ECE4132 : Fiber Optics

Programme: B.Tech. ECE **Year:** 4th **Semester :** Even
Course Type: Programme Elective **Credits:** 3 **Hours :**40

Course Context and Overview (100 words):
The course provides knowledge of optical fiber waveguide, essentials of an optical fiber communication system and understanding of various components of an optical fiber telecommunication system.

Prerequisites Courses: Engineering Electromagnetics

Course outcomes(COs):

On completion of this course, the students will be able
CO1: to understand need of optical fiber communication, salient features of fiber, its transmission characteristics and analyze the propagation of light in the fiber under different medium and boundary condition.
CO2: to analyze propagation of electromagnetic wave for symmetric and anti-symmetric modes in planar, planar mirror waveguide with different dielectric medium and power associated with modes.
CO3: to understand optical fiber modes, loss mechanisms, chromatic dispersion, pulse broadening, optical fiber components and devices
CO4: to understand fiber gratings, fabrication process, dispersion management, optical fiber sources and Detectors.

Course Topics:

Topics	**Lecture Hours**	
UNIT - I **1. Basic definitions and concepts**	**10**	
1.1 Introduction, need for optical communication, salient features of optical fiber ray theory of light guidance.	1	
1.2 numerical aperture, modes of a fiber, single and multimode fibers,	1	
1.3 step-index and graded-index fibers, fiber fabrication techniques	2	
1.4 Transmission characteristics of optical fibers, attenuation, pulse broadening	2	
1.5 intermodal dispersion, bit rate - length product, material dispersion,.	2	
1.6 electromagnetic wave analysis of light propagation in an infinitely extended medium, em waves in dielectrics, boundary conditions	2	
UNIT - II **2. Electromagnetic Properties of Fiber**	**10**	
2.1 Electromagnetic analysis of planar optical waveguides, TE and TM modes, planar mirror waveguide,	2	
2.2 dielectric symmetric step-index, planar waveguide, symmetric and anti-symmetric modes, b-V curves, modal fields	2	
2.3 Power associated with modes of dielectric symmetric planar waveguide,	2	
2.4 asymmetric planar waveguide, single polarization single mode waveguide, excitation of guided modes by prism coupling technique,	2	
2.5 radiation modes, optical fiber waveguide, EH and HE modes, weakly guiding fibers, LP modes, mode cut-offs, b-V curves	2	

UNIT-III **3. Optical Fiber Modes, components and devices**	**10**	
3.1 Optical fiber modes, field patterns, degeneracies, fractional power in the core, single mode fiber, cut-off wavelength, mode field diameter,	2	
3.2 Bend loss, splice loss, waveguide dispersion, group delay	2	
3.3 Total chromatic dispersion, pulse broadening and chirping, dispersion in graded-index and multilayer fibers,	3	
3.4 Optical fiber components and devices, directional coupler, power splitter,	2	
3.5 WDM coupler, polarization controllers, Various types of fiber Bragg gratings	1	
UNIT-IV **4. Optical Fiber fabrication, Sources, Detectors**	**10**	
4.1 Fabrication methods, applications, long period gratings, optical fiber amplifier, erbium doped fiber amplifier,	1	
4.2 Dispersion management, dispersion shifted fiber, dispersion compensating fiber,	1	
4.3 Sources for optical fiber communication, light emitting diode, internal and external quantum efficiencies, LED characteristics, laser diode	2	
4.4 Detectors for optical communication, p-i-n photo detector, APD, System design	1	
4.5 Dispersion and attenuation limited systems, BER calculation	2	
4.6 Optical network ,Power budgeting of fiber link	1	
4.7 Recent Advances in Optical Fiber	2	

Text Books:

[1] Ghatak A K and Thyagarajan K, "Introduction to Fiber Optics", Cambridge University Press
[2] Saleh B E A and Teich M C, "Fundamentals of Photonics," Wiley-Interscience
[3] Agrawal G P, " Optical Fiber Communication System," Wiley-Interscience
[4] Keiser G, "Optical Fiber Communications", McGraw Hill
[5] Senior J M, "Optical Fiber Communications," Pearson Prentice Hall

Reference book:

Snyder A and Love J, "Optical Waveguide Theory", Chapmann and Hall

Paper:

[1] R.J. Essiambre, G. Kramer, P.J. Winzer, G.J. Foschini, B. Goebel, "Capacity limits of optical fiber networks", *J. Lightwave Techmol.*, vol. 28, no. 4, pp. 662-701, 2010.

Additional Resources (Web resources etc.):

https://onlinecourses.nptel.ac.in/noc19_ph05

Evaluation Methods:

Item	Weightage (%)
Assignments	**30**
Mid Term	**20**
End Term	**50**

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