



Warmest Regards

from

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Optical Fiber Communications



— Chapter 1 —
— Introduction —

Introduction

- Communication may be broadly defined as the **transfer of information from one point to another.**
- When the information is to be conveyed over any distance a **communication system is usually required.**
- Information transfer is frequently achieved by **superimposing or modulating the information onto an electromagnetic wave** which acts as a carrier for the information signal
- Sophisticated techniques have been developed for this process

Historical development

- As early as 1880 Alexander Graham Bell reported the transmission of speech using a light beam
- Although some investigation of optical communication continued in the early part of the twentieth century its use was limited to mobile
- This was due to both
 - the lack of suitable light sources and
 - Severely affected by disturbances such as rain, snow, fog, dust and atmospheric turbulence (disorder).

Historical development

- A renewed interest in optical communication was stimulated in the **early 1960s with the invention of the laser**
- This device provided a powerful **coherent light source, together with the possibility of modulation at high frequency**
- The use of the laser for free space optical communication proved somewhat limited

Historical development

- The proposals for optical communication via dielectric waveguides or optical fibers fabricated from glass to avoid degradation of the optical signal by the atmosphere were made almost simultaneously in 1966 by Kao and Hockham

The general system

- An optical fiber communication system is similar in basic concept to any type of communication system.
- In electrical communications the information source provides an electrical signal, usually derived from a message signal which is not electrical (e.g. sound), to a transmitter comprising electrical and electronic components which converts the signal into a suitable form for propagation over the transmission medium.

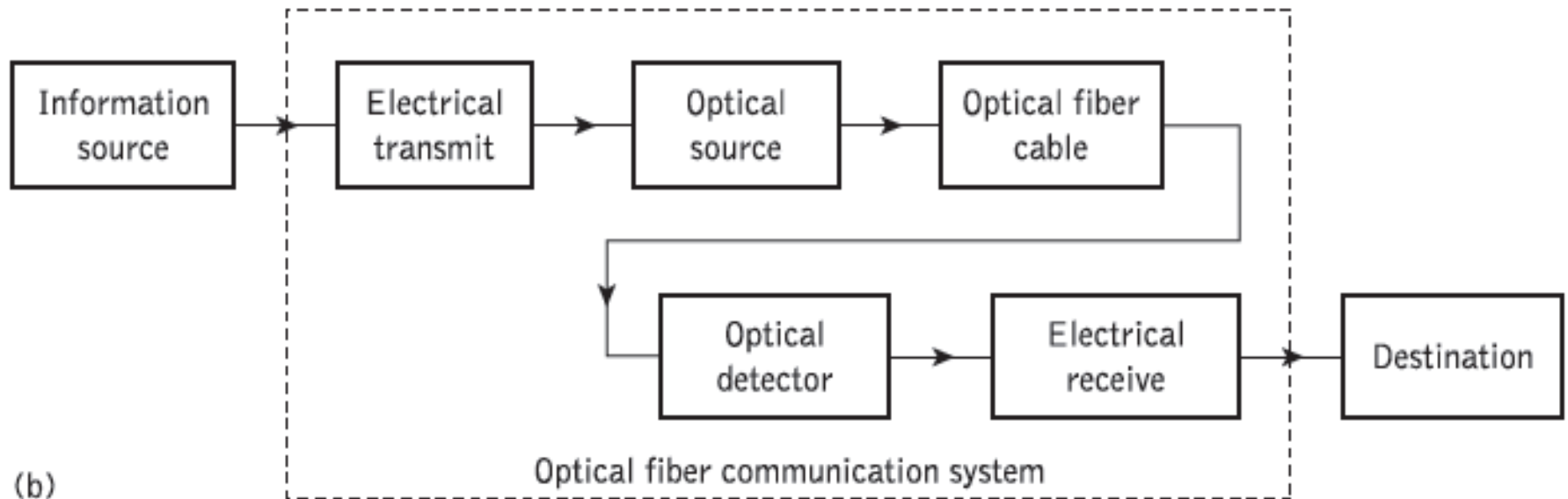
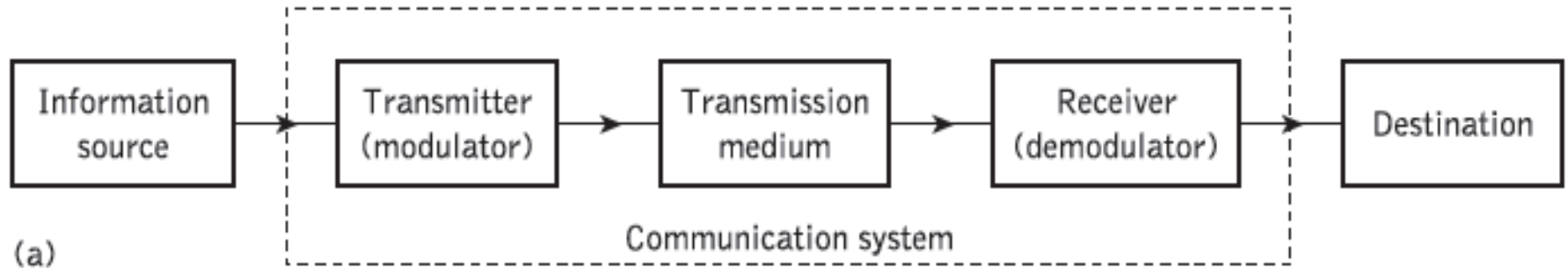
The general system

- This is often achieved by modulating a carrier, which may be an electromagnetic wave.
- The transmission medium can consist of
 - a pair of wires,
 - a coaxial cable or
 - a radio link
- In any transmission medium the signal is
 - attenuated, or
 - suffers loss, and
 - is subject to **degradations due to contamination (pollution) by random signals and noise**, as well as
 - possible distortions imposed by mechanisms within the medium itself

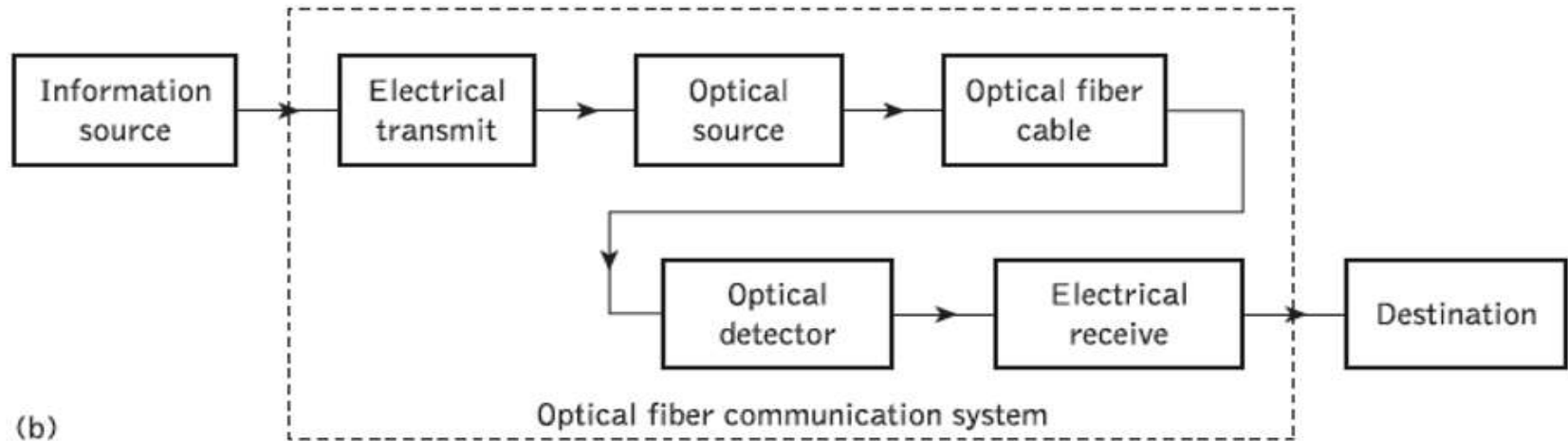
The general system

- in any communication system there is a maximum permitted distance between the transmitter and the receiver **beyond which the system effectively ceases (ends) to give intelligible communication**
- For long haul applications these factors necessitate
 - the installation of repeaters or
 - line amplifiers at intervals,
- both to remove signal **distortion and to increase signal level before transmission is continued down the link**

General communication system & optical fiber communication system

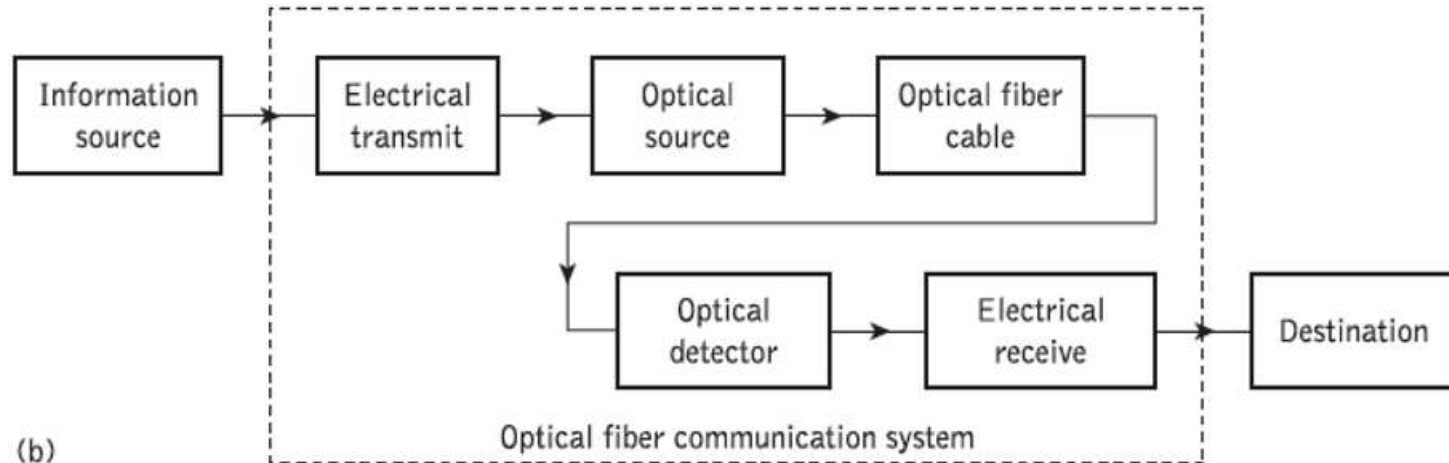


Electrical Communications



- Information source provides an **electrical signal to a transmitter comprising an electrical stage** which drives an optical source to give modulation of the light wave carrier.
- The optical source which provides the electrical–optical conversion may be
 - either a semiconductor laser or
 - light-emitting diode (LED)
- The transmission medium consists of an optical fiber cable and
- the receiver consists of an optical detector which drives a further electrical stage and hence provides demodulation of the optical carrier. Photodiodes

The optical fiber communications



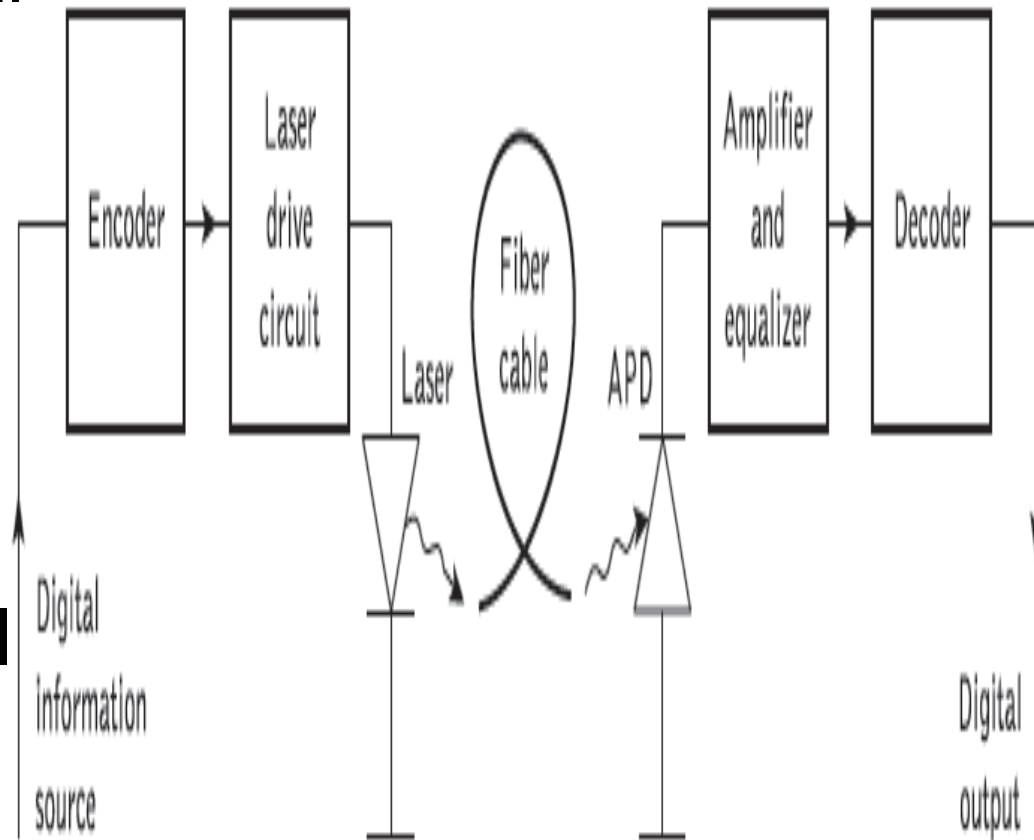
- The optical carrier may be modulated using either
 - an analog or digital information signal.
- In analog modulation involves the variation of the light emitted from the optical source in a continuous manner
- With digital modulation, however, discrete changes in the light intensity are obtained (i.e. on-off pulses)
- Although often simpler to implement, analog modulation with an optical fiber communication system is less efficient, requiring a far higher signal-to-noise ratio at the receiver than digital modulation.

The optical fiber communications

- For these reasons, analog optical fiber communication links are generally limited to shorter distances and lower bandwidth operation than digital links

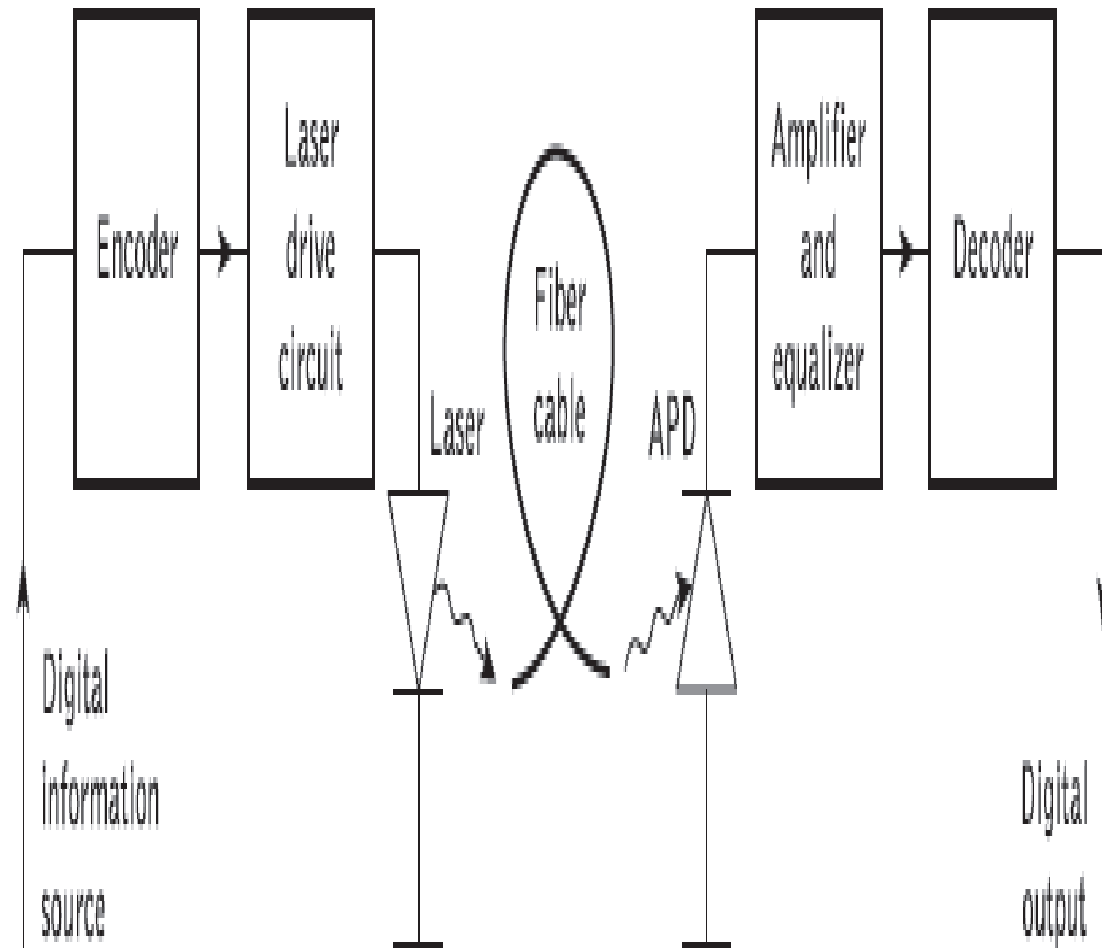
A digital optical fiber link using a semiconductor laser source and an avalanche photodiode (APD) detector

- Initially, the input digital signal from the information source is suitably **encoded** for optical transmission.
- The **laser drive circuit** directly modulates the intensity of the semiconductor laser with the encoded digital signal.
- Hence a digital optical signal is launched into the optical fiber cable.

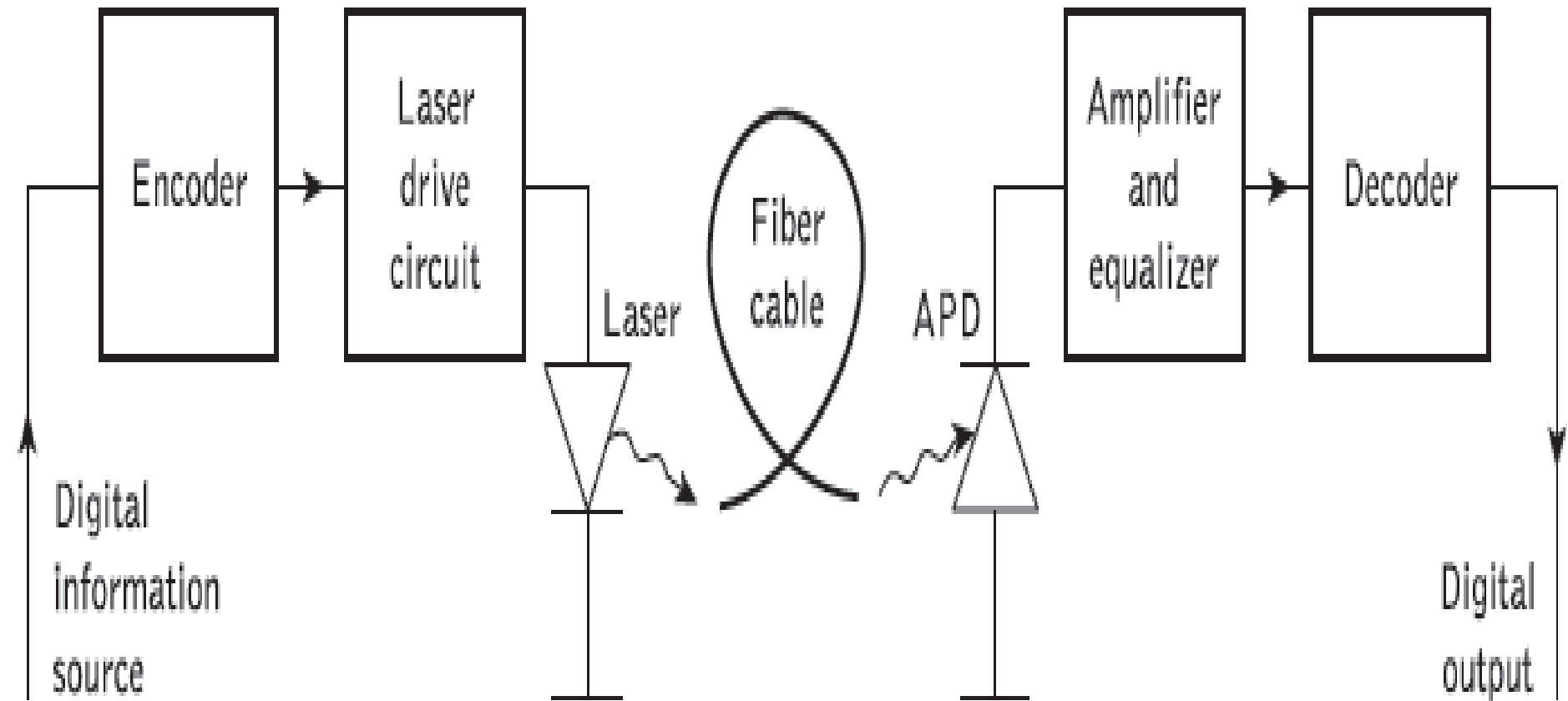


A digital optical fiber link using a semiconductor laser source and an avalanche photodiode (APD) detector

- The avalanche photodiode (APD) detector is followed by a front-end amplifier and equalizer or filter to provide
 - gain as well as linear signal processing and
 - noise bandwidth reduction
- Finally, the signal obtained is decoded to give the original digital information



A digital optical fiber link using a semiconductor laser source and an avalanche photodiode (APD) detector



Advantages of optical fiber communication

- *Enormous potential bandwidth*
 - The optical carrier frequency in the range 10^{13} to 10^{16} Hz
 - Coaxial cable bandwidth typically around 20 MHz over distances up to a maximum of 10 km
- *Small size and weight*
 - *Optical fibers have very small diameters which are often no greater than the diameter of a human hair*
 - Even when such fibers are covered with protective coatings they are **far smaller and much lighter than corresponding copper cables**.
 - This is a tremendous advantage towards the improvement of channel congestion in cities

Advantages of optical fiber communication

■ *Electrical isolation*

- *Optical fibers which are fabricated from glass, or sometimes a plastic polymer, are electrical insulators and therefore, unlike their metallic counterparts, they do not exhibit earth loop and interface problems.*
- This property makes optical fiber transmission ideally suited for communication in **electrically hazardous environments**

■ *Immunity to interference and crosstalk*

- *Optical fibers free from electromagnetic interference (EMI), radio-frequency interference (RFI), or switching transients giving electromagnetic pulses (EMPs)*
- Hence the operation of an optical fiber communication system is **unaffected by transmission through an electrically noisy environment**

Advantages of optical fiber communication

■ *Signal security.*

- *The light from optical fibers **does not radiate significantly and therefore** they provide a high degree of signal security*
- Unlike the situation with copper cables, a transmitted optical signal cannot be obtained from a fiber in a noninvasive manner (i.e. without drawing optical power from the fiber).
- This feature is obviously attractive for military, banking and general data transmission (i.e. computer network) applications.

■ *Low transmission loss.*

- *The development of optical fibers over the last 20 years has resulted in the production of optical fiber cables which exhibit very low attenuation or transmission loss in comparison with the best copper conductors.*

Advantages of optical fiber communication

- *Ruggedness and flexibility.*
 - *Although protective coatings are essential, optical fibers may be manufactured with very high tensile প্রসারণসাহ্য strengths*
 - Cable structures have been developed which have proved flexible, compact
- *System reliability and ease of maintenance.*
 - With fewer optical repeaters or amplifiers, system reliability is generally enhanced in comparison with conventional electrical conductor systems
- *Potential low cost.*
 - *The glass which generally provides the optical fiber transmission medium is made from sand – not a scarce দুর্লভ resource.*
 - So, in comparison with copper conductors, optical fibers offer the potential for low-cost line communication

The following table lists the papers related to Cryptography course that have been accepted in IEEE conferences by students of the CSE 17th batch, session 2019–2020.

Student ID	Name	Conference Name	Conference Venue	Author List * Indicate corresponding author	Status
1902073	Hasan Ahammad	2025 IEEE Interdisciplinary Conference on Electrics and Computer (INTCEC)	Chicago, USA	1. Hasan Ahammad * 2. Golam Md. Muradul Bashir 3. Md Samsuzzaman 4. Arpita Howlader 5. Md Abdul Masud 6. Md Harunur Rashid	Accepted but not presented (processing for journal)
		2025 IEEE 7th International Conference on Cybernetics, Cognition and Machine Learning Applications (ICCCMLA)	Germany		
1902016, 1902034, 1902045	Md Mohidul Alam, Effat Ara Naznin Ema, and Kallol Mondal	28th International Conference on Computer and Information Technology (ICCIT 2025)	Cox's Bazar	1. Md Mohidul Alam * 2. Effat Ara Naznin Ema 3. Kallol Mondal	Not yet registered
1902067, 1902051	Md Intishar Ahmed, and Ahammad Hossen Eazaz	IEEE SPICSCON 2025	Rajshahi University	1. Md Intishar Ahmed * 2. Ahammad Hossen Eazaz 3. Golam Md Muradul Bashir	Presentation done at Rajshahi University
1902066	Md. Abdur Rakib	28th International Conference on Computer and Information Technology (ICCIT 2025)	Cox's Bazar	1. Md. Abdur Rakib * 2. Mohidul Alam 3. Dabasish Das 4. Golam Md. Muradul Bashir 5. Md Mahbubur Rahman	Not yet registered