

Broadcasting Towers Operation

WEEK 2 – Equipment identification and
selection

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Objectives

At the end of the topic students will be able to:

1. Define and list out Electrical and electronics equipment used in broadcasting towers.
 2. Explain the uses of equipment for broadcasting towers operation.
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Turn and talk

- In your telecommunication background, you have seen many equipment which can be used to perform various tasks to ensure a good operation of a broadcasting tower, discuss in pair all the possible equipment you think are necessary for the operation of a broadcasting tower.
 - Take 3 minutes for pair share and let us share to the entire class.
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2.0 Recap

- Last week, we discussed about tools required for broadcasting towers operation.
 - The tools described are useful in maintenance and monitoring of equipment used for broadcasting towers operation in transmission, radio communication (transmitting and receiving signals), power systems and air conditioning of the systems.
 - To remind ourselves, let us bring the list: Cutters, saws, spanners, screw drivers, crimpers, Allen keys, pliers, hammers, testers, thermometers, meters, strippers, site masters, etc.
 - Clamp and multimeters were found important as well as cutters and screw drivers which are often used in Broadcasting Towers Operation.
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2.1 List of equipment

- Generally, equipment available in laboratories and Workshops are the basis towards the study of specific purpose equipment.
 - We can list equipment such as the power supply, the signal generator and function generator, the oscilloscope, the digital electronics trainer kits among other.
 - Specialized equipment may be taken as (not in all aspects), modulation trainer kits or modulators, antenna trainer kits, GPS, GSM or mobile communication trainer kits, splicing machines, OTDR, spectrum analyzer, network equipment, etc.
 - All the stated equipment will be described in detail as we go in the session thoroughly.
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2.1.1 The power supply

- A power supply is a device that provides power to the load. Its primary function is to convert electric current from a source to the correct voltage, current, and frequency required.
 - In laboratory, a supply is essential for providing controlled and stable power to various electronic circuits and devices during testing and development.
 - It provides a stable DC voltage to the circuit. By adjusting the voltage and current.
 - Power supplies are indispensable in any electronics lab, providing the necessary power and control to develop, test, and refine electronic devices and systems.
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2.1.1 The power supply cont'd

- The power supply has adjustable Voltage and Current with precise control over the output voltage and current, which is crucial for testing different components and circuits under various conditions.
 - Power supplies have digital or analogue displays to monitor output voltage and current in real-time. They are very safe as they include over-voltage, over-current, and short circuit protection to prevent damage to both the power supply and the devices under test.
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2.1.1 The power supply cont'd

The main functions of a power supply include:

- Voltage conversion by converting input voltage to the required output voltage.
- Rectification by converting AC (alternating current) to DC (direct current).
- Filtering by removing any noise or fluctuations from the output voltage.
- Regulation by maintaining a constant output voltage regardless of changes in load or input voltage.

Types of power supplies

- Linear regulated power supply provides a very stable and low-noise output with less efficient due to heat dissipation but ideal for sensitive analogue circuits. Uses a transformer to step down the voltage.
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2.1.1 The power supply cont'd

- Switched-mode power supplies (**SMPS**) more efficient and compact. They can generate electrical noise, making them less suitable for sensitive analogue applications. Uses high-frequency switching to convert voltage.
 - Uninterruptible power supply (**UPS**) provides backup power during power outage. Includes a battery to supply power when the main source fails.
 - Programmable power supplies allow user to set and control the output parameters via software. Useful for automated testing and complex experiments. Used in testing and development environments.
 - Battery power supply uses batteries as the power source. Portable and used in mobile devices.
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2.1.1 The power supply cont'd

Applications

- Consumer electronics to provide the power for devices like televisions, computers, and smartphones.
 - Industrial equipment to provide the power for machinery and control systems.
 - Medical devices to ensure reliable operation of equipment like MRI machines and patient monitors and others.
 - Telecommunications to provide the power for network equipment and communication devices.
 - Laboratory equipment to supply stable power for testing and measurement instruments.
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2.1.1 The power supply cont'd

- Circuit and components testing to power and test various electronic circuits, ensuring they operate correctly under different voltage and current conditions as well as testing individual components like resistors, capacitors, and transistors.
- Prototyping with reliable power for developing and debugging prototypes.
- Educational specifically in academic settings for teaching electronics and electrical engineering concepts.

The image shows a DC PS that we use for various experiments, it is in Electronics Laboratory.



2.1.2 The signal/function generator

- A signal generator (SG) is an electronic device that produces non-repeating or repeating electronic signals in either analogue or digital domains. These signals are used for testing, designing, and troubleshooting electronic circuits.
- The signals created have specific characteristics such as frequency, amplitude, and waveform shape. They are essential for testing and calibrating electronic devices, ensuring they operate correctly under various conditions.

Types

- RF SG used to test radio frequency circuits like in wireless communications, radar, and electronic warfare.
 - Audio SG used to produce signals in the audio frequency range for testing audio equipment.
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2.1.2 The signal/function generator cont'd

- Analogue SG used to generate continuous wave signals of adjustable frequency and amplitude.
- Digital SG used to produce digital signals for testing digital circuits and systems.

Applications

- Testing and troubleshooting electronic circuits.
 - Designing and verifying communication systems.
 - Calibrating measurement instruments.
 - Simulating real-world signals for research and development.
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2.1.2 The signal/function generator cont'd

- A function generator (FG) is a type of signal generator that produces various waveforms, such as sine, square, triangle, and sawtooth waves. It is commonly used in electronics laboratories for testing and designing circuits.
- It provides convenient way to deliver stimulus signals to a circuit allowing users to adjust the waveform type, frequency, amplitude, duty cycle, and DC offset.

Types

Standard FG produces basic waveforms like sine, square, and triangle waves.

Arbitrary FG (**AFG**) allows users to create custom waveforms and store them in memory for later use.

2.1.2 The signal/function generator cont'd

Applications

- Testing and troubleshooting analogue and digital circuits.
- Simulating sensor signals for development and testing.
- Generating clock signals for digital systems.
- Creating modulation signals for communication systems.

Key differences between SG and FG

SN	Key points	SG	FG
1	Waveform variety	typically produce simple waveforms like sine waves.	can produce a variety of waveforms.
2	Frequency range	often cover a broader frequency range, from fractions of a Hertz to gigahertz.	are usually limited to tens or hundreds of megahertz.
3	Modulation capabilities	generate modulated signals (AM, FM, PM)	focus on generating standard waveforms.

2.1.2 The signal/function generator cont'd



This image shows an FG that we use for various experiments, it is in Electronics Laboratory.

<https://www.tek.com/en/products/signal-generators>

2.1.3 The Oscilloscope

- It is an electronic test instrument that graphically displays varying voltages of one or more signals as a function of time. It captures information on electrical signals for debugging, analysis or characterization.
 - It is used to measure and visualize electrical signals allowing users to observe the change in an electrical signal over time while providing a visual representation of the waveform. It displays the amplitude of the signal by measuring the voltage and shows the time interval between events through timing analysis.
 - It determines the frequency of the signal and analyses the integrity of the signal by checking for noise, distortion among other related issues.
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2.1.3 The Oscilloscope cont'd

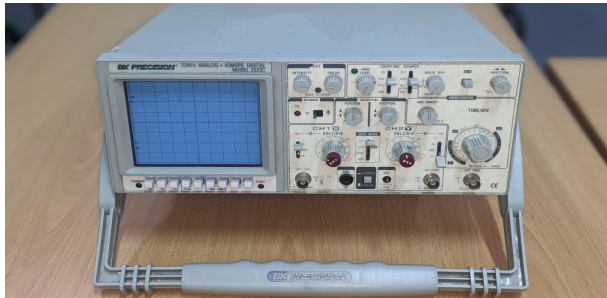
Types

- Analogue uses a cathode ray tube (CRT) to display continuous waveforms. This type is less accurate but more affordable.
 - Digital converts analogue signals into digital data using an (ADC) to offers higher accuracy and additional features like storage and analysis.
 - Mixed-signal (**MSO**) combines the functions of an oscilloscope and logic analyzer, allowing for the analysis of both analogue and digital signals.
 - Handheld portable and battery-operated, suitable for fieldwork.
 - PC-based uses a computer for display and analysis, offering flexibility and advanced features
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2.1.3 The Oscilloscope cont'd

Applications

- Electronics design and testing to verify and debug circuit designs.
- Automotive diagnostics to analyse signals from sensors and actuators.
- Telecommunications to test signal integrity and performance.
- Medical equipment to monitor and analyse biomedical signals.
- Education and research for teaching and experimenting with electronic principles.



This image shows an Oscilloscope that we use during experiments, it is in Electronics Laboratory.

(<https://siglentna.com/digital-oscilloscopes/sds1000x-u/>)

2.1.4 The digital electronics trainer kit

- It is an educational tool used in electronics laboratories to teach and experiment with digital circuits. It provides a hands-on approach to understand the principles and applications of digital electronics.
- It facilitates the learning and testing of digital circuits. It allows students and engineers to design, build, and troubleshoot various digital logic circuits without the need for complex and expensive equipment.

Types

- Basic digital trainer kits which include fundamental components like logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR), switches, LEDs, and a breadboard for circuit assembly.
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2.1.4 The digital electronics trainer kit cont'd

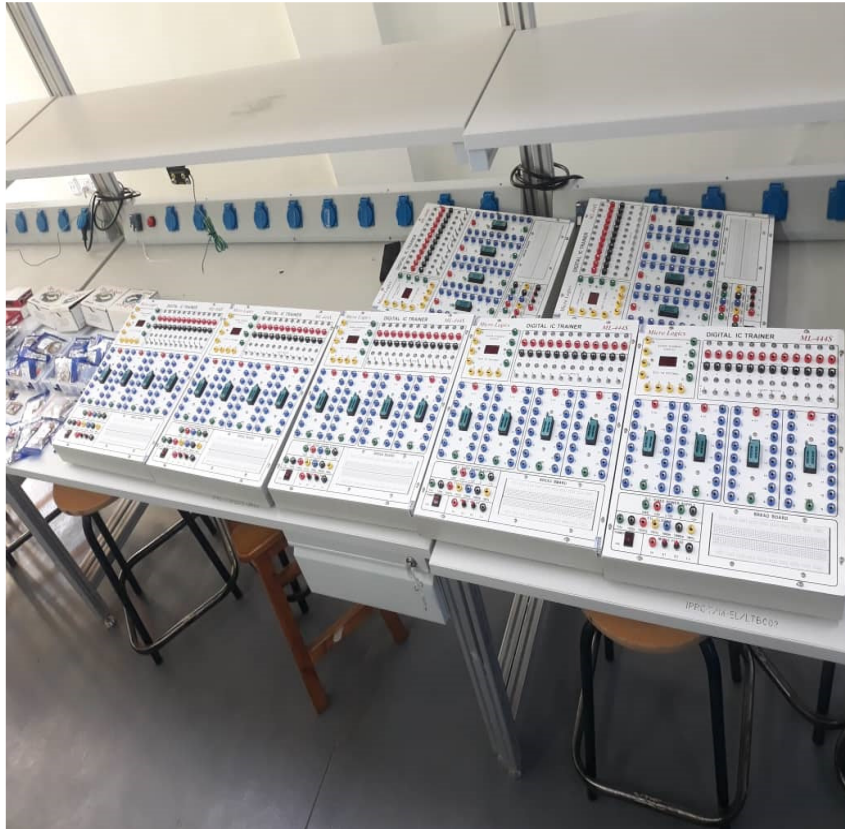
- Advanced digital trainer kits which have additional features like microcontrollers, programmable logic devices (PLDs), and more complex integrated circuits (ICs).
 - Microcontroller trainer kits to teach microcontroller programming and interfacing. They contains microcontroller units, programming interfaces, and various input/output devices.
 - FPGA trainer kits designed for learning about Field Programmable Gate Arrays (FPGAs) and include FPGA boards, programming tools, and related components.
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2.1.4 The digital electronics trainer kit cont'd

Applications

- Educational purposes where universities and technical institutes widely use trainer kits to teach digital electronics, logic design, and microcontroller programming.
 - Prototyping for engineers and hobbyists to prototype and test digital circuits before implementing them in real-world applications.
 - Research and development for developing and testing new digital circuits and systems
 - Troubleshooting for diagnosing and fixing issues in digital circuits to allow easy manipulation and observation of circuit behaviour.
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2.1.4 The digital electronics trainer kit cont'd



The images show trainer kits that we use in practical classes, it is in Telecommunication Laboratory.

2.1.5 The Modulation trainer kits

- Modulation is a very essential terminology in telecommunication because it provides a way to transmit signal for long distance by allowing a modulating signal to superimpose with the carrier signal to increase the strength required for propagation at long distances. The concept of modulation shall be explored.
 - The trainer kits related to modulation which are mostly used are analogue modulation, pulse modulation and digital modulation.
 - They work on varying the parameters of a signal namely: amplitude frequency and phase.
 - Thus; we have: AM, FM, PM, PAM, PWM, PPM, PCM, DM, ASK, FSK, PSK, etc.
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2.1.5 The Modulation trainer kits cont'd



The images show different modulation kits located in our Telecommunication Laboratory

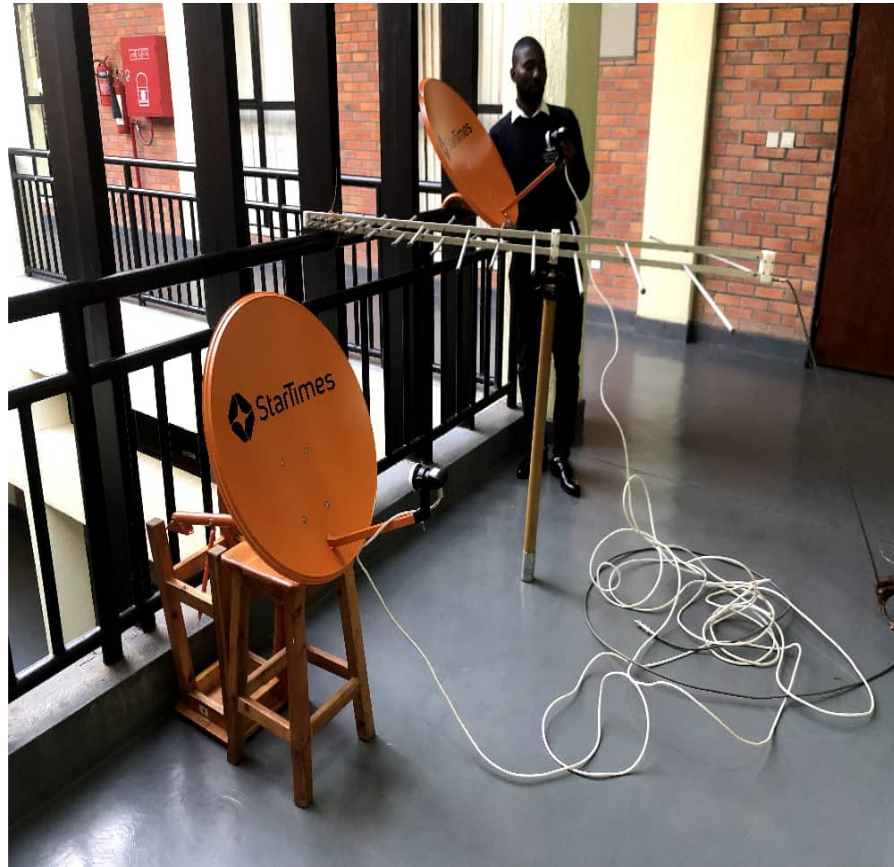
2.1.6 The antenna trainer kit

- The antenna trainer kits are important in learning antenna functionalities to understand how broadcasting towers use antenna to transmit and receive signals.



The images show different antenna kits located in our Telecommunication Laboratory

2.1.6 The antenna trainer kit cont'd



The images show different antenna: sector mounted on the mast with image taken during study visit and dishes located in our Telecommunication Laboratory.

2.1.6 The antenna trainer kit cont'd



The image was taken during Students' study visits in Havillah Engineering Group Ltd, they were introduced with different antenna with applications.

2.1.7 The GPS

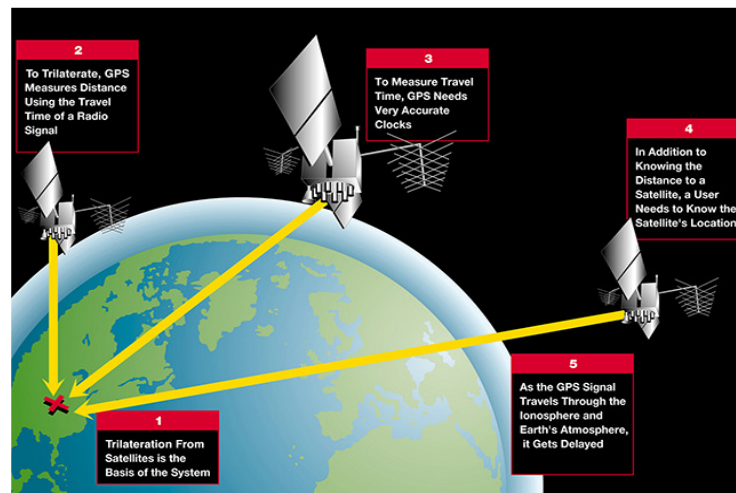
- The Global Positioning System (GPS) is a satellite-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites.
 - It works by using a network of satellites that send precise signals, allowing GPS receivers to calculate and display accurate location, speed, and time information to the user. The basic principle involves measuring the time it takes for a signal to travel from the satellite to the receiver.
 - It uses satellites, receivers and algorithms to contemporize location, land and sea travel, velocity and time data for air.
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2.1.7 The GPS cont'd

- Its elements are Earth-based monitor stations, master control stations and ground aerial making the **ground control segment** to operate and monitor satellites in space and track transmissions, **space (satellites) segment** surrounding the Earth transmit signals to users on the time of day and geographical location, **user component** with transmitters and GPS receivers like watches, smartphones and telematic devices
 - Active GPS tracker is based on constant tracking of locations relying more on storing information for future access use. Works with satellite or cellular networks to process and deliver data in real time with regular connection especially for machines and vehicles that are constantly being used.
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2.1.7 The GPS cont'd

- Passive GPS tracker stores data at set intervals or triggers. These can include breaching a geofence or reaching a certain location. Data that can be downloaded from the tracker and without continuous network connection for data transmission making it cheaper than other types.
- (<https://www.locate2u.com/articles/what-does-gps-tracking-system-do/>)



([https://www.faa.gov/about/office org/headquarters offices/ato/service units/techops/navservices/gnss/gps/howitworks](https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/gps/howitworks))

2.1.7 The GPS cont'd

Applications

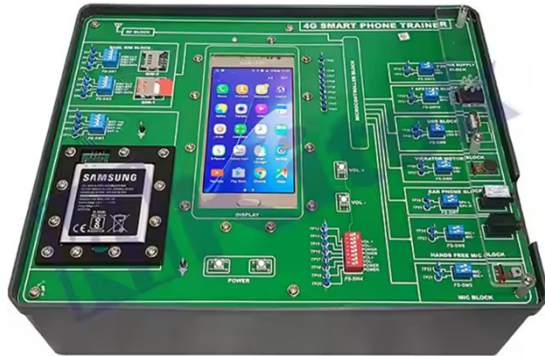
- Navigation for vehicles, ships, and aircraft in route planning and real-time navigation.
 - Surveying and mapping for precise location data in creating maps and land surveying.
 - Timing for clocks synchronization and networks, crucial in telecommunications and financial transactions.
 - Tracking for monitoring the movement of assets, vehicles, and individuals for security and logistics.
 - Geocaching in recreational activity where participants use GPS to hide and seek containers, called “geocaches,” at specific locations marked by coordinates.
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2.1.8 The GSM trainer kit

- GSM (Global System for Mobile Communications) is a standard developed to describe protocols for second-generation (2G) digital cellular networks used by mobile devices. Mobile communication trainer kits are educational tools designed to help students and professionals understand the principles and applications of GSM technology.
 - The kits simulate real-world GSM networks, allowing users to perform various experiments and understand the functioning of mobile communication systems. They typically include components such as GSM modems, antennas, SIM card interfaces, and software for controlling and monitoring the system.
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2.1.8 The GSM trainer kit cont'd

- GSM has many application specifically in cellular communication.



https://www.alibaba.com/product-detail/4G-GSM-Smart-Phone-Trainer-Kit_1600166751371.html



<https://www.scientechworld.com/education-software-training-and-skill-development/wireless-communication/understanding-dual-sim-mobile-phone>

2.1.9 The Splicing machine

- A splicing machine is a device used to join two optical fibers end-to-end, ensuring minimal loss and reflection at the splice point to maintain the integrity and performance of fiber optic communication systems. It works by aligning and fusing the ends of optical fibers using an electric arc to create a seamless connection.
 - They can be into two types namely **fusion splicers** which use electric arc to melt and fuse the fiber ends with low splice loss and high reliability, **mechanical splicers** which use alignment fixture and index matching gel to join the fibers with quicker but generally have higher splice loss compared to fusion splicers.
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2.1.9 The Splicing machine cont'd

Applications

- Telecommunications for the installation and maintenance of fiber optic networks.
- Data centers for creating and repairing fiber optic connections.
- Broadcasting to ensure high-quality signal transmission in broadcast networks.
- Medical for medical imaging and diagnostic equipment that relies on fiber optics.



2.1.9 The Splicing machine cont'd



Splicing machine located in our Telecommunication laboratory.

<https://www.dreamstime.com/splicing-machine-fusion-splice-fiber-optic-cable-image179698357>

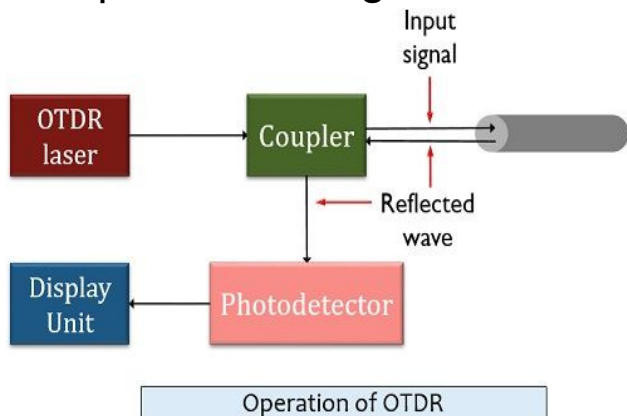
2.1.10 The OTDR

- Instrument used to characterize an optical fiber by measuring the time and intensity of light reflected along the fiber and providing a detailed picture of the fiber's condition.
 - It sends a series of light pulses into the fiber and measures the light that is scattered back. By analyzing the returned signal, the OTDR can identify faults, measure loss, and determine the length of the fiber.
 - **Handheld** are portable easy to use, usually for fieldwork. **Benchtop** are large and powerful to suit laboratories activities and detailed analysis. **Modular** are customized with different modules for various testing needs.
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2.1.10 The OTDR cont'd

Applications

- Network installation and maintenance to approve new fiber installations and troubleshoot existing networks.
- Fault detection in identifying breaks, bends, and other faults in the fiber.
- Performance monitoring through measurements of the overall performance and health of the fiber optic network.
- Research and development as labs equipment to develop and test new fiber optic technologies.



(https://en.wikipedia.org/wiki/Optical_time-domain_reflectometer)

(<https://circuitglobe.com/optical-time-domain-reflectometer.html>)

2.1.11 The spectrum analyzer

- An electronic device used to measure and visualize the amplitude of signals as they vary with frequency and provides graphical representation of the signal's frequency spectrum, with amplitude on the vertical axis and frequency on the horizontal axis.
- It works by analysis of the frequency components of a signal focusing on the power of different frequency components within a signal, which is crucial for various applications in electronics and telecommunications.

Applications

- Telecommunications by testing and troubleshooting RF and microwave signals in communication systems, including cellular networks, satellite communications, and broadcasting.
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2.1.11 The spectrum analyzer cont'd

- Electronics laboratories while designing and testing electronic circuits, especially those involving RF components.
 - Spectrum monitoring for regulatory bodies and telecommunication companies to monitor and manage the frequency spectrum, ensuring compliance with regulations and detecting unauthorized transmissions.
 - Audio and acoustic analysis where audio engineers conduct analysis on sound signals and improve the quality of audio equipment.
 - EMC testing to identify and mitigate electromagnetic interference (EMI) in electronic devices, ensuring they meet regulatory standards.
-

2.1.11 The spectrum analyzer cont'd



The images show the spectrum analyzer located in our Telecommunication Laboratory

2.1.12 Network equipment

- Network devices such as access points, switches, routers, servers and others are hardware components used to connect computers and other electronic devices to form a network to facilitate communication, data transfer, and resource sharing among connected devices.
 - They serve for proper data transmission ensuring the responsibility of network management by controlling the traffic with efficient data flow
 - They are responsible for the security of the data on the network and protect them from unauthorized access and threats while enabling connection among devices on the network to communicate with each other.
-

2.1.12 Network equipment cont'd

Applications

- In telecommunications, network devices are crucial for building and maintaining communication networks, including cellular networks, internet service providers, and enterprise networks.
 - In electronics laboratories, they are used for testing and developing network protocols, devices, and applications.
 - In data centers, they are essential for managing large-scale data storage, processing, and distribution.
 - In home networks, they provide internet connectivity and enable smart home devices to communicate.
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2.2 Considerations for broadcasting towers

- The equipment described in this lecture are very essential for broadcasting towers operation in direct or indirect way.
 - The power supply and function generators as well as the oscilloscope are the basic to understand signal generation and monitoring.
 - While antenna are very important for electrical signal handling and transmitting in free space, modulators play a key role to provide a means of carrying these signals.
 - The cellular network operate in various spectrum range which makes it crucial to have a good concept in the use of spectrum analyzers, splicing machines, OTDR as well as network devices to ensure the communication or broadcasting of the signals is successful.
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Thank you for your good attention
Q&A

References

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