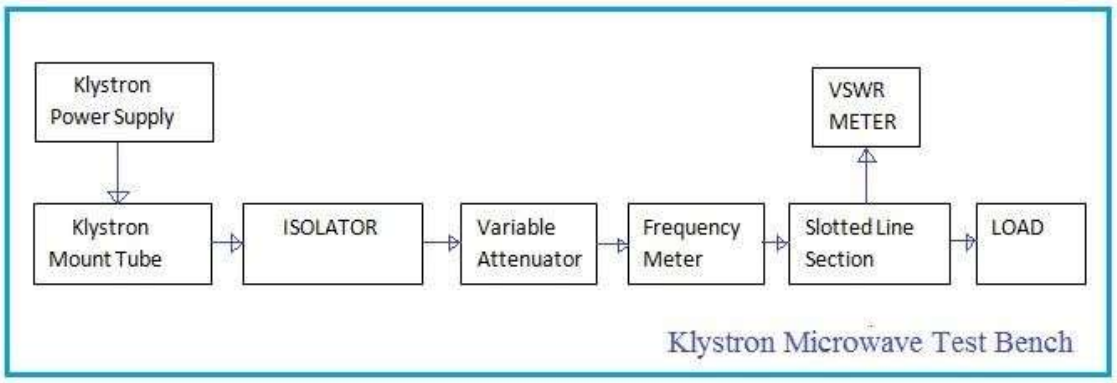
1. *MICROWAVE TEST BENCH*

Introduction:

The typical microwave test bench are precision microwave systems. It consists of rectangular microwave waveguide components. They are used for test and measurement of various microwave modules in the lab. Let us understand klystron and Gunn oscillator based microwave test benches.

Block diagram with components:



The figure-1 depicts klystron microwave test bench. It consists of klystron power supply, klystron mount tube, isolator, variable attenuator, frequency meter, slotted line section, VSWR meter and load. Let us understand functions of each in brief.

• Klystron power supply: It helps in operating low power klystron (e.g. 2K25). It houses AM modulation, FM modulation and external modulating signal functionalities. It usually provides display for beam voltage, beam current and repelled voltage.

• Klystron mount tube: This consists of reflex klystron. It uses velocity modulation in order to transform continuous electron beam into corresponding microwave power.

• Isolator: It passes microwave signal only in one direction and blocks signal going in the other direction.

• Variable attenuator: It is used to attenuate microwave signal with variable attenuation settings as made by the user. The different attenuation can be set.

• Frequency meter: It is used for frequency measurement.

• Slotted line section: It should cover desired frequency and should be equipped with accurate scale/indicator.

• VSWR meter: It is used for standing wave measurement with suitable detector and slotted line (or waveguide) section. It is used to measure VSWR or SWR. It is designed such that it avoids harmonics of line frequency.

• Load: It is microwave matched termination at desired characteristic impedance either 50 or 75 ohm. It is used to absorb microwave power.

Application of Microwave Test Bench:

These products are well suited for conducting various experiments. Further, our Klystron Microwave Test Bench is best choice for the experiments of study of reflex klystron, measure SWR, reflection co-efficient, measure frequency, impedance measurement & guide wavelength.

2. MOTORIZED ANTENNA TRAINER

Introduction:

The desktop Antenna Training System Scientech 2261 has been specially designed for engineering colleges and training canters. It is very useful for introducing practical verification of antenna operation to the students. The work book provides theoretical concepts and detail procedure of experiments with different type of antennas. The training system includes set of modular mechanical elements forming various antennas, a transmitter unit and a detector unit. All the accessories are packed in a convenient carrying case.

Features of Motorized Antenna Trainer:

- Self-contained simple and student friendly platform
- Hands on set-up for measuring and plotting radiation
- Patterns of 22 different types of Antennas
- Built in RF & Modulation Generators
- Antenna Characteristics and SWR Measurement
- On board RF & Tone generators
- Antenna matching stub
- Transmitting and receiving levels observed on built- in
- meters
- Polar graphs (2 types)
- “Antenna kit” for fabricating special antenna
- Microcontroller based high precision DC stepper motor
- Automatic home position setting
- Instant & real time plotting of radiation pattern
- Antenna rotation resolution 1°

- PC Interface - RS232 (Serial port)
- Radiation pattern plotting software (Windows
- compatible)
- Compact design
- Lightweight

Application of Motorized Antenna Trainer:

Motorized Antenna Unit is design for automate the recording of the radiation pattern of the antennas. The Motorized Antenna Unit is Microcontroller based PC interface system for capturing, displaying and printing of Antenna radiation pattern. A Window based software plots the radiation pattern which displayed on PC screen. The PC communication is via Serial port.

3. CST Studio Suite 3D EM simulation and analysis software

CST Studio Suite® is a high-performance 3D EM analysis software package for designing, analyzing and optimizing electromagnetic (EM) components and systems. Electromagnetic field solvers for applications across the EM spectrum are contained within a single user interface in CST Studio Suite. The solvers can be coupled to perform hybrid simulations, giving engineers the flexibility to analyze whole systems made up of multiple components in an efficient and straightforward way. Co-design with other SIMULIA products allows EM simulation to be integrated into the design flow and drives the development process from the earliest stages.Common subjects of EM analysis include the performance and efficiency of antennas and filters, electromagnetic compatibility and interference (EMC/EMI), exposure of the human body to EM fields, electro-mechanical effects in motors and generators, and thermal effects in high-power devices. CST Studio Suite is used in leading technology and engineering companies around the world. It offers considerable product to market advantages, facilitating shorter development cycles and reduced costs. Simulation enables the use of virtual prototyping. Device performance can be optimized, potential compliance issues identified and mitigated early in the design process, the number of physical prototypes required can be reduced, and the risk of test failures and recalls minimized.

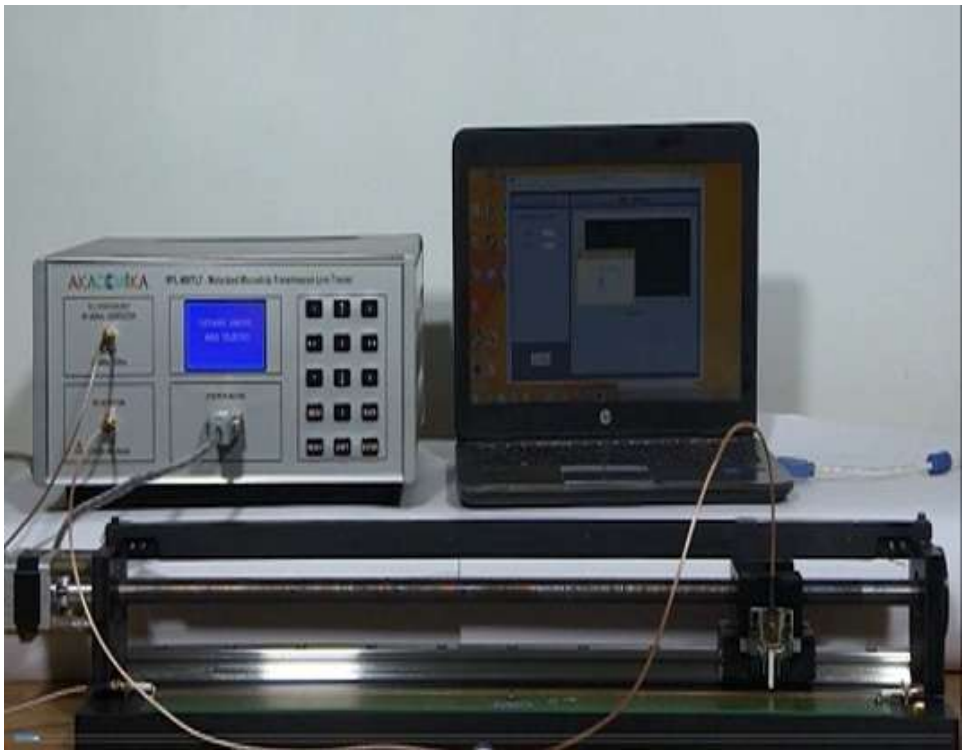
4. Ansys HFSS 3D High Frequency Simulation Software

Ansys HFSS is a 3D electromagnetic (EM) simulation software for designing and simulating high-frequency electronic products such as antennas, antenna arrays, RF or microwave components, high-speed interconnects, filters, connectors, IC packages and printed circuit boards. Engineers worldwide use Ansys HFSS software to design high-frequency, high-speed electronics found in communications systems, advanced driver assistance systems (ADAS), satellites, and internet-of-things (IoT) products.

5. RFL-MMTLT: Motorised Microstrip Transmission Line Trainer Kit

Introduction:

RFL-MMTLT is designed to understand the transmission line theory. The setup primarily focuses on minima and maxima measurement in standing wave for various load conditions as well as various frequencies. The sensor probe moves along the transmission line using a motorized mechanism. User-friendly GUI of PC-based software allows parameter settings, control, as well as analysis of acquired data in graphical and tabular manner. It allows various measurements such as Return Loss, VSWR, Impedance, Power, etc.
These parameters help students to learn the characteristics of transmission lines terminated with various impedance conditions. MMTLT operates over a frequency range from 250 MHz to 1500 MHz in the UHF band. A standalone mode of operation allows all the operations that are possible with PC-based software.



Microstrip Transmission Lines

Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board technology, and is used to convey microwave- frequency signals. It consists of a conducting strip separated from a ground plane by a dielectric layer known as the substrate. Microwave components such as antennas, couplers, filters, power dividers etc. can be formed from microstrip, with the entire device existing as the pattern of metallization on the substrate. Microstrip is thus much less expensive than traditional waveguide technology, as well as being far lighter and more compact Microstrip lines are also used in high-speed digital PCB designs, where signals need to be routed from one part of the assembly to another with minimal distortion, and avoiding high cross-talk and radiation.

Transmission line Terminated with LOAD (Z_0)

For maximum transfer of energy into a transmission line from a source or from a transmission line to a load (the next stage of an amplifier, anantenna, etc.), the impedance of the source and load should match the characteristic impedance of the transmission line. In general, then, Zo is the target for input and output impedances of devices and networks.
Let's review what happens when transmission lines are terminated in various impedances, starting with a Zo load. Since a transmission line terminated in its characteristic impedance results in maximum transfer of power to the load, there is reflected signal.

Transmission line Terminated with SHORT

When Transmission line is terminated by short circuit then purely reactive elements cannot dissipate any power, and there is nowhere else for the energy to go, a reflected wave is launched back down the line toward the source. Our reflected and incident voltage (and current) waves will be identical in magnitude but traveling in the opposite direction.

Voltage Standing wave ratio (VSWR)

In radio engineering and telecommunications, standing wave ratio (SWR) is a measure of impedance matching of loads to the characteristic impedance of a transmission line or waveguide. Impedance mismatches result in standing waves along the transmission line, and SWR is defined as the ratio of the partial standing wave's amplitude at an antinode (maximum) to the amplitude at a node (minimum) along the line.

Features:

- 50 Ohm Microstrip Transmission line
- 1mm Sensing Probe Resolution
- Standing wave pattern at various frequencies
- Guided Wavelength Measurement
- Characterization for given LOADS.
- Characterization for Unknown LOADS Vs. Frequency
- S-Parameters (S11, S21, S12, S22) Measurement
- Analysis of reflection coefficients, VSWR and Impedance for LOAD, OPEN and SHORT termination
- Smith Chart Analysis

Applications:

- Wave Measurement: Finds guided wavelength and plots standing wave patterns at different frequencies.
- Load Characterization: Analyzes open, short, and matched load terminations.
- Impedance Analysis: Evaluates reflection coefficient, voltage standing wave ratio (VSWR), and impedance.
- Scattering Parameters: Measures S-parameters (S_{11}, S_{21}, S_{12}, S_{22}) for network analysis.
- Smith Chart Practice: Plots and matches load impedance visually using software.

6. PCB Basics Lab

PCB is the abbreviation for Printed Circuit Board. Some may refer it as PWB which stands for Printed Wiring Board. The board consists of copper tracks connected and printed on the surface of a non-conducting material. Your designed circuit connection will be contained within this board. This method of fabrication is an efficient method for reproducing a circuit. The circuit quality can be more consistent and the reproduction can be faster. This makes it suitable for manufacturing large quantities of electronic circuits.
PCB allows you to produce custom prototype quality circuit boards in a few hours with inexpensive equipment. Short development cycles have previously been restricted to the domain of software projects. Hardware designers can now benefit from improved, if still somewhat slow, cycle times.

Applications:

1. **Consumer Electronics** – Used in televisions, mobile phones, laptops, computers, cameras, calculators, and home appliances.

2. **Communication Systems** – Used in routers, modems, mobile communication equipment, satellite systems, and networking devices.

3. **Medical Equipment** – Found in ECG machines, MRI scanners, patient monitoring systems, X-ray machines, and diagnostic instruments.
4. **Industrial Automation** – Used in PLCs (Programmable Logic Controllers), motor control systems, industrial robots, and automation equipment.
5. **Automotive Electronics** – Used in engine control units (ECUs), ABS systems, airbag controllers, infotainment systems, GPS, and vehicle lighting.
6. **Aerospace and Defense** – Used in aircraft control systems, radar equipment, navigation systems, satellites, and military communication devices.
7. **Power Electronics** – Used in inverters, UPS systems, battery chargers, power supplies, and renewable energy systems.
8. **Computer Hardware** – Used in motherboards, graphics cards, RAM modules, hard drives, and peripheral devices.
9. **Instrumentation and Measurement** – Used in digital multimeters, oscilloscopes, signal generators, and laboratory instruments.
10. **IoT and Embedded Systems** – Used in smart home devices, wearable electronics, sensors, microcontroller-based projects, and Internet of Things (IoT) applications.