ECE4191: Photonics Communication and Networking

Programme: ECE Year: III Semester: Odd
Course: Program Elective Credits: 3 Hours: 40

Course Context and Overview (100 words):
With novel photonic and opto-electronic devices, components and integrated photonic circuits, the field of photonics communication is very fascinating, leading to unsurpassed capabilities of terabit transmission, switching and networking. The course provides the fundamental understanding of key photonics devices, and the guidelines for photonic communication links and network operation and design. Finally, the emerging photonics technologies are highlighted to inspire future thought and interests.

Prerequisite Courses: Principles of Communication, Digital Communication

Course Outcomes: On completion of this course, the students will have the ability to:
CO1: Recognize the current practices in broadband photonic networks and communication Systems
CO2: Develop and design improved techniques for dispersion and nonlinearity management
CO3: Characterize the performance of a photonic WDM system with novel and flexible modulation formats
CO4: Develop efficient survivable routing for a wavelength convertible WDM network
CO5: Undertake research in next-generation photonics communication system

Course Topics:

Topics	Lecture Hours
UNIT-1: Introduction: Evolution of PC (1st-6th Generation)	**2**
1.1 Motivation for PC and State-of-the-art Scenario	1
1.2 Applications Portfolio	1
1.3 Future trends, opportunities and challenges	
UNIT-2: Photonics Communication Fundamentals	**9**
2.1 Generic PC system model: Key elements, standards, performance metrics	1
2.2 Transmitter sub-systems: 2.2.1 LEDs/ LASERs (DFB/ DBR/ VCELS) 2.2.2 Source Characteristics, Linearity, Source-to fibre coupling 2.2.3 Biasing and Temperature Stabilization 2.2.4 Transmitter modules for Different Modulation Formats	3

2.3 Fibre sub-system 2.3.1 Propagation in optical fibres (SMF/ MMF) 2.3.2 Special fibres: DSF/ DCF/ LEAF/ RDF 2.3.3 Fibre Characteristics: NA, RI profile, loss and loss-spectrum 2.3.4 Chromatic Dispersion (CD), Dispersion slope, PMD 2.3.5 Non-linear Effects (NLE): (SPM/ XPM/ FWM) 2.3.6 Compensation of CD and NLE	2
2.4 Receiver sub-system 2.4.1 Photo detector (PN/ PIN/ APD) 2.4.2 Detector Characteristics: Noise, responsivity, response time 2.4.3 Receiver structures: Direct Detection, Pre-amplified Receiver (Amplifier: EDFA, SOA, DRA), Coherent Receiver (Heterodyne vs. Homodyne), Balanced Receiver 2.4.4 Receiver Sensitivity, RIN 2.4.5 BER Performance and impact of Source Linewidth	3
UNIT-3: Transmission System Engineering	**5**
3.1 Light-wave Transmission Link design 3.1.1 Point-to-Point/ WDM/ Optically amplified system 3.1.2 Performance Metrics (OSNR/ EO Penalty/ BER/ Q-value) 3.1.3 WDM System Simulation by Beam Propagation Method: A case study	5
UNIT-4: Photonic Networking	**5**
4.1 Photonic Network Architectures 4.1.1 Network Topology 4.1.2 Classification (Single-hop/ Multi-hop, B/S, WR, OBS/ OPS) 4.1.3 Single-wavelength Networks (Bus/ Star/ Ring/ FDDI/ SONET/ SDH/ DQDB)	5
UNIT-5: Wavelength-Routed Photonic Networks	**7**
5.1.Wavelength-Routed (WR) Photonic Network 5.1.1. Routing and Wavelength Assignment (RWA) 5.1.2. Wavelength Conversion, Wavebands, Optical cross-connect (OXC) 5.1.3. Blocking Probability Performance of WDM Networks 5.1.4. Multi-granularity OXC	4
5.2. Network Survivability 5.2.1 Protection vs. Restoration 5.2.2 Self-Healing Ring Network 5.2.3 Protection/ Restoration in Mesh Networks: Path Protection vs. Link protection	3

UNIT-6: Fibre optic Access Network	**3**
6.1. PON Architectures: TPON/ WDM-PON/ WR-PON	1
6.2. Access Control Schemes: Conventional Polling, Pipeline Polling, Framed Pipeline Polling	1
6.3. EPON: Architecture and Functional Elements, IPACT	1
6.4. GPON/ Gb-Ethernet: Major Features	
UNIT-7: Emerging Topics in Photonics Communication	**9**
7.1 Optical-wireless and Visible Light communication	2
7.2 Ultra-dense DWDM Coherent Communication	3
7.3 Silicon Photonics and PICs	2
7.4 Optical Packet and Burst-Switching	2

Text Books (IEEE format):

1. Gerd Keiser, *Optical Fibre Communication*, 5th Edition, Tata McGraw Hill
2. R. Ramaswami and K. N. Sivarajan, *Optical Networks - A Practical Perspective*, Morgan Kaufmann; 3 Edition

Reference Books:

1. G. P. Agarwal, John Wiley, *Fibre-optic Communication System*
2. John Power, *Fibre optic System*, IRWIN

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):

Evaluation Methods:

Item	Weightage (%)
Quizzes and Assignments	20
Mid Semester Examination	30
End Semester Examination	50

Prepared By: Prof. R. Gangopadhyay
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