BECE308L – Optical Fiber Communications
Winter(2023-24)

Course Instructor

Dr. T. Ilavarasan

- Associate Professor
- School of Electronics Engineering
- Mail: ilavarasan.t@vit.ac.in
- Contact: +91-9790040384
- Cabin : Sigma Block – L37

Guidelines to be followed:

- Be on time for the class as per the schedule.
- Always have a **dedicated notebook** and your own **calculator** to solve the numerical problems during the class hours.
- Stick to the **deadlines** for the Assignments, Quizzes and other assessment activities.
- Be attentive and ask your doubts then and there during the class hours.
- Feel free to share your views towards the course/topic and the instructor regarding the content delivery.
- Let it be more of a discussion and Happy learning for all..!!

General course information:

- Prerequisite – BECE306L/Digital Communication System
- Important concepts will be explained qualitatively using real-life examples
- However, as an engineering student, extensive use of mathematics is necessary for accurate system modelling and analysis
- Theory – 2 credits - 2 hrs per week – Totally 30 hrs
- Lab – 1 credit – 2 hrs per week

Course objectives:

- To understand the principles of optical fibers and their signal degradation
- To familiarize with the fundamentals of optical sources and detectors used in communications
- To learn WDM techniques and its components in contemporary optical communication systems

Course outcomes:

- List the fundamental optical laws, structures and waveguides
- Comprehend the various signal degradation in the fiber optical communication
- Design the optical transmitters and receivers and evaluate their performances
- Estimate the system requirements for point to point communication
- Examine the significance of WDM techniques and their applications
- Comprehend and analyse the performance of the various optical amplifiers

Syllabus

- **Module:1 Optical Fiber: Structures, Waveguides**
- **Module:2 Signal Degradation**
- **Module:3 Optical Transmitters**
- **Module:4 Optical Receivers**
- **Module:5 Digital links and Measurements**
- **Module:6 WDM Concepts and Components**
- **Module:7 Optical Amplifiers**

Text/Reference Books

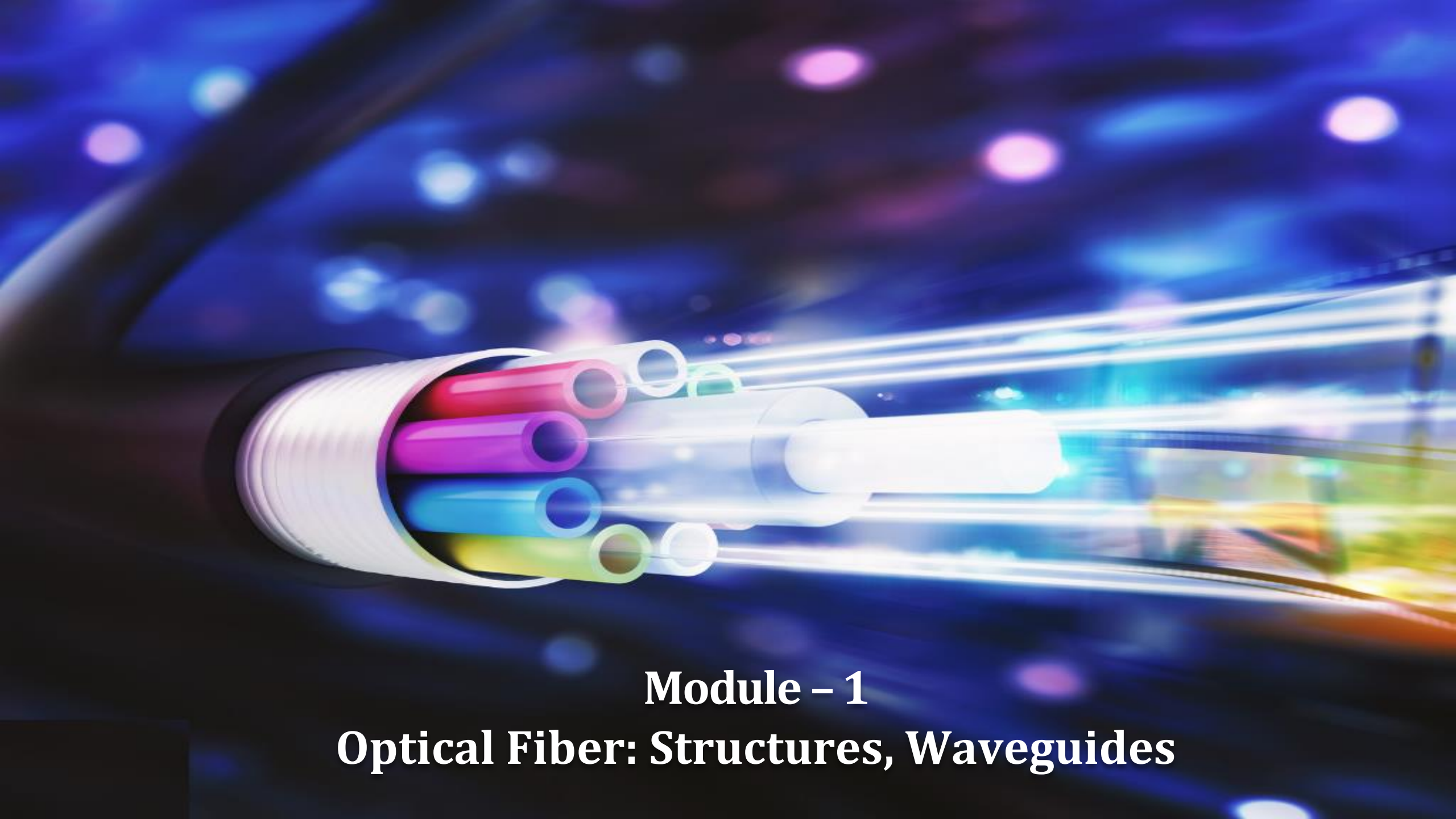
- Gerd Keiser, Optical Fiber Communications, 2017, 5th Edition, McGraw Hill Education, India
- John M. Senior , Optical Fiber Communication, Pearson Education, 2011
- G.P.Agarwal , Fiber Optic Communication System, Wiley, Second Edition, 2011
- Conway, E., Optical Fiber Communications Principles and Practice, 2018, 1st Edition, ED-TECH Press, United Kingdom
- Singal, T. L. Optical Fiber Communications: Principles and Applications, 2017, Cambridge University Press, India

Evaluation Metrics

- DA – 1 – 10 marks
- Quiz – 1 - 10 marks (After CAT-1) {OR} Research Project – 30 marks
- Quiz – 2 - 10 marks (After CAT-2)

- CAT – 1 – 15 marks
- CAT – 2 – 15 marks

- FAT – 40 marks



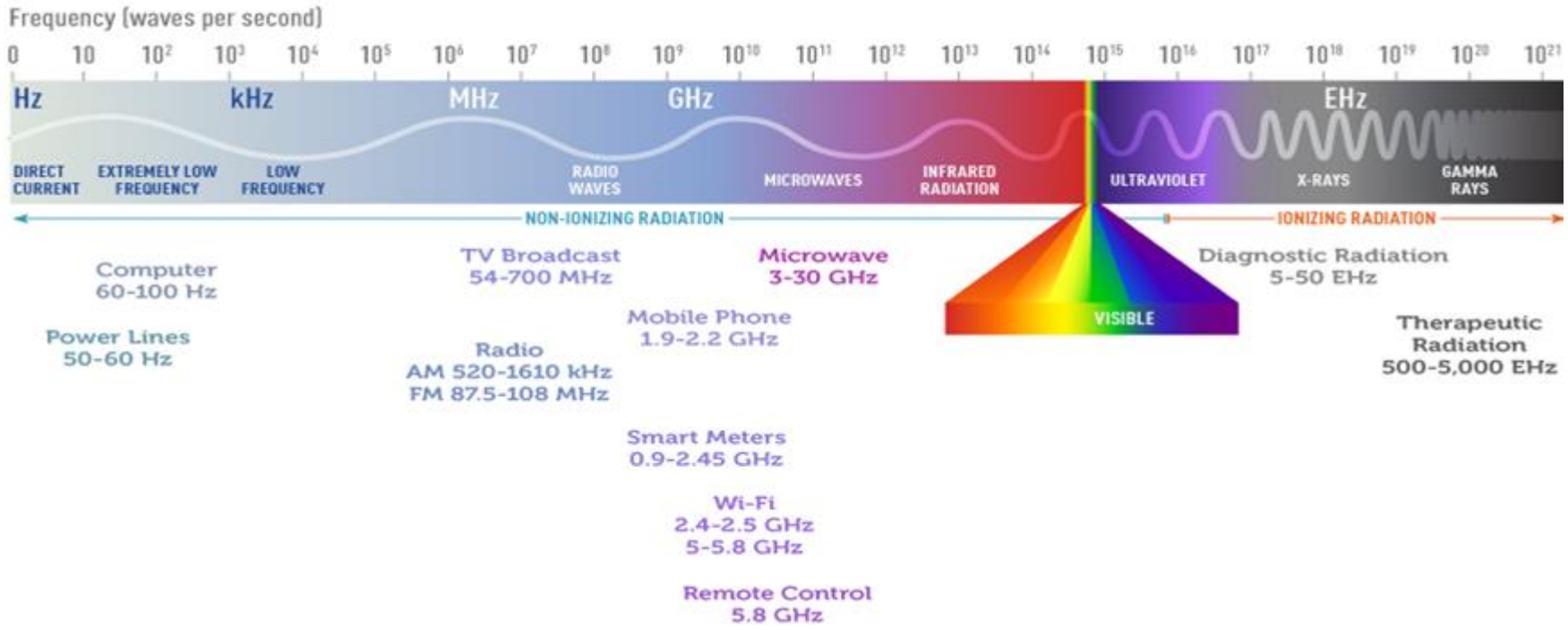
Module – 1
Optical Fiber: Structures, Waveguides

Topics to be discussed

- Key elements of optical fiber system
- Ray optics
- Mode theory
- Geometrical-Optics
- Fiber types

History of communication system

Electromagnetic spectrum



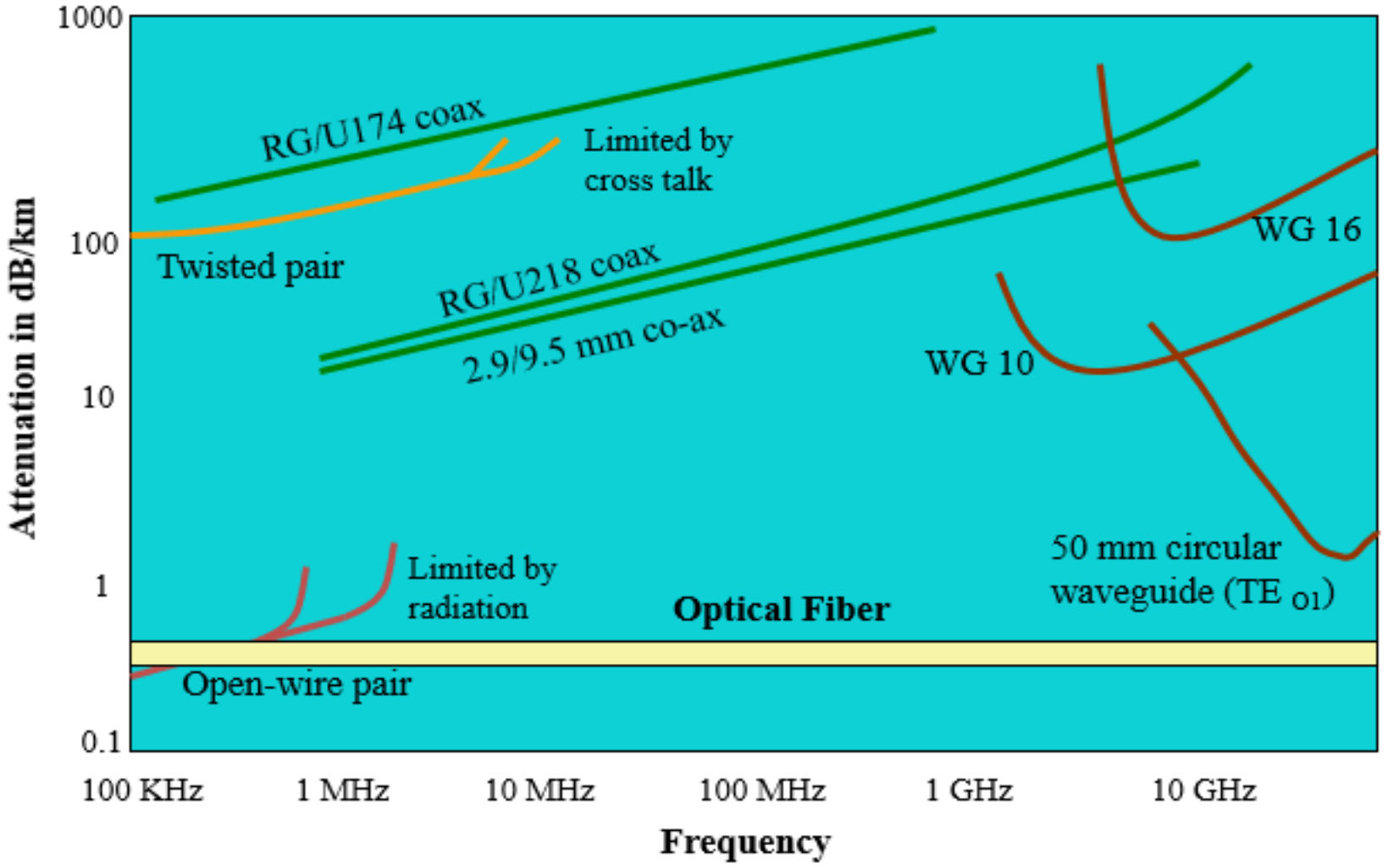
$$BW = f_0/Q$$

$$BW \propto f_0$$

Introduction

- Fiber optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber
- Communication systems with light as the carrier and optical fiber as communication medium
- The light forms an electromagnetic carrier wave that is modulated to carry information
- Optical fiber is used to contain and guide light waves
  - Typically made of glass or plastic
  - Propagation of light in atmosphere is impractical*
  - This is similar to cable guiding electromagnetic waves

Why optical fibers?



Functional advantages

- The transmission bandwidth of the fiber optic cables is higher than the metal cables
- The amount of data transmission is higher in fiber optic cables
- The power loss is very low and hence helpful in long-distance transmissions
- Fiber optic cables provide high security and cannot be tapped
- Fiber optic cables are the most secure way for data transmission
- Fiber optic cables are immune to electromagnetic interference
- These are not affected by electrical noise

Physical advantages

- The capacity of these cables is much higher than copper wire cables
- Though the capacity is higher, the size of the cable doesn't increase like it does in copper wire cabling system
- The space occupied by these cables is much less
- The weight of these FOC cables is much lighter than the copper ones
- Since these cables are di-electric, no spark hazards are present
- These cables are more corrosion resistant than copper cables, as they are bent easily and are flexible
- The raw material for the manufacture of fiber optic cables is glass, which is cheaper than copper
- Fiber optic cables last longer than copper cables

Disadvantages

- Though fiber optic cables last longer, the installation cost is high
- The number of repeaters are to be increased with distance
- They are fragile if not enclosed in a plastic sheath. Hence, more protection is needed than copper ones

Applications

- Used in telecommunication systems
- Used in sub-marine cable networks
- Used in data link for computer networks, CATV Systems
- Used in CCTV surveillance cameras
- Used for connecting fire, police, and other emergency services
- Used in hospitals, schools, and traffic management systems
- They have many industrial uses and also used for in heavy duty constructions

Satellite Vs. Optical Communication

Satellite	Optical
Point to Multipoint	Point to point
BW ~ GHz	BW ~ THz
Maintenance free	Needs maintenance
Short life	Long life
No upgradeability	Upgradeable