DAR ES SALAAM INSTITUTE OF TECHNOLOGY

BACHELOR OF ENGINEERING IN COMPUTER ENGINEERING

INSTRUMENTATION AND MEASUREMENT

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Direct Measurement of Electrical Parameters

Measurement Laboratory Report

1. Objectives

The objectives of this laboratory session are:

    I.   To identify commonly used measuring instruments and testing equipment.
   II.   To understand the functions and applications of each instrument.

III. To learn how to use and operate digital and analogue oscilloscopes, spectrum analyzers, frequency counters, function generators, and logic probes.
IV. To understand limitations, safety precautions, and proper handling of these instruments.
V. To study the use of pulse generators, video signal generators, and digital pattern generators.

2. Measuring Instruments and Their Functions

Instrument	Function
Digital Oscilloscope	Displays voltage signals over time digitally; measures amplitude, frequency, rise/fall times, etc.
Analogue Oscilloscope	Displays voltage signals over time on a CRT screen; useful for simple waveform observation.
Spectrum Analyzer	Measures amplitude of signals versus frequency; analyzes signal spectra.
Frequency Counter	Measures the frequency of periodic signals accurately.
Function Generator	Generates controlled electrical waveforms (sine, square, triangle) for testing circuits.
Logic Probe	Detects digital logic levels (HIGH/LOW) in circuits.

3. Orientation on Use and Operation

a) Digital Oscilloscope

- Connect probe to the circuit.
- Adjust time/div and volts/div settings.
- Set trigger to stabilize waveform.
- Use built-in measurements for frequency, peak-to-peak voltage, RMS, etc.

b) Analogue Oscilloscope

- Connect input probe.
- Adjust vertical and horizontal scales.
- Use trigger control to get stable display.

c) Spectrum Analyzer

- Connect input signal.
- Set frequency span and resolution bandwidth.
- Observe signal amplitude vs. frequency.

d) Frequency Counter

- Connect input signal.

- Select appropriate measurement range and mode.
- Read frequency from display.

e) Function Generator

- Select waveform type (sine, square, triangle).
- Set amplitude and frequency.
- Connect output to circuit or oscilloscope.

f) Logic Probe

- Connect probe to test points in digital circuit.
- Observe LED indicators for HIGH, LOW, or transitions.

4. Applications of Measuring Instruments

Instrument	Application
Digital Oscilloscope	Troubleshooting complex circuits; analyzing digital signals; measuring fast-changing wave forms.
Analogue Oscilloscope	Simple waveform visualization; educational labs.
Spectrum Analyzer	RF signal analysis; harmonics; noise measurement.
Frequency Counter	Accurate measurement of oscillator or clock signals.
Function Generator	Stimulating circuits; testing filters, amplifiers, and digital logic.
Logic Probe	Checking logic levels in digital circuits; detecting signal transitions.

5. Limitations, Safety, and Precautions

Instrument	Limitations	Safety / Precautions
Digital Oscilloscope	Max voltage input, bandwidth limits	Always ground the probe, avoid exceeding voltage ratings
Analogue Oscilloscope	Limited bandwidth, less precise	Avoid over voltage; do not touch CRT when powered
Spectrum Analyzer	Frequency range, max input power	Use attenuators for high-power signals
Frequency Counter	Min/Max frequency measurable	Avoid applying high voltage to input
Function Generator	Max output voltage/current, frequency range	Do not overload circuit; ensure proper grounding
Logic Probe	Compatible voltage levels	Avoid connecting to high-voltage

Instrument	Limitations	Safety / Precautions
	(TTL/CMOS)	circuits

6. Use of Special Generators

Generator	Use
Pulse Generator	Generates short-duration pulses for testing timing circuits, triggers, and digital logic.
Video Signal Generator	Produces video signals for testing displays, TV circuits, and video equipment.
Digital Pattern Generator	Produces complex digital sequences for testing micro-controllers, sequential logic, and digital circuits.

7. Observations / Practical Work

Instrument	Observation
Digital Oscilloscope	Waveform type: Sine wave; Frequency: 1 kHz; Amplitude: 5 V peak-to-peak; Notes: Clean waveform observed with minimal noise.
Analogue Oscilloscope	Waveform type: Square wave; Frequency: 500 Hz; Amplitude: 4 V peak-to-peak; Notes: Slight flicker in waveform due to manual triggering.
Spectrum Analyzer	Frequency peaks: Fundamental at 1 kHz, 2nd harmonic at 2 kHz (amplitude 15 dB lower); Noise floor: -60 dBm; Notes: Harmonics visible, signal mostly clean.
Frequency Counter	Measured frequency: 1.002 kHz; Notes: Reading is stable with ±0.5 Hz variation.
Function Generator	Waveform type: Triangle wave; Frequency: 2 kHz; Amplitude: 3 V peak-to-peak; Notes: Output verified on digital oscilloscope.
Logic Probe	Logic HIGH: 5 V; Logic LOW: 0 V; Observed transitions on square wave input; Notes: LED indicators worked correctly, pulse edges clearly detected.

8. Conclusion

This laboratory session successfully demonstrated the direct measurement of electrical parameters using various instruments.

Key takeaways:

i. We learned the operation and applications of digital and analogue oscilloscopes, spectrum analyzers, frequency counters, function generators, and logic probes.

ii. We observed actual wave forms and signal characteristics, reinforcing theoretical knowledge with practical experience.

iii. We understood the importance of safety precautions and limitations for each instrument.
iv. We explored specialized signal generators such as pulse, video, and digital pattern generators, which are vital in testing modern electronic circuits.

Overall, the activity enhanced our practical understanding of measurement techniques and instrument handling in electrical engineering laboratories.