betterment of the society."



Optical Fiber Fusion Splicing Machine





## OBJECTIVES

- Development of Laboratories in the area of Fiber Optics and Optical Communication to support on-going program at B.E. / M.Sc. / M.E. level.
- Starting new academic program (M.E. -Microwave & Optical Communication).
- Offering special courses related to Fiber Optics and Optical Communication at B.E. / M.Sc. / M.E. / Ph.D. catering to the emerging needs of the industry.
- Ph.D. programs supported by experiments and simulation work in the field related to Fiber Optics, Optical Communication Systems and Networks.
- Undertaking join R&D projects in collaboration with industrial partner and other academic / scientific organizations.
- Exploring & Establishing international collaborations.
- To conduct workshops, short term training programs, organize seminars and conference related to the general area of optics and telecommunication systems.



Optical Fiber Talk Set



Optical Imaging Experiments using CCD Camera



## TEAM

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- Prof. P. B. Sharma, Vice-Chancellor, DTU
- Prof. Rajeev Kapoor, Head of Department, ECE, DTU
- Prof. R. K. Sinha, Head of Department, Applied Physics, DTU
- Prof. O. P. Verma, Head of Department, IT, DTU
- Mr. Rajesh, Co-ordinator, ECE Department
- Mr. N. S. Raghava, Co-ordinator, IT Department
- Mr. Avinash Singh, ECE Department
- Dr. M. S. Mehta, Applied Physics
- Dr. Yogita Kalra, Applied Physics
- Dr. Ajeet Kumar, Applied Physics

## MONITORING COMMITTEE

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- Dr. D.P.S. Seth  
Member TRAI, Chairman - RMC
- Dr. O. P. Nijhawan  
Former Director IRDE &  
Former President of Optical Society of India, Member
- Shri A. Razdan  
Associate General Manager  
Sterlite Optical Technologies Limited, Aurangabad, Member
- Dr. Y. N. Singh  
EE Department, IIT Kanpur, Member
- Mr. S. Muneshwar  
SSO, TIFAC
- Prof. P. B. Sharma  
Vice-Chancellor, Delhi Technological University, Delhi
- Representative of Industrial Partners  
Permanent Invitee
- Prof. R. K. Sinha  
Chief Co-ordinator



## DEPARTMENTS INVOLVED

Currently following departments of Delhi Technological University (formerly Delhi College of Engineering), are involved in this project:

- Applied Physics
- Electronics & Communication Engineering
- Information Technology



## RESEARCH SCHOLARS

- Ms Swati Rawal  
Photonic Crystal Waveguides and Devices
- Ms Monika Rajput  
Devices and components based on negative refraction
- Ms Sri Vidya Sridhar  
Growth and field emission studies of carbon nanotubes
- Ms Shruti Singh  
Design and development of planar waveguide devices
- Mr Kamal Kishor  
Photonic Crystal Fiber and Metamaterials
- Ms Bhawana Dabas  
Linear and Nonlinear characteristics of Photonic Crystal Fibres
- Ms Venus Dillu  
Plasmonic Waveguides & Devices

## B.E. / M.E. / M.Sc. STUDENTS

- Jivesh Kaushal, Optical Soliton
- Mohit Aggarwal, Optical Network
- Over 60 student members of the International Society for Optical Engineering, (SPIE) DCE Chapter & B.Tech. Engineering Physics.
- Over 10 student members of Optical Society of America, OSA-DCE Chapter
- Mohit Mittal, Website Administrator
- Students of M.Tech. (Microwave & Optical Communication Engg.) and M.Tech. (Nano Science & Technology)

## COURSES & PROGRAM

- Special Courses on Fiber Optics and Optical Communication at B.E. and M.Sc. / M.E. level with adequate laboratory facilities.
- M.Tech. in Microwave and Optical Communication.
- Specialization in Fiber Optics, Optical Communication, Photonics at B.Tech. (Engineering Physics).
- Ph.D. in the area of Optical Fiber Communication with emphasis on experimental and simulation work in all aspects of photonics.
- Short term / training oriented course in the areas covering Fiber Optics, Optoelectronics, Photonics and Telecommunication systems and Networks.
- Specialization in Nano Photonics at M.Tech. (Nano Science & Technology).



Optical Time Domain Reflectometer



Members of TIFAC-CORE @ DCE



Administrative Block, Delhi Technological University



## RESEARCH & DEVELOPMENT

- Theoretical and Experimental studies of speciality optical fibers and integrated optical waveguides.
- Nano-Photonic and Nano-optoelectronic devices.
- Multiple accesses techniques in Optical Fiber Communication Systems and Networks.
- Design & Development of optical fiber sensors & Opto Transceiver.
- Development of numerical techniques of light wave and electron wave propagation.
- Theory and Experiments on Photonic Crystal Fibers and on Photonic Bandgap Devices.
- Optical Systems for measurement of high electrical voltage and current.
- Development of Educational Kits related to Optical Fiber Communication System.

## MAJOR RESEARCH PUBLICATIONS : 2009-2010

### Journals :

- Characterization of specially designed Polarization Maintaining Photonic Crystal Fiber from Far-field measurement”, R.K.Sinha, Kamal Kishore, Anshu D Varshney and Jaspreet Singh, Accepted for publication in Optics Communication, BE-1906 R1, 2010.
- Slow light propagation in liquid crystal infiltrated silicon on insulator photonic crystal channel waveguides, Swati Rawal, R.K.Sinha and Richard M De La Rue, Accepted for publication in IEEE/OSA Journal of Lightwave Technology, Paper Number JLT-12257-2010.R1, 2010.
- “All Angle Negative Refraction for visible light from left handed Metallo-Dielectric Photonic Crystal: Theoretical and Numerical demonstration with nano-Photonic Device Applications” Monika Rajput and R.K.Sinha, Applied Physics B: Laser and Optics, Vol. 98, pp 99-106, 2010.
- “Titanium Buffer layer for improved field emission of CNT based cold cathode” S Sridvidya, S. Gautam, P.Jha, P.Kumar, A. Kumar, US Ojha, JSBS Rawat, S.Pal, P.K. Choudhary, Harsh and R.K.Sinha, Applied Surface science, Vol. 256, Issue 11, pp 3563-3566, 2010.
- “Effect of different plasmonic Nano-inclusion on Double Negative-semiconductor photonic crystal in visible region: Gain assistance and All-Angle Negative Refraction” Monika Rajput and R. K. Sinha, Journal of Electronic Science and Technology, Vol. 8, No. 1, pp 10-15, 2010.
- “Low-Loss Slow Light Transmission in Photonic Crystal Waveguides Comprising of Liquid Crystal Infiltration”, Swati Rawal and R. K. Sinha, Journal of Electronic Science and Technology, Vol. 8, No. 1, pp 35-38, 2010.
- “Dispersion characteristics of Hexagonal and Square lattice Chalcogenide As<sub>2</sub>Se<sub>3</sub> glass Photonic crystal Fiber”, Bhawana Dabas and R. K. Sinha, Optics Communications, Vol. 283, pp 1331-1337, 2010
- “Design of S-band Erbium Doped Concentric Dual-core Photonic Crystal Fiber Amplifiers with ASE suppression”, Shailendra K Varshney, K. Saitoh, M.Koshiba, B. P. Pal, R.K.Sinha, IEEE/OSA J. of Lightwave Technology,(USA), Vol.27, No.11, pp 1725-1733, 2009.
- “Slow Light Miniature Devices with Ultra-flattened dispersion in Silicon-on Insulator Photonic Crystal”, Swati Rawal, R. K. Sinha and Richar M. De La Rue, Optics Express (OSA,USA) Vol. 17, No.16, pp. 13315-13325, 2009.
- “Coupling Characteristics of multicore photonic crystal Fiber based 1x4 power splitters”, S. K. Varshney, K. Saitoh, R.K.Sinha & M.Koshiba IEEE/OSA, J. Lightwave Technology (USA), Vol.27, No.13, pp.2062-2068, 2009.







- “Design, Analysis and Optimization of Silicon-on-Insulator Photonic Crystal dual band wavelength De-multiplexure”, Swati Rawal & R. K. Sinha, Optics Communications, vol. 282, pp. 3889-3894, Oct 2009.
- “Non-linear Properties of Photonic Crystal Fiber: Improved effective index method”, A.D. Varshney & R. K. Sinha, Chinese Journal of Physics, Vol.47, No.2, pp185-192, 2009.
- “Analysis of Electrical Conductance of Carbon Nanotubes “, Neeraj Jain, Harsh & R.K.Sinha, Advanced Materials Research, Vol 67, pp 109-114, 2009.
- “Anti-resonant reflecting Photonic Crystal Waveguide (ARROW): Modelling and Design, Shruti, R. K. Sinha and R. Bhattacharya, Optical and Quantum Electronics, Vol. 4, pp 181-187, 2009.
- "Ultrahigh birefringent photonic crystal fiber: An Improved Design", Anshu D Varshney and Ravindra K. Sinha, International Journal of Microwave and optical technology, Vol 4(5), pp. 324-327, September 2009.
- "Lest Handed Materials and Nano Photonic Devices", Monika Rajput and R. K. Sinha bookchapter is accepted to publish in the book entitled photonic crystal of Nova Publication.

#### Research Papers in Conferences / Proceedings :

- “Demonstration of All-Angle Negative Refraction in Plasmonic metamaterial for blue light and nanophotonic device application”, Monika Rajput and R. K. Sinha, Presented in International conference ISMOT-2009 held at New Delhi during 16th-19th December 2009.
- “Slow light Propagation in Photonic Crystal Waveguides due to Liquid Crystal infiltration: Design and Applications”, Swati Rawal and R. K. Sinha, Presented in International conference ISMOT-2009 held at New Delhi during 16th-19th December 2009.
- “Polarization maintaining chalcogenide glass Photonic Crystal Fiber”, Bhawana Dabas and R. K. Sinha, Presented in International conference ISMOT-2009 held at New Delhi New Delhi during 16th-19th December 2009.
- "Photonic Crystal as k-vector superprism", Anshu D Varshney and R. K. Sinha, Presented in International conference ISMOT-2009 held at New Delhi during 16th-19th December 2009 .
- "Double Clad Photonic Crystal Fiber:Flattened dispersion with low loss", Anshu D Varshney and R. K. Sinha, Presented in International conference ISMOT-2009 held at New Delhi during 16th-19th December 2009 .
- “All-angle negative refraction in gain assisted Metallo-Semiconductor Photonic Crystal for visible light: Effect of Plasmonic Metals and Nano-photonic device application”, Monika Rajput and R. K. Sinha, Presented in an international conference ELECTRO-2009 held at Banaras Hindu University, Varanasi during 22th -24th December,2009 and published in “Macmillan Advanced research series” (Proc. of ELECTRO), pp 512-515, 2009 and in Pro. of IEEE, pp-500-503, 2010
- “Liquid Crystal Tuning of Slow light Propagation in Photonic Crystal Waveguides” Swati Rawal and R. K. Sinha, Presented in an international conference ELECTRO-2009 held at Banaras Hindu University, Banars during 22th -24th December,2009 and published in “Macmillan Advanced research series” (Proc. of ELECTRO), pp 593-595, 2009. Later will be published in Pro. of IEEE, pp 580-582, 2010
- “Zero dispersion demonstration of chalcogenide glass Photonic Crystal Fiber :analysis and evolution” Bhawana Dabas and R. K. Sinha, Presented in an international conference ELECTRO-2009 held at Banaras Hindu University, Banars during 22th -24th December,2009 and published in “Macmillan Advanced research series” (Proc. of ELECTRO), pp 516-519, 2009. Later will be published in Pro. of IEEE, pp 504-507, 2010.
- “Slow Light Devices in Silicon-on-Insulator Photonic Crystal”, Swati Rawal and R. K. Sinha, Presented in an International conference ICOP-2009 International Conference on Optics and Photonics held at Chandigarh, India during 30th October to 1st November, 2009.



- “Theory and Experiment on characterization of polarization maintaining photonic crystal fiber from its far-field measurements,” Kamal Kishor, R. K. Sinha, Presented in an International conference ICOP-2009 International Conference on Optics and Photonics held at Chandigarh, India during 30th October to 1st November, 2009.
- “Negative Refraction in visible region from Metallo-dielectric Photonic Crystal: Design, Characterization and Device Application” Monika Rajput and R. K. Sinha, , Presented in an International conference ICOP-2009 International Conference on Optics and Photonics held at Chandigarh, India during 30th October to 1st November, 2009.
- “Dispersion Properties of Chalcogenide As<sub>2</sub>Se<sub>3</sub> Glass Photonic Crystal Fiber”, Bhawana Dabas and R. K. Sinha, Presented in an International conference ICOP-2009 International Conference on Optics and Photonics held at Chandigarh, India during 30th October to 1st November, 2009.
- “Design of photonic crystal slab waveguides based infiltrated sensors”, Shruti and R. K. Sinha, Presented in an International conference ICOP-2009 International Conference on Optics and Photonics held at Chandigarh, India during 30th October to 1st November, 2009.
- “Analysis of rectangular core photonic crystal fiber: first order perturbation approach,” Anshu D Varshney and R. K. Sinha, Presented in an International conference ICOP-2009 International Conference on Optics and Photonics held at Chandigarh, India during 30th October to 1st November, 2009.
- “Liquid Crystal Assisted slow light propagation in Photonic Crystal and Device Application”, Swati Rawal and R. K. Sinha, Presented in an international conference OSA Frontiers in Optics held at San Jose, California, USA during October 11-15th, 2009 and is published in Proceedings of OSA Frontiers in Optics 2009, Oct, 2009,
- “Negative Refraction in visible region using nano-structured Metallo dielectric photonic crystal”, Monika Rajput, R.K.Sinha, Presented in SPIE International conference on Optics and Photonics, held at San Diego during August 02-06, 2009, published in Proc. Of SPIE , Vol 7420, pp 742009, August 2009.
- “High delay bandwidth product and low dispersion slow light in silicon-on-insulator based photonic crystal waveguides”, Swati Rawal and R. K. Sinha, Presented in SPIE International conference on Optics and Photonics, held at San Diego during August 02-06, 2009, published in Proc. Of SPIE, vol. 7420, pp-742014, 2009.
- “Dispersion properties of chalcogenide photonic crystal fiber”, Bhawana Dabas, R. K. Sinha and Anshu D. Varshney, Presented in SPIE International conference on Optics and Photonics, held at San Diego during August 02-06, 2009, published in Proc. Of SPIE, Vol. 7420, pp-74200A, 2009.
- “Characterization of polarization maintaining photonic crystal fiber from far field measurement” , Kamal Kishor, R. K. Sinah, Anshu D. Varshney and Jaspreet singh, Presented in SPIE International conference on Optics and Photonics, held at San Diego during August 02-06, 2009, published in Proc. Of SPIE, Vol. 7420, pp-742015, 2009.



Optical Fiber Network Analysis Setup



Integrated Optical Wave Guide Characterization Setup (Prism Coupling Technique)



## INDUSTRIAL PARTNERS

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- Reliance Infocom Ltd.
- Sterlite Optical Technology Ltd.
- Bench Mark Electronics Systems Pvt. Ltd.
- HFCL Ltd. - R&D Division
- Railtel Corporation of India Ltd.
- Agilent India
- Trinity Microsystems Pvt. Ltd.
- Falcon Electro Tek Pvt. Ltd.
- Fiberonics, New Delhi (Business Partner, Opto Sci. Ltd., U.K.)

## MAJOR FACILITIES

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- High DC Voltage Measurement using Electro-Optics Effects
- High DC Current Measurement using Magneto-Optics Effects
- Fusion Splicing Machine
- Measurement of Dielectric Constant
- Characterization of Optical Fiber
- Optical Time Domain Reflectometer
- WDM Network Analyzer
- Characterization of Integrated Optical Waveguides
- CCD & CMOS based Imaging System
- Erbium Doped Fiber Amplifier
- Measurement of Speed of Light using Optical Fiber
- Fiber Optics Voice and Video Links
- New Port Projects Setup in Fiber Optics
- Fiber Optic Ed Com (Opto Sci.)
- BER & EYE Diagram Analyzer
- Clean Room - Facility
- Vibration Free Optical Bench
- Computational Lab
- Matlab Release 14
- RSOF Simulation Suit
- OPTIWAVE Simulation Package
- VPI Photonics Software Package
- Photon Design Suit
- Machzender Interferometer set up
- Fiber Laser Characteristics set up
- Optical Spectrum Analyzer
- DWDM optical communication set up



**SPIE**  
**SPIE DCE CHAPTER**  
**DELHI TECHNOLOGICAL UNIVERSITY**  
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**OSA**  
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## An Advance R&D Center



### SUPPORTS ACADEMIC PROGRAMS

- **B. Tech.- Engineering Physics (Special Focus on PHOTONICS)**
- **M. Tech. -Microwave and Optical Communication**
- **M. Tech.- Nano-science & Technology**

**Prof. R. K. Sinha**

Chief Co-ordinator

### **TIFAC-CORE**

#### **Fiber Optics and Optical Communication**

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