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2 REGISTER TODAY AT WWW.OFCNFOEC.ORG/SHORTCOURSE
### Short Course Schedule

#### SUNDAY, MARCH 4

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<td>SC171</td>
<td>Introduction to Optical Control Plane Concepts, Technologies and Practices</td>
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<td></td>
<td>SC177</td>
<td>High-Speed Semiconductor Lasers and Modulators</td>
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<td></td>
<td>SC265</td>
<td>Passive Optical Components and Filtering Technologies</td>
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<td></td>
<td>SC289</td>
<td>Basics of Optical Communication Systems and WDM</td>
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<td>SC328</td>
<td>New Developments in Optical Transport Networking (OTN)</td>
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<td>SC359</td>
<td>Datacenter Networking 101</td>
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<td>9:00 AM - 1:00 PM</td>
<td>SC141</td>
<td>Combating and Monitoring Data-Degrading Effects in Non-Static WDM Systems</td>
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<td>9:00 AM - 4:30 PM</td>
<td>SC105</td>
<td>Modulation Formats and Receiver Concepts for Optical Transmission Systems</td>
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<td>SC182</td>
<td>Biomedical Optical Diagnostics and Sensing</td>
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<td>SC267</td>
<td>Silicon Microphotonics: Technology Elements and the Roadmap to Implementation</td>
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<td>SC341</td>
<td>OFDM for Optical Communications</td>
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<td>SC357</td>
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<td>SC325</td>
<td>Power-Efficient Optical and Electrical Links</td>
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<td>SC210</td>
<td>Highly Integrated Monolithic Photonic Integrated Circuits</td>
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<td>SC160</td>
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<td>SC114</td>
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<td>SC207</td>
<td>Fundamentals of Polarization, PDL, and PMD</td>
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<td>SC288</td>
<td>Silicon Microphotonics: Technology Elements and the Roadmap to Implementation</td>
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<td>SC353</td>
<td>Computercom Interconnects: Circuits and Equalization Methods for Short Reach</td>
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<td>SC325</td>
<td>Power-Efficient Optical and Electrical Links</td>
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<td>Hands-on Workshop on Fiber Optic Measurements and Component Testing</td>
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<td>SC102</td>
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<td>SC342</td>
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<td>9:00 AM - 12:00 PM</td>
<td>SC356</td>
<td>40G/100G Ethernet Technologies and Applications</td>
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<td>SC358</td>
<td>Data Center Cabling: Transitioning from Copper to Fiber</td>
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<td>Quantum Cryptography and Quantum Information</td>
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<td>SC208</td>
<td>Optical Fiber Design for Telecommunications and Specialty Applications</td>
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<td>SC187</td>
<td>Hands-on Basic Fiber Optics for the Absolute Beginner</td>
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<td>1:30 PM - 4:30 PM</td>
<td>SC205</td>
<td>Integrated Electronic Circuits and Signal Processing for Fiber Optics</td>
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<td>NEW COURSE! FEC Technology in Optical Communications</td>
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<td>SC373</td>
<td>NEW COURSE! Specialty Fiber Splicing and Interconnection</td>
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<td>1:30 PM - 5:30 PM</td>
<td>SC360</td>
<td>Hands-On Fiber Optic Terminations with Emphasis on MTP Connectorized Ribbon Fiber</td>
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#### TUESDAY, MARCH 6

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<td>Hands-on Fiber Optics for Engineers Designing for Military, Aerospace, Shipboard and Industrial Harsh Environmental Applications</td>
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<td>Hands-on Fiber Characterization for the Engineering of Long Haul and Metro Deployments</td>
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<td>9:00 AM - 12:00 PM</td>
<td>SC374</td>
<td>NEW COURSE! Cloud Computing and Dynamic Networks</td>
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CATEGORY 1: OPTICAL NETWORK APPLICATIONS AND SERVICES

SPEAKERS INCLUDE (see website for more speakers):

Neal S. Bergano  Lou Berger  Greg Bernstein  Loudon Blair  Jeffrey Cox  Wes Doonan  René-Jean Essiambre  Ori A. Gerstel

Osamu Ishida  Thomas Strasser  Stephen Trowbridge

SC102 WDM in Long-Haul Transmission Systems
NEAL S. BERGANO; TE SUBCOM, USA

SC171 Introduction to Optical Control Plane Concepts, Technologies and Practices
GREG BERNSTEIN; GROTTO NETWORKING, USA

SC176 Metro Network: The Transition to Ethernet
LOUDON BLAIR; CIENA CORP., USA

SC203 40/100 Gb/s Transmission Systems, Design and Design Trade-offs
BENNY MIKKELSEN; MARTIN BIRK; ACACIA COMMUNICATIONS, USA, AT&T LABS, USA

SC243 Next Generation Transport Networks: The Evolution from Circuits to Packets
ORI A. GERSTEL; CISCO SYSTEMS, USA

SC261 ROADM Technologies and Network Applications
THOMAS STRASSER; NISTICA INC., USA

SC264 Introduction to Ethernet Technologies
JEFFREY COX; JUNIPER NETWORKS, USA

SC327 Modeling and Design of Fiber-Optic Communication Systems
RENE-JEAN ESSIAMBRE; BELL LABS, ALCATEL-LUCENT, USA

SC328 New Developments in Optical Transport Networking (OTN)
STEPHEN TROWBRIDGE; ALCATEL-LUCENT, USA

SC356 40G/100G Ethernet Technologies and Applications
OSAMU ISHIDA; NTT, JAPAN

NEW COURSE! SC371 Multi-Layer Control Plane Technologies - Managing Hybrid Networks
LOU BERGER, LABN CONSULTING, USA; WES DOONAN, ADVA OPTICAL, USA
**CATEGORY 2: NETWORK TECHNOLOGIES AND APPLICATIONS**

**SPEAKERS INCLUDE** (see website for more speakers):

Loudon Blair, Thomas Chapuran, Caroline Connolly, Jeffrey Cox, Tasshi Dennis, Dennis Horwitz, Mike Hughes, Richard Hughes

Greg LeCheminant, Daniel Peterson, Stojan Radic, Jerry Renville, Brian Teipen, Christine Tremblay, Neal Wagman

SC101 Hands-on Workshop on Fiber Optic Measurements and Component Testing
CAROLINE CONNOLLY, CHRIS HEISLER, JOSEPH BOS, MICHELLE COLLIER, OPTOTEST CORP., USA, LUNA TECHNOLOGIES, USA, AFL TELECOMMUNICATIONS, USA

SC176 Metro Network: The Transition to Ethernet
LOUDON BLAIR, CIENA CORP., USA

SC178 Test and Measurement of High-Speed Communications Signals
GREG LECHÉMINANT, AGILENT TECHNOLOGIES, USA

SC185 Hands-on Polishing, Inspection and Testing of Connectors
JERRY RENVILLE, STEVE BALDO, NEAL WAGMAN, LIGHT BRIGADE INC., USA, SEIKOH GIKEN CO. LTD., USA, NORLAND PRODUCTS, USA

SC187 Hands-on Basic Fiber Optics for the Absolute Beginner
DENNIS HORWITZ, MICRONOR INC., USA

SC203 40/100 Gb/s Transmission Systems, Design and Design Trade-offs
BENNY MIKKELENS, MARTIN BIRK, ACACIA COMMUNICATIONS, USA, AT&T LABS, USA

SC210 Hands-on Polarization-Related Measurements Workshop
DANIEL PETERSON, TASSHI DENNIS, BRIAN TEIPEN, CHRISTINE TREMBLAY, VERIZON, USA, NIST, USA, ADVA OPTICAL NETWORKING, USA, ÉCOLE DE TECHNOLOGIE SUPÉRIEURE, UNIVERSITÉ DU QUÉBEC, CANADA

SC264 Introduction to Ethernet Technologies
JEFFREY COX, JUNIPER NETWORKS, USA

SC266 Quantum Cryptography and Quantum Information
RICHARD HUGHES, THOMAS CHAPURAN, LOS ALAMOS NATL. LAB, USA, TELCORDIA, USA

SC291 Hands-on Fiber Optics for Engineers Designing for Military, Aerospace, Shipboard and Industrial Harsh Environmental Applications
DENNIS HORWITZ, MICRONOR INC., USA

NEW COURSE! SC312 Parametric Optical Processing and Systems
STOJAN RADIC, UCSD, USA

SC314 Hands-on Fiber Characterization for the Engineering of Long Haul and Metro Deployments
DANIEL PETERSON, CHRISTINE TREMBLAY, VERIZON, USA, ÉCOLE DE TECHNOLOGIE SUPÉRIEURE, UNIVERSITÉ DU QUÉBEC, CANADA

SC347 Reliability and Qualification of Fiber-Optic Components
DAVID MAACK, CORNING, USA

SC360 Hands-On Fiber Optic Terminations and Measurements with Emphasis on MTP Connectorized Ribbon Fiber
CAROLINE CONNOLLY, LOIC CHEREL, TONY NICHOLSON, MIKE HUGHES, BRIAN TEAGUE, OPTOTEST CORP., USA, DATA-PIXEL SAS, FRANCE, CONNECTED FIBERS, USA, CONEC LTD., USA
Short Course Program
CONTINUED

CATEGORY 3: FTTX TECHNOLOGIES, DEPLOYMENT, AND APPLICATIONS

SPEAKERS INCLUDE (see website for more speakers):

Caroline Connolly
Frank J. Effenberger
Dennis Horwitz
Jeffrey Cox
Lionel Kimerling

SC101 Hands-on Workshop on Fiber Optic Measurements and Component Testing
CAROLINE CONNOLLY*, CHRIS HEISLER*, JOSEPH BOS*, MICHELLE COLLIER*;
‘OPTOTEST CORP., USA; 2LUNA TECHNOLOGIES, USA; 3AFL TELECOMMUNICATIONS, USA

SC114 Passive Optical Networks (PONs) Technologies
FRANK J. EFFENBERGER; HUAWEI TECHNOLOGIES, USA

SC187 Hands-on Basic Fiber Optics for the Absolute Beginner
DENNIS HORWITZ; MICRONOR INC., USA

SC264 Introduction to Ethernet Technologies
JEFFREY COX; JUNIPER NETWORKS, USA

SC267 Silicon Microphotonics: Technology Elements and the Roadmap to Implementation
LIONEL KIMERLING; MIT, USA

SC347 Reliability and Qualification of Fiber-Optic Components
DAVID MAACK; CORNING, USA

CATEGORY 5: FIBERS AND OPTICAL PROPAGATION EFFECT

SPEAKERS INCLUDE (see website for more speakers):

Caroline Connolly
Tasshi Dennis
Nicholas Frigo
Mike Hughes
Gerd Keiser
Daniel Peterson
Brian Teipen
Christine Tremblay

Andrew Yablon

SC208 Optical Fiber Design for Telecommunications and Specialty Applications
DAVID J. DIGIOVANNI; OFS LABS, USA

SC210 Hands-on Polarization-Related Measurements Workshop
DANIEL PETERSON*, TASSHI DENNIS*, BRIAN TEIPEN*, CHRISTINE TREMBLAY*; 4VERIZON, USA; 5NIST, USA; 6ADVANTEC OPTICAL NETWORKING, USA; 7ÉCOLE DE TECHNOLOGIE SUPÉRIEURE, UNIVERSITÉ DU QUÉBEC, CANADA

SC288 Fundamentals of Polarization, PDL, and PMD
NICHOLAS FRIGO PH.D; US NAVAL ACADEMY, USA
SC289 Basics of Optical Communication Systems and WDM
GERD KEISER1,2; 1PHOTONICS COMM SOLUTIONS INC., USA, 2NATL. TAIWAN UNIV. OF SCIENCE AND TECHNOLOGY, TAIWAN

SC360 Hands-On Fiber Optic Terminations and Measurements with Emphasis on MTP Connectorized Ribbon Fiber
CAROLINE CONNOLLY1, LOIC CHEREL2, TONY NICHOLSON3, MIKE HUGHES4, BRIAN TEAGUE4; 1OPTOTEST CORP., USA, 2DATA-PIXEL SAS, FRANCE, 3CONNECTED FIBERS, USA, 4CONÉC LTD., USA

NEW COURSE! SC373 Specialty Fiber Splicing and Interconnection
ANDREW YABLON; INTERFIBER ANALYSIS, USA

CATEGORY 6: FIBER AND WAVEGUIDE-BASED DEVICES: AMPLIFIERS, LASERS, SENSORS, AND PERFORMANCE MONITORS

SPEAKERS INCLUDE (see website for more speakers):

Lionel Kimerling

SC208 Optical Fiber Design for Telecommunications and Specialty Applications
DAVID J. DIGIOVANNI; OFS LABS, USA

SC267 Silicon Microphotonics: Technology Elements and the Roadmap to Implementation
LIONEL KIMERLING; MIT, USA

CATEGORY 7: OPTICAL DEVICES FOR SWITCHING, FILTERING, AND SIGNAL COMPENSATION

SPEAKERS INCLUDE (see website for more speakers):

Christi Madsen Bruce Nyman

SC265 Passive Optical Components and Filtering Technologies
BRUCE NYMAN1, CHRISTI MADSEN2; 1TE SUBCOM, USA, 2TEXAS A&M UNIV., USA

“Lisa did an excellent job of covering the basics as well as emerging trends in datameters. The Case studies at the end brought home the considerations extremely well!”

—ATTENDEE OF SC358 DATA CENTER CABLEING: TRANSITIONING FROM COPPER TO FIBER INSTRUCTED BY LISA HUFF

FOR MORE INFORMATION VISIT WWW.OFCNFOEC.ORG/SHORTCOURSE
Short Course Program
CONTINUED

CATEGORY 8: OPTOELECTRONIC DEVICES

SPEAKERS INCLUDE (see website for more speakers):

John Bowers
Christopher R. Doerr
Thomas Huser
Gerd Keiser
Greg LeCheminant

SC177 High-Speed Semiconductor Lasers and Modulators
JOHN BOWERS, UNIV. OF CALIFORNIA AT SANTA BARBARA, USA

SC178 Test and Measurement of High-Speed Communications Signals
GREG LECHEMINANT; AGILENT TECHNOLOGIES, USA

SC182 Biomedical Optical Diagnostics and Sensing
THOMAS HUSER; UNIV. OF CALIFORNIA AT DAVIS, USA

SC289 Basics of Optical Communication Systems and WDM
GERD KEISER1,2; 1PHOTONICSCOMM SOLUTIONS INC., USA, 2NATL. TAIWAN UNIV. OF SCIENCE AND TECHNOLOGY, TAIWAN

SC325 Highly Integrated Monolithic Photonic Integrated Circuits
CHRISTOPHER R. DOERR PH.D; BELL LABS, ALCATEL-LUCENT, USA

CATEGORY 9: DIGITAL TRANSMISSION SYSTEMS

SPEAKERS INCLUDE (see website for more speakers):

Neal S. Bergano
René-Jean Essiambre
Oliver Funke
Kerry Hinton
Gerd Keiser
Yoshikuni Miyata
Takashi Mizuochi
Bernd Nebendahl

Maurice O’Sullivan
Daniel Peterson
Christine Tremblay
Rod S. Tucker

SC102 WDM in Long-Haul Transmission Systems
NEAL S. BERGANO; TE SUBCOM, USA

SC203 40/100 Gb/s Transmission Systems, Design and Design Trade-offs
BENNY MIKKELSEN; MARTIN BIRK; 1ACACIA COMMUNICATIONS, USA, 2AT&T LABS, USA

SC289 Basics of Optical Communication Systems and WDM
GERD KEISER1,2; 1PHOTONICSCOMM SOLUTIONS INC., USA, 2NATL. TAIWAN UNIV. OF SCIENCE AND TECHNOLOGY, TAIWAN

SC314 Hands-on Fiber Characterization for the Engineering of Long Haul and Metro Deployments
DANIEL PETERSON; CHRISTINE TREMBLAY; 1VERIZON, USA, 2ÉCOLE DE TECHNOLOGIE SUPÉRIEURE, UNIVERSITÉ. DU QUÉBEC, CANADA

SC327 Modeling and Design of Fiber-Optic Communication Systems
RENÉ-JEAN ESSIAMBRE; BELL LABS, ALCATEL-LUCENT, USA
Short Course Program

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SC342 Digital Coherent Optical Systems
MAURICE O’SULLIVAN; CIENA, CANADA

NEW COURSE! SC369 Test and Measurement of Complex Modulated Optical Signals
BERND NEBENDAHL & OLIVER FUNKE; AGILENT TECHNOLOGIES, GERMANY

NEW COURSE! SC370 FEC Technology in Optical Communications
TAKASHI MIZUOCHI AND YOSHIKUNI MIYATA; MITSUBISHI ELECTRIC, JAPAN

NEW COURSE! SC372 Energy-Efficiency Networking
ROD S. TUCKER AND KERRY HINTON, UNIV. MELBOURNE, AUSTRALIA

Category 10: Transmission Subsystems and Network Elements

Speakers Include (see website for more speakers):

Y. K. Chen  Caroline Connolly  Chris Fludger  Mike Hughes  Sander L. Jansen  Noriaki Kaneda  Gerd Keiser  Greg Lecheminant

Xiang Liu  Seb Savory  Chandrasekar Sethumadhavan  Alan Willner  Peter Winzer

SC101 Hands-on Workshop on Fiber Optic Measurements and Component Testing
CAROLINE CONNOLLY1; CHRIS HEISLER2; JOSEPH BOS3; MICHELLE COLLIER4; ‘OPTOTEST CORP., USA, ‘LUNA TECHNOLOGIES, USA, ‘AFL TELECOMMUNICATIONS, USA

SC105 Modulation Formats and Receiver Concepts for Optical Transmission Systems
PETER WINZER, CHANDRASEKHAR SETHUMADHAVAN, XIANG LIU; BELL LABS, ALCATEL-LUCENT, USA

SC141 Combating and Monitoring Data-Degrading Effects in Non-Static WDM Systems
ALAN WILLNER; UNIV. OF SOUTHERN CALIFORNIA, USA.

SC178 Test and Measurement of High-Speed Communications Signals
GREG LECHEMINANT; AGILENT TECHNOLOGIES, USA

SC205 Integrated Electronic Circuits and Signal Processing for Fiber Optics
Y. K. CHEN, NORIAKI KANEDA; BELL LABS, ALCATEL-LUCENT, USA

SC239 Short-Reach Optical Interconnects
STEVE JOINER; FINISAR, USA

SC259 Electronic and Optical Impairment Mitigation
CHRIS FLUDGER; SEB SAVORY; ‘COREOPTICS GMBH, GERMANY, ‘UNIV. COLLEGE LONDON, UNITED KINGDOM

SC289 Basics of Optical Communication Systems and WDM
GERD KEISER2; ‘PHOTONICSCOMM SOLUTIONS INC., USA, ‘NATL. TAIWAN UNIV. OF SCIENCE AND TECHNOLOGY, TAIWAN

SC341 OFDM for Optical Communications
SANDER L. JANSEN; NOKIA SIEMENS NETWORKS, GERMANY

SC360 Hands-On Fiber Optic Terminations and Measurements with Emphasis on MTP Connectorized Ribbon Fiber
CAROLINE CONNOLLY1; LOIC CHEREL2; TONY NICHOLSON3; MIKE HUGHES4; BRIAN TEAGUE4; ‘OPTOTEST CORP., USA, ‘DATA-PIXEL SAS, FRANCE, ‘CONNECTED FIBERS, USA, ‘CONELC LTD., USA

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Short Course Program
CONTINUED

CATEGORY 11 OPTICAL PROCESSING AND ANALOG SUBSYSTEMS

SPEAKERS INCLUDE (see website for more speakers):

KEITH WILLIAMS; NAVAL RESEARCH LAB, USA

SC160 Microwave Photonics

DALMA NOVAK, PHD; PHARAD, LLC, USA

CATEGORY 12: CORE NETWORKS

SPEAKERS INCLUDE (see website for more speakers):

GREG BERNSTEIN; GROTTO NETWORKING, USA

SC171 Introduction to Optical Control Plane Concepts, Technologies and Practices

JANE M. SIMMONS; MONARCH NETWORK ARCHITECTS, USA

SC216 An Introduction to Optical Network Design and Planning

ORI A. GERSTEL; CISCO SYSTEMS, USA

SC243 Next Generation Transport Networks: The Evolution from Circuits to Packets

THOMAS STRASSER; NISTICA INC., USA

SC261 ROADM Technologies and Network Applications

JEFFREY COX; JUNIPER NETWORKS, USA

SC264 Introduction to Ethernet Technologies

RENE-JEAN ESSIAMBRRE; BELL LABS, ALCATEL-LUCENT, USA

SC327 Modeling and Design of Fiber-Optic Communication Systems

STEPHEN TROWBRIDGE; ALCATEL-LUCENT, USA

SC328 New Developments in Optical Transport Networking (OTN)

NEW COURSE! SC372 Energy-Efficiency Networking

ROD S. TUCKER AND KERRY HINTON, UNIV. MELBOURNE, AUSTRALIA

REGI1STER1 TODAY aT www.OFCNFOEC.ORG/SHORTCOURSE
CATEGORY 13: ACCESS NETWORKS

SPEAKERS INCLUDE (see website for more speakers):

Jeffrey Cox  Frank J. Effenberger  Kerry Hinton  Lionel Kimerling  Dalma Novak  Rod S. Tucker

**SC114** Passive Optical Networks (PONs) Technologies
FRANK J. EFFENBERGER; HUAWEI TECHNOLOGIES, USA

**SC217** Hybrid Fiber Radio – The Application of Photonic Links in Wireless Communications
DALMA NOVAK, PHD; PHARAD, LLC, USA

**SC264** Introduction to Ethernet Technologies
JEFFREY COX; JUNIPER NETWORKS, USA

**SC267** Silicon Microphotonics: Technology Elements and the Roadmap to Implementation
LIONEL KIMERLING; MIT, USA

**NEW COURSE! SC372** Energy-Efficiency Networking
ROD S. TUCKER AND KERRY HINTON, UNIV. MELBOURNE, AUSTRALIA
CATEGORY 14: DATACOM, COMPUTERCOM, AND SHORT RANGE AND EXPERIMENTAL OPTICAL NETWORKS

SPEAKERS INCLUDE (see website for more speakers):

- SC187 Hands-on Basic Fiber Optics for the Absolute Beginner
  DENNIS HORWITZ; MICRONOR INC., USA

- SC267 Silicon Microphotonics: Technology Elements and the Roadmap to Implementation
  LIONEL KIMERLING; MIT, USA

- SC291 Hands-on Fiber Optics for Engineers Designing for Military, Aerospace, Shipboard and Industrial Harsh Environmental Applications
  DENNIS HORWITZ; MICRONOR INC., USA

- SC356 40G/100G Ethernet Technologies and Applications
  OSAMU ISHIDA; NTT, JAPAN

- SC357 Computercom Interconnects: Circuits and Equalization Methods for Short Reach Power-Efficient Optical and Electrical Links
  ALEXANDER RYLYAKOV, IBM T.J. WATSON RESEARCH CENTER, USA

- SC358 Data Center Cabling: Transitioning from Copper to Fiber
  LISA HUFF; DATACENTERSTOCKS.COM, USA, DDISCERNING ANALYTICS, LLC, USA

- SC359 Datacenter Networking 101,
  CEDRIC LAM AND HONG LIU; GOOGLE INC., USA

NEW COURSE! SC371 Multi-Layer Control Plane Technologies - Managing Hybrid Networks
LOU BERGER, LABN CONSULTING, USA; WES DOONAN, ADVA OPTICAL, USA

NEW COURSE! SC374 Cloud Computing and Dynamic Networks
GEORGE CLAPP; TELCORDIA TECHNOLOGIES, USA; DOUGLAS FREIMUTH, IBM RESEARCH, USA

ADDITIONAL SHORT COURSE CATEGORY: INDUSTRY BEST PRACTICES

- SC347 Reliability and Qualification of Fiber-Optic Components
  DAVID MAACK; CORNING, USA.
**SC371 Multi-Layer Control Plane Technologies - Managing Hybrid Networks**

**INSTRUCTOR:** LOU BERGER, LABN CONSULTING, USA; WES DOONAN, ADVA OPTICAL, USA  
**Level:** Advanced Beginner (basic understanding of topic is necessary to follow course material)

**DESCRIPTION:**
Network services and switching technologies have traditionally been deployed and operated along a per-layer approach, where network equipment supports only a single switching technology and management of each set of equipment is independent. More recently there has been a trend to integrate multiple switching technologies into the same network equipment and to integrated operation support tools and technologies. Such hybrid networks incorporate different and distinct classes, or multiple-layers, of transport services and switching. Examples of hybrid-network technologies include integrated packet-optical transport platforms, and OTN equipment that can simultaneously switch at ODUk multiplexing levels. Networks constructed with such network equipment present a unique set of deployment and control challenges. Integration between transport technologies involves adaptation in both data and control planes, and in order to efficiently manage these adaptations, a clear and consistent operational framework is required. In the context of the control plane, multi-layer integration enables opportunities for dynamic cross-layer interactions as well increased resource optimization.

This course will provide participants with an understanding of existing GMPLS-based control plane standards, techniques and mechanisms for operating hybrid networks. This course will review the relevant control plane concepts and standards. Both single-layer and multi-layer perspectives will be presented. The course will also identify specific concepts, tools and mechanisms which can be used by network operators to efficiently and functionally control a hybrid network controlled by a standards-based control plane. Such topics as dynamic forwarding adjacencies, dynamic service activation, virtual links, virtual nodes, and remote path computation will be covered. Use of these technologies in context of emerging network virtualization applications is also outlined. Examples of how these techniques can be deployed within optical hybrid network topologies are also discussed, along with the advantages and consequences of each.

**BENEFITS:**
- Identify and describe the primary operational support functions provided by a GMPLS-based control plane in a transport network.
- Discuss and compare different control-plane based approaches for the integrated control of a multi-layer transport network.
- Determine how the capabilities of a specific control-plane implementation may be leveraged in a particular transport network.
- Begin the design of multi-layer transport network control systems employing single-layer or multi-layer control plane techniques and mechanisms.
- Initiate designs for the use of new network virtualization capabilities enabled by advanced control plane features.

**AUDIENCE:**
This course is intended for network engineers and network managers who are looking to gain an understanding of how a dynamic control plane can be leveraged in their current and planned transport networks. Much of this course will also be of interest to those looking for a high-level introduction to a GMPLS-based control plane. Basic familiarity with WDM and other transport network technologies is assumed. No familiarity with control plane routing or signaling is required.
SC372 Energy-Efficiency Networking
INSTRUCTOR: ROD S. TUCKER, AND KERRY HINTON, UNIV. MELBOURNE, AUSTRALIA
Level: Beginner (no background or minimal training is necessary to understand course material)

DESCRIPTION:
This short course will provide an introduction and overview of energy efficiency in communications networks. The course will look at trends (past and future), challenges and opportunities presented by the evolution to energy-efficient telecommunications.

COURSE COMPONENTS ARE:
- Growth of ICT and its power consumption
- Sustainability implications of ICT growth
- Modelling network power consumption
  - Sales and inventory based models
  - Network-design-based model
  - Transaction-based model
  - Important parameters: PUE, peak vs average access speed, dimensioning for growth, redundancy, protection and replacement
- Power consumption modelling of networks
  - Access networks: Wireless, PON, FTTN, HFC and Point-to-Point
  - Edge and Metro networks
  - Core networks: Terrestrial and submarine
- Power consumption of equipment
  - IP Routers (edge and core)
  - Switches (Ethernet, MPLS and TDM)
  - Cross connect, add/drop multiplexer
  - Multi-layer switches (GMPLS)
  - Transmission systems
  - OLTs and ONUs
  - Equipment for cloud services
- Equipment power consumption trends
  - Time evolution
  - Traffic load dependence
  - Bringing it all together
  - Future trends and directions
  - Identifying leverage points for improvements in energy efficiency
  - Improving energy efficiency using:
    - Architectures
    - Protocols
    - Technologies
  - What is attainable
    - Lower theoretical limits on power consumption
    - How close can we get to these limits?: Network control, management and monitoring
    - Overview of global activities in green networking
      - GreenTouch
      - Carbon Trust
      - GreenGrid
      - GeSi
      - ITU, EU & others

BENEFITS:
- Compare networks from the perspective of energy efficiency.
- Compute an estimate of the energy efficiency of network equipment, designs and architectures (in Joules/bit).
- Explain the principles of energy efficiency in telecommunications networks
- Identify key factors and leverage points for improving the energy efficiency future networks
- Describe the key determinants of network energy efficiency

AUDIENCE:
Telecommunications engineers, managers, policy makers, researchers and educators.
A basic knowledge of telecommunications networks and equipment will be advantageous. Little or no knowledge of energy efficiency issues in telecommunications networks is required.
SC312 Parametric Optical Processing and Systems
INSTRUCTOR: STOJAN RADIC; UCSD, USA

DESCRIPTION:
The course will introduce the basics of parametric signal processing and its application in communication and sensing. The course is structured in three segments and will cover:
1. parametric physics in lumped and distributed platforms,
2. device design in time and spectral domains and
3. digital, analog and coherent applications.

Performance, impairments and physical limits of parametric amplification, band conversion, signal regeneration, coherent sampling and conjugation will be described in detail. The course will introduce wideband device synthesis and outline fundamental and practical performance limits. Emerging applications that include tunable sources, coherent sampling, analog-to-digital conversion, reconfigurable delays, and low-latency spectral monitoring will be covered. Finally, the parametric processor role in sensing systems such as distant-band LiDAR will conclude the course.

BENEFITS:
• Design the basic parametric amplifier using conventional, off-the shelf elements.
• Design and test single- and multiple-band converter.
• Construct coherent parametric processor.
• Design and construct high-rate multiplexer, demultiplexer.
• Design and construct scalable multicaster blocks.
• Introduce parametric module into general purpose instruments in communication, sensing and measurements.
• Design, construct and characterize high-rate analog-to-digital converter.
• Explain advantages and disadvantages between translated and band-specific sensing and communication systems.

AUDIENCE:
Recommended audience includes researchers interested in ultrafast signal processing, high performance amplification, band conversion and general parametric technology. The course requires only basic fiber course background and will support attendance from junior graduate students and up. The course will cover topics in communications, sensing, metrology and general laser design and welcomes attendance from diverse backgrounds.
Device bandwidth constraints and typical 50 GHz channel spacing force system designers to consider combined phase and amplitude modulation as a method to increase channel information capacity. Test and measurement of the transmitters and receivers used in these complex modulation systems requires techniques that are vastly different than those used for the simple amplitude modulation based systems that have dominated optical communications. This course will give an overview of the basics of complex modulation. For test and measurement there will be an emphasis on systems based on polarization diverse coherent receivers with their signals being sampled in real time. In order to extract meaningful results topics like polarization and carrier phase tracking are discussed. Various parameters that quantify the signal quality of a complexly modulated signal are introduced that allow rating the performance and identifying problems of a transmitter for complexly modulated signals. The definition of the error-vector-magnitude (EVM) and its relationship to BER and Q-factor will be explained. Methods to quantify the uncertainty of a test system and to validate its performance will be presented.

**Benefits:**
- Compare the quality of various transmitters through the use of EVM measurements
- Determine the relationships between EVM, BER, and Q-factor
- Compare the different techniques used for complex modulation analysis and determine which provide optimum results for a given measurement scenario
- Relate details of constellation diagrams to specific device and/or measurement system impairments
- Identify the root causes of measurement degradation and uncertainty
- Develop test strategies to validate the accuracy of test results

**Audience:**
This short course is intended for engineers who start to work or already have experience in manufacturing and development of transmitters, links and receivers operating with complex modulated signals. Attendees should be aware of basic concepts of optical transmission and polarization of light. Research and manufacturing managers as well as technical buyers will get a profound background in order to make optimal decision for their test and measurement needs. Students will extend their knowledge in complex signal analysis to setup optimal test concepts.

"The instructor was eloquent and knowledgeable in network planning. Enough time was given for questions—Network demo example at end of the course was also very helpful. Excellent course!!!"

—Attendee of SC216 An Introduction to Optical Network Design and Planning Instructed by Jane Simmons
SC370 **FEC Technology in Optical Communications**

**INSTRUCTOR:** TAKASHI MIZUOCHI AND YOSHIKUNI MIYATA; MITSUBISHI ELECTRIC, JAPAN

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

**DESCRIPTION:**

This course describes the types of forward error correction (FEC) technique used for optical communications. The basic concepts and terminology of FEC, e.g. block codes, Hamming distance, parity check matrix, and syndrome, are explained using the fundamental equations. The key terms related to FEC in optical communications are clarified, e.g. net coding gain, code rate, redundancy, interleaving, and Q limit. We then review the history of FEC in optical communications. The various types of FEC developed to date are classified as belonging to three generations: RS(255,239) represents the first generation, concatenated codes are the second generation, and more powerful FEC based on soft-decision decoding is the third generation. The second generation FECs will be explained, and recently developed concatenated codes discussed. The third generation FECs are analyzed in detail, with emphasis on low-density parity-check (LDPC) codes for superior NCGs with soft decision decoding. The positive impacts on existing systems are also discussed. We will relate each generation of FEC to the Shannon Limit, and discuss the ultimate NCG as a function of code rate. The circuit implementation of a 100G Digital Coherent DSP is discussed. The additional useful functionalities obtained by employing FEC and the application of FEC to error monitoring for adaptive equalization will also be covered. Finally, this course anticipates the possible roles for optical technologies in future optical communication networks.

**BENEFITS:**

- Explain key terms related to FEC in optical communications
- Define the FEC key parameters
- Compute the basic generator polynomial
- Describe the three generations of FEC
- Compare the net coding gain with the Shannon Limit
- Calculate the Q budget table based on the FEC performance
- Measure the FEC error correction capability
- Design a circuit implementation for 100G Digital Coherent DSP
- Discuss possible roles for optical technologies in future optical communication networks

**AUDIENCE:**

This course is intended for systems engineers, circuit-board designers, system operators and managers who need to understand and apply FECs to optical systems. Knowledge of information theory is not needed.
MONDAY, MARCH 5, 2012

1:30 PM - 4:30 PM

SC373 Specialty Fiber Splicing and Interconnection
INSTRUCTOR: ANDREW YABLON; INTERFIBER ANALYSIS, USA
Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

DESCRIPTION:
The recent emergence of a diversity of optical fiber designs and applications has made optical fiber interconnection more challenging even as it has become more important. Effective interconnection of optical fibers is critical for all applications, including traditional telecom links, optical fiber sensors, and high-power fiber amplifiers and sources.

This course provides an introduction to all aspects of optical fiber interconnection, and compares the benefits and disadvantages of fusion splices, fiber connectors, and free space optics. Performance metrics and their measurement are introduced, including optical loss, reflectance, mode conversion, polarization crosstalk, and tensile strength. Special issues relevant to field deployment, factory production, and laboratory environments are all covered.

An overview of equipment for fusion splicing as well as for fiber preparation and splice packaging is presented. Special fusion splicing strategies and fusion splice optimization are reviewed. Practical approaches for interconnection specialty fibers, including multimode, single-mode, dispersion managed, rare-earth-doped, large effective area, multi-core, high-power, polarization-maintaining, non-silica, and microstructured fibers are all discussed.

Proof testing and long term mechanical reliability of fusion splices are addressed. A numerical approach for modeling fusion splicing is presented.

BENEFITS:
- Improve the quality of your fusion splices
- Compare competing interconnection technologies
- Select equipment for optical fiber interconnection
- Estimate interconnection performance
- Test and measure optical fiber interconnections
- Avoid problems with splice reliability
- Evaluate and apply special fusion splicing strategies

AUDIENCE:
This course is intended for engineers and scientists who are concerned about the problem of optical fiber interconnection and are looking for practical solutions to their problems. This course presupposes a familiarity with contemporary optical fibers and their theory of operation.

“I think this is one of the best short courses at OFC. This is the second time that I took it, and it has a lot of new information. Neal Bergano is an excellent instructor, extremely articulate.”

—ATTENDEE OF SC102 WDM IN LONG-HAUL TRANSMISSION SYSTEMS INSTRUCTED BY NEAL BERGANO
SC374 Cloud Computing and Dynamic Networks

INSTRUCTOR: GEORGE CLAPP, TELCORDIA TECHNOLOGIES, USA; DOUGLAS FREIMUTH, IBM RESEARCH, USA

Level: Beginner (no background or minimal training is necessary to understand course material)

DESCRIPTION:
Cloud computing is playing an increasingly prominent role as providers offer more complete and robust services and as enterprises adopt the technology into their IT infrastructure. Cloud computing lowers the total cost of computing through large pools of resources that are shared across many clients and managed as a single entity. Virtualization is a key enabler that creates a logical version of a physical resource such as a computer or storage device and permits the resource to be allocated to different users as demands change. Networks are essential resources in cloud computing, just as essential as computers and storage devices, but unlike virtual computers and storage, cloud providers have treated their networks between data centers as static resources over which they had little control. This model is changing rapidly as new network technologies and services emerge. The optical control plane has enabled agile, intelligent and autonomous networks that can rapidly provision new services, and carriers are deploying them to offer dynamic services. The Research & Education community is also offering dynamic network services and integrating them into cloud computing for large scale experiments.

This course is an introduction to cloud computing and to the emerging dynamic network services. The course will describe cloud computing infrastructures and technologies such as virtualization and cover the different dynamic network technologies and services, describing how they can be virtualized and integrated into cloud computing. It will also describe sample cloud applications and how they can make use of the new services.

BENEFITS:
• Identify and describe the key technologies that underlie cloud computing.
• Describe the network within the data center and how it is virtualized and managed by the cloud provider.
• Describe the key technologies that underlie dynamic network services.
• Describe and compare the different dynamic network services either presently offered or under development by carriers and the Research & Education community.
• Describe how the dynamic network services can be virtualized and integrated into cloud management systems.
• Discuss sample cloud applications and how they can benefit from the dynamic network services.

AUDIENCE:
This course is intended for planners and architects of both networks and data centers who are involved in designing networks both between and within data centers. The course will also be helpful to system vendors who wish to understand the emerging requirements of cloud and network service providers for dynamic network services. The course is at an introductory level but some familiarity with data network architecture and protocols is assumed.
LEARN ABOUT THE LATEST OPTICAL COMMUNICATIONS INNOVATIONS IN KEY AREAS SUCH AS:

- Data center networking
- Green networks
- Spatial multiplexing
- Coherent detection for high spectral efficiency
- 100G and beyond
- Wireline-wireless networking
- High-speed photonic integration
- And More!