



# **CURRICULUM**

## **Microwave Technician**

### **03 Month Program**

**NATIONAL TRAINING BUREAU  
H-9, ISLAMABAD**

## 1. Introduction:

This training course provides the student with a strong background in the area of planning telecommunication transmission networks using modern Radio-relay Digital Microwave radio.

The course covers in detail all the important aspects of radio propagation, starting from free-space loss and absorption loss, followed by statistical analysis of various phenomena impairing radio reception process - rain, multipath fading (both flat and selective), K-factor variation and ducting.

The introductory part of the course also reviews basic parameters of the microwave radio systems, antenna, transmission lines and all other auxiliary equipment used during implementation of microwave radio-relay sites.

Classroom discussion of all the above topics will be complemented by interactive student exercises. The course concludes with a guide to several ITU-T/ITU-R references, students can access for additional information.

## 2. Course Objectives:

At the end of this course the student will understand the essentials of Transmission engineering and will be able to design and manage microwave networks. This course is designed to teach students the essence of microwave path planning.

The students will also learn how to design paths that will not suffer from interference, or disturb other radio systems in the vicinity.

## 3. Key Benefits:

The person who will attend this course;

- He will understand why a certain link or network is not functioning as per performance specifications and will be able to successfully resolve them.
- He will be able to select the best component for the network.
- He will have the knowledge to optimize and improve the network performance and quality.

## 4. Curriculum Salient

Entry-level	Matric/F.Sc/DAE
Duration of course	3 Months
Training Hours	360
	30 hours a week
Training Methodology	80% Practical
	20% Theory
Medium of Instructions	Urdu / English

## 5. Scheme of Studies

Sr.	Module	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
1.	Introduction to Computer	3	40	43
2.	Basic Electricity and Electronics	13	60	73
3.	Telecommunication Fundamentals	5	15	20
4.	Data Communication	4	10	14
5.	Modulation Techniques	5	10	15
6.	Antennas	8	15	23
7.	Multiplexing/De-multiplexing	5	2	7
8.	Microwave Communication Overview	10	6	16
9.	Digital Microwave Communication Equipment	5	30	35
10.	Digital Microwave Networking and Application	8	10	18
11.	Installation Testing & Commissioning Exercises	6	90	96
<b>Total</b>		<b>72</b>	<b>288</b>	<b>360</b>

Sr. No.	Detail of Topics	Theory Hours
1.	<p><b><u>Introduction to Computer</u></b></p> <p><b>1.1. General introduction to computers</b>  1.1.1. Definition of computer  1.1.2. Characteristics of computer  1.1.3. Use of computer</p> <p><b>1.2. I/O devices</b>  1.2.1. Mouse  1.2.2. Key board  1.2.3. Microphone  1.2.4. Speaker  1.2.5. Printer  1.2.6. Scanner  1.2.7. Monitor</p> <p><b>1.3. Storage devices</b>  1.3.1. Hard Disk (HDD)  1.3.2. Floppy Disk  1.3.3. Compact Disk (CD)  1.3.4. Universal Serial Bus (USB)</p> <p><b>1.4. CPU</b>  1.4.1. Power Supply  1.4.2. Mother Board  1.4.3. Processor  1.4.4. Memory  1.4.5. Expansion Board  1.4.6. I/O prots  1.4.7. Network interface card  1.4.8. Hard disk  1.4.9. Floppy disk  1.4.10. CD ROM  1.4.11. DVD ROM</p> <p><b>1.5. Ms Office</b>  1.5.1. Microsoft Word  1.5.2. Microsoft Excel  1.5.3. Microsoft Visio</p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><b>1</b></p>

<p><b>2.</b></p>	<p><b><u>Basic Electricity and Electronics</u></b></p> <p><b>2.1. Electricity</b></p> <p>2.1.1. Atom</p> <p>2.1.2. K, L and M shell</p> <p>2.1.3. Valence electrons</p> <p>2.1.4. Conductors, insulators and semiconductors</p> <p>2.1.5. Electrical Quantities</p> <p>    2.1.5.1. Charge</p> <p>    2.1.5.2. Potential</p> <p>    2.1.5.3. Potential difference</p> <p>    2.1.5.4. Current</p> <p>    2.1.5.5. Resistance</p> <p>    2.1.5.6. Unit of each quantity</p> <p><b>2.2. <u>Electrical Measuring Instruments</u></b></p> <p>2.2.1. Ampere Meter</p> <p>2.2.2. Volt Meter</p> <p>2.2.3. Digital Multimeter</p> <p>2.2.4. Clamp-On AC Meter</p> <p>2.2.5. Oscilloscope</p> <p><b>2.3. <u>DC Fundamentals</u></b></p> <p>2.3.1. Ohm's Law</p> <p>    2.3.1.1. Definition of Ohm's law</p> <p>    2.3.1.2. Mathematical formula</p> <p>    2.3.1.3. Calculation on ohm's law</p> <p>2.3.2. Resistor</p> <p>    2.3.2.1. Construction of resistor</p> <p>    2.3.2.2. Types of resistors</p> <p>    2.3.2.3. Colorcoding of resistors</p> <p>2.3.3. Series combination of resistors</p> <p>2.3.4. Parallel combination of resistors</p> <p><b>2.4. <u>Batteries</u></b></p> <p>2.4.1. What is a battery?</p> <p>2.4.2. Working principle of batteries</p> <p>2.4.3. Type of batteries</p> <p>2.4.4. Purpose of batteries in telecommunication</p> <p>2.4.5. Series connection of batteries</p> <p>2.4.6. Parallel connections of batteries</p> <p>2.4.7. Charging of a secondary battery</p> <p><b>2.5. <u>AC Fundamentals</u></b></p> <p>2.5.1. Sine wave</p> <p>2.5.2. Cycle</p> <p>2.5.3. Wavelength and its unit</p> <p>2.5.4. Frequency ant its unit</p> <p>2.5.5. Amplitude and its unit</p> <p>2.5.6. AC sine wave form and its characteristics.</p> <p>2.5.7. Audio and Radio frequencies</p> <p>2.5.8. Radio frequency spectrum.</p> <p><b>2.6. <u>Transformer</u></b></p> <p>2.6.1. Definition of transformer</p> <p>2.6.2. Working principle of transformer</p>	<p><b>2</b></p> <p><b>1</b></p> <p><b>2</b></p> <p><b>2</b></p> <p><b>1</b></p> <p><b>1</b></p>
------------------	--	---

	<p>2.6.3. Construction of transformer  2.6.4. Types of transformer  2.6.5. Use of transformer in electronics and telecommunication</p> <p><b>2.7. <u>Semiconductors</u></b>  2.7.1. Definition  2.7.2. Intrinsic semiconductors  2.7.3. Extrinsic semiconductors  2.7.4. Doping  2.7.4.1. Trivalent impurities  2.7.4.2. Pentavalent impurities  2.7.5. N-type semiconductors  2.7.6. P-type semiconductors</p> <p><b>2.8. <u>Diode</u></b>  2.8.1. PN Junction diode  2.8.2. Depletion region  2.8.3. Barrier potential  2.8.4. Diode as forward bias  2.8.5. Diode as reverse bias  2.8.6. Diode as switch</p> <p><b>2.9. <u>Rectifiers</u></b>  2.9.1. What is rectifier?  2.9.2. Working Principle of rectifier.  2.9.3. Types of rectifier.  2.9.3.1. Half wave rectifier  2.9.3.2. Full wave centre tapped rectifier  2.9.3.3. Full wave bridge rectifier  2.9.4. Purpose of rectifier in telecommunication</p>	<p><b>1</b></p> <p><b>1</b></p> <p><b>2</b></p>
<p><b>3.</b></p>	<p><b><u>Telecommunication Fundamentals</u></b></p> <p>3.1. <b><u>Definition and concept</u></b>  3.1.1. Components of a communication system  3.1.1.1. Transmitter  3.1.1.2. Medium  3.1.1.3. Receiver  3.1.2. Definition of Telecom  3.1.3. Examples</p> <p>3.2. <b><u>Major parts of a telecommunication network</u></b>  3.2.1. Access network  3.2.1.1. Fixed line Access Network  3.2.1.2. Wireless Access Network (WLL)  3.2.2. Switching network  3.2.3. Transmission Network  3.2.3.1. Transmission by copper cables (Twisted pair, coaxial cable, wave guide)  3.2.3.2. Transmission by satellite  3.2.3.3. Transmission by microwave  3.2.3.4. Transmission by fiber optic</p>	<p><b>2</b></p> <p><b>3</b></p>

<p><b>4.</b></p>	<p><b><u>Data Communication</u></b></p> <p>4.1. <b><u>Basic component of data communication</u></b></p> <p>4.1.1. DTE/DCE</p> <p>4.1.2. Media</p> <p>4.1.3. Network</p> <p>4.1.4. Link</p> <p>4.1.5. Interface</p> <p>4.1.6. Network terminating unit</p> <p>4.2. <b><u>Connecting methods</u></b></p> <p>4.2.1. Dial up</p> <p>4.2.2. Leased line</p>	<p><b>3</b></p> <p><b>1</b></p>
<p><b>5.</b></p>	<p><b><u>Modulation Techniques</u></b></p> <p>5.1. <b><u>Modulation</u></b></p> <p>5.1.1. What is modulation?</p> <p>5.1.2. Need for modulation</p> <p>5.1.3. Carrier signal</p> <p>5.1.4. Modulating signal</p> <p>5.1.5. Modulated signals</p> <p>5.1.6. Amplitude modulation</p> <p>5.1.7. Frequency modulation</p> <p>5.1.8. Phase Modulation</p> <p>5.1.9. Advantages of FM over AM</p> <p>5.2. <b><u>Digital Modulation Techniques</u></b></p> <p>5.2.1. Amplitude Shift Keying</p> <p>5.2.2. Frequency Shift Keying</p> <p>5.2.3. Phase Shift Keying</p> <p>5.2.4. Quadrature Amplitude Modulation</p>	<p><b>3</b></p> <p><b>2</b></p>
<p><b>6.</b></p>	<p><b><u>Antennas</u></b></p> <p>6.1. <b><u>Electromagnetic waves</u></b></p> <p>6.1.1. Magnetic field around a current carrying conductor</p> <p>6.1.2. Generation of Radio Waves</p> <p>6.1.3. Propagation of EM waves</p> <p>6.1.4. Types of Electromagnetic waves according to propagation</p> <p>6.1.4.1. Ground waves</p> <p>6.1.4.2. Sky waves</p> <p>6.1.4.3. Space waves</p> <p>6.1.5. Spectrum of electromagnetic waves</p> <p>6.2. <b><u>Antenna</u></b></p> <p>6.2.1. Definition and working principle of antenna</p> <p>6.2.2. Construction of a simple antenna</p> <p>6.2.3. Intensity of radiation field and unit of measurement</p> <p>6.2.4. Antenna gain, resistance, beam width, effective length and polarization</p> <p>6.2.5. Effect of ground on radiation of energy of an antenna</p> <p>6.2.6. Different types of broadcast, horn and parabolic antenna</p>	<p><b>3</b></p> <p><b>5</b></p>
<p><b>7.</b></p>	<p><b><u>Multiplexing/De-multiplexing</u></b></p>	

	<ul style="list-style-type: none"> <li>7.1. What is multiplexing/de- multiplexing</li> <li>7.2. Types of multiplexing</li> <li>7.3. Frequency division multiplexing.</li> <li>7.4. Time division Multiplexing. <ul style="list-style-type: none"> <li>7.4.1. PCM 24</li> <li>7.4.2. PCM 30</li> </ul> </li> </ul>	<b>5</b>
<b>8.</b>	<p><b><u>Microwave Communication Overview</u></b></p> <ul style="list-style-type: none"> <li>8.1. <b><u>Basic of Microwave</u></b> <ul style="list-style-type: none"> <li>8.1.1. Transmission methods in current communication networks</li> <li>8.1.2. What is Microwave?</li> <li>8.1.3. Microwave Vs Fiber Optics</li> <li>8.1.4. Electromagnetic wave spectrum</li> <li>8.1.5. Microwave History</li> <li>8.1.6. Concept of digital microwave communication</li> <li>8.1.7. Commonly used Intermediate frequencies</li> <li>8.1.8. Advantages and disadvantages of digital microwave communication</li> <li>8.1.9. Long haul and short haul microwave systems</li> <li>8.1.10.</li> </ul> </li> <li>8.2. <b><u>Digital Microwave Communication</u></b> <ul style="list-style-type: none"> <li>8.2.1. Microwave Frequency Band Selection</li> <li>8.2.2. RF Channel Configuration</li> <li>8.2.3. Digital Microwave Communication Modulation</li> <li>8.2.4. Microwave Frame Structure</li> </ul> </li> </ul>	<b>6</b>
<b>9.</b>	<p><b><u>Digital Microwave Communication Equipment</u></b></p> <ul style="list-style-type: none"> <li>9.1. <b><u>Microwave Equipment Category</u></b> <ul style="list-style-type: none"> <li>9.1.1. Trunk Microwave Equipment</li> <li>9.1.2. All Outdoor Microwave Equipment</li> <li>9.1.3. Split Mount Microwave Equipment</li> </ul> </li> <li>9.2. <b><u>Split Mount Microwave Equipment</u></b> <ul style="list-style-type: none"> <li>9.2.1. Installation</li> <li>9.2.2. Outdoor Unit (ODU)</li> <li>9.2.3. Indoor Unit (IDU)</li> <li>9.2.4. Microwave Antenna</li> <li>9.2.5. Antenna Adjustment</li> </ul> </li> </ul>	<b>2</b>
<b>10.</b>	<p><b><u>Digital Microwave Networking and Application</u></b></p> <ul style="list-style-type: none"> <li>10.1. <b><u>Networking Modes</u></b> <ul style="list-style-type: none"> <li>10.1.1. Common networking modes of Digital Microwave</li> <li>10.1.2. Types of Digital Microwave Stations <ul style="list-style-type: none"> <li>10.1.2.1. Terminal station</li> <li>10.1.2.2. Relay station</li> <li>10.1.2.3. Add/Drop relay station</li> <li>10.1.2.4. Pivotal station</li> </ul> </li> </ul> </li> <li>10.2. <b><u>Relay Stations</u></b></li> </ul>	<b>4</b>
		<b>3</b>

	<ul style="list-style-type: none"> <li>10.2.1. Active Relay station <ul style="list-style-type: none"> <li>10.2.1.1. Radio Frequency relay station</li> <li>10.2.1.2. Regenerator relay station</li> </ul> </li> <li>10.2.2. Passive Relay Station <ul style="list-style-type: none"> <li>10.2.2.1. Parabolic reflector passive relay station</li> <li>10.2.2.2. Plane Reflector Passive Relay Station</li> </ul> </li> </ul> <p>10.3. <b><u>Application of Digital Microwave</u></b></p>	<b>1</b>
<b>11.</b>	<p><b><u>Installation Testing &amp; Commissioning Exercises</u></b></p> <ul style="list-style-type: none"> <li>11.1. <b><u>Installation of hardware</u></b> <ul style="list-style-type: none"> <li>11.1.1. Installation method of equipment rack</li> <li>11.1.2. Installation method of microwave radios</li> <li>11.1.3. Installation method of signal cables</li> <li>11.1.4. Installation method of electrical power cables</li> <li>11.1.5. Installation method of microwave antennas</li> <li>11.1.6. Installation method of ODU</li> <li>11.1.7. Installation method of IF cables from ODU to microwave radios</li> <li>11.1.8. Earthing of microwave transmission system</li> <li>11.1.9. Installation method of battery bank</li> </ul> </li> </ul>	<b>6</b>

Sr. No.	Detail of Topics	Practical Hours
1	<p><b><u>Introduction to Computer</u></b></p> <ul style="list-style-type: none"> <li>1.1. Installation of I/O devices <ul style="list-style-type: none"> <li>1.1.1. Mouse</li> <li>1.1.2. Key board</li> <li>1.1.3. Microphone</li> <li>1.1.4. Speaker</li> <li>1.1.5. Printer</li> <li>1.1.6. Scanner</li> <li>1.1.7. Monitor</li> </ul> </li> <li>1.2. Installation and working of Storage devices <ul style="list-style-type: none"> <li>1.2.1. Hard Disk (HDD)</li> <li>1.2.2. Floppy Disk</li> <li>1.2.3. Compact Disk (CD)</li> <li>1.2.4. Universal Serial Bus (USB)</li> </ul> </li> <li>1.3. Working and Operation of CPU <ul style="list-style-type: none"> <li>1.3.1. Power Supply</li> <li>1.3.2. Mother Board</li> <li>1.3.3. Processor</li> <li>1.3.4. Memory</li> <li>1.3.5. Expansion Board</li> <li>1.3.6. I/O prots</li> <li>1.3.7. Network interface card</li> <li>1.3.8. Hard disk</li> <li>1.3.9. Floppy disk</li> <li>1.3.10. CD ROM</li> <li>1.3.11. DVD ROM</li> </ul> </li> <li>1.4. Practice of Ms Office <ul style="list-style-type: none"> <li>1.4.1. Microsoft Word</li> <li>1.4.2. Microsoft Excel</li> <li>1.4.3. Microsoft Visio</li> </ul> </li> <li>1.5. Internet Browsing and surfing</li> </ul>	40

<p style="text-align: center;"><b>2</b></p>	<p style="text-align: center;"><b><u>Basic Electricity and electronics</u></b></p> <p>2.1. Function and application of measuring instruments  2.1.1. Ampere Meter  2.1.2. Volt Meter  2.1.3. Digital Multimeter  2.1.4. Clamp-On AC Meter  2.1.5. Oscilloscope</p> <p>2.2. Measurement of current, voltage and resistance using Ammeter, voltmeter and multimeter</p> <p>2.3. Verification of ohm law by  2.3.1. Keeping the voltage constant  2.3.2. Keeping the Resistance constant</p> <p>2.4. Practice of resistor color coding</p> <p>2.5. Verify the laws of series combination of resistors</p> <p>2.6. Verify the laws of parallel combination of resistors</p> <p>2.7. Series connection of batteries</p> <p>2.8. Parallel connections of batteries</p> <p>2.9. Charging of a secondary battery</p> <p>2.10. Installation of battery banks</p> <p>2.11. Diode as switch</p> <p>2.12. Diode as rectifier</p> <p>2.13. Assemble a half wave rectifier and verify its output wave form with the help of oscilloscope</p> <p>2.14. Assemble a full wave rectifier with centre taped transformer and verify its output wave form with the help of oscilloscope</p> <p>2.15. Assemble a full wave bridge rectifier and verify its output wave form with the help of oscilloscope.</p> <p>2.16. Installation practice of rectifiers for microwave communication systems</p>	<p style="text-align: center;"><b>60</b></p>
<p style="text-align: center;"><b>3</b></p>	<p style="text-align: center;"><b><u>Telecommunication Fundamentals</u></b></p> <p>4.1. Function and applications of components  6.1.1. Transmitter  6.1.2. Receiver  6.1.3. Medium  6.1.4. Transducer  6.1.5. Transceiver</p> <p>4.2. More about the medium  6.2.1. Shielded Twisted pair  6.2.2. Unshielded twisted pair  6.2.3. Coaxial cable</p>	<p style="text-align: center;"><b>15</b></p>

	<ul style="list-style-type: none"> <li>6.2.4. Wave guide</li> <li>6.2.5. Drop wire</li> <li>6.2.6. Single mode optical fiber cable</li> <li>6.2.7. Multimode optical fiber cable</li> <li>4.3. Working of transmission system <ul style="list-style-type: none"> <li>6.3.1. Copper based transmission</li> <li>6.3.2. Optical fiber transmission</li> <li>6.3.3. Microwave transmission</li> <li>6.3.4. Voice and data transmission systems</li> </ul> </li> </ul>	
	<p><b><u>Data Communication</u></b></p> <ul style="list-style-type: none"> <li>5.1. Function and application of DTE</li> <li>5.2. Configuration of DCE</li> <li>5.3. Connecting a DCE with DTE</li> <li>5.4. Types of medium according to DCE and DTE interface</li> <li>5.5. Different types of interfaces like RJ-11, RJ-45, BNC, RS-232 etc.</li> <li>5.6. Function and working of an NTU.</li> <li>5.7. Create a link between two DTEs using DCE, medium, interface and NTU.</li> <li>5.8. Function of dialup and leased line</li> </ul>	<b>10</b>
	<p><b><u>Modulation Techniques</u></b></p> <ul style="list-style-type: none"> <li>6.1. Construct an FM transmitter</li> <li>6.2. Implement an FM transmitter</li> <li>6.3. Construct FM receiver</li> <li>6.4. Implement FM receiver</li> <li>6.5. Observe modulated signal on oscilloscope</li> </ul>	<b>10</b>
	<p><b><u>Antennas</u></b></p> <ul style="list-style-type: none"> <li>7.1. Working of different types of antennas like <ul style="list-style-type: none"> <li>7.1.1. Sector antenna</li> <li>7.1.2. Omni-directional antenna</li> <li>7.1.3. Directional antenna</li> <li>7.1.4. LOS antenna</li> </ul> </li> <li>7.2. Construct a simple antenna</li> <li>7.3. Measurement the intensity of radiation of antenna</li> <li>7.4. Adjustment and alignment of antenna</li> <li>7.5. Antenna gain calculation</li> </ul>	<b>15</b>
	<p><b><u>Multiplexing/De-multiplexing</u></b></p> <ul style="list-style-type: none"> <li>8.1. Multiplexing of telephone lines</li> <li>8.2. De-multiplexing of telephone lines</li> <li>8.3. Time division multiplexing procedure with the help of PCM multiplexer</li> </ul>	<b>2</b>
	<p><b><u>Microwave Communication Overview</u></b></p> <ul style="list-style-type: none"> <li>9.1. Selection of frequencies according to propagation distance</li> <li>9.2. Channel configuration of microwave equipment</li> <li>9.3. Modulation and de-modulation of microwave signals</li> <li>9.4. Multiplexing and de-multiplexing of communication signal</li> </ul>	<b>6</b>
	<p><b><u>Digital Microwave Communication Equipment</u></b></p> <ul style="list-style-type: none"> <li>10.1. Trunk microwave radios and its accessories</li> </ul>	<b>30</b>

	<ul style="list-style-type: none"> <li>10.2. All outdoor microwave radios and its accessories</li> <li>10.3. Split mount microwave radios and its accessories</li> <li>10.4. Installation of IDU</li> <li>10.5. Installation of ODU</li> <li>10.6. Installation of IF cables</li> <li>10.7. Installation of E1 cables</li> <li>10.8. Installation of Ethernet cables</li> <li>10.9. Microwave antennal installation</li> <li>10.10. Antenna alignment</li> <li>10.11. Antenna adjustment</li> <li>10.12. Horizontal and Vertical polarization</li> </ul>	
	<p><b><u>Digital Microwave Networking and Application</u></b></p> <ul style="list-style-type: none"> <li>11.1. Combination of microwave equipment in star topology</li> <li>11.2. Combination of microwave equipment in mesh topology</li> <li>11.3. Combination of microwave equipment in ring topology</li> <li>11.4. Combination of microwave equipment in chain topology</li> <li>11.5. Working and function of terminal station</li> <li>11.6. Working and function of relay station</li> <li>11.7. Working and function of add/drop station</li> </ul>	<b>10</b>
	<p><b><u>Installation Testing &amp; Commissioning Exercises</u></b></p> <ul style="list-style-type: none"> <li>12.1. Site Survey</li> <li>12.2. Selection of site</li> <li>12.3. Selection of route for transmission</li> <li>12.4. Clearance of route</li> <li>12.5. Path profile using software</li> <li>12.6. Path profile using web</li> <li>12.7. Link Budgeting</li> <li>12.8. Calculation of free space transmission loss</li> <li>12.9. Selection of frequency band</li> <li>12.10. Selection of channel width</li> <li>12.11. Antenna Installation</li> <li>12.12. Alignment of microwave antennas</li> <li>12.13. Adjustment of antenna</li> <li>12.14. Measurement of signal strength</li> <li>12.15. Checking of alignment</li> <li>12.16. ODU Installation</li> <li>12.17. IDU Installation</li> <li>12.18. IF cable installation</li> <li>12.19. IF cable grounding</li> <li>12.20. Equipment Grounding</li> <li>12.21. Installation of E1 cables</li> <li>12.22. Installation of Electrical power cables</li> <li>12.23. Installation of battery bank for power backup</li> <li>12.24. IDU Configuration</li> <li>12.25. ODU configuration</li> <li>12.26. Protection modes of microwave communication</li> <li>12.27. Link Testing <ul style="list-style-type: none"> <li>12.27.1. RSSI (Receive Signal Strength Indication)</li> <li>12.27.2. BERT analysis</li> </ul> </li> </ul>	<b>90</b>

	<p>12.27.3. IP , Ethernet over Microwave</p> <p>12.28. Hard loop back test with E1 tester</p> <p>12.29. Digital loop back with the help of software</p> <p>12.30. Remote loop back with the help of software</p> <p>12.31. Baseband loop back with the help of software</p> <p>12.32. RF loop back with the help of software</p> <p>12.33. Commissioning of Microwave transmission link</p> <p>12.34. Transportation of E1 traffic on microwave link</p> <p>12.35. Transportation of IP traffic on microwave link</p>	
--	---	--

**Reference Book:**

- Training Manual

## 6. Tools / Equipment Detail

Sr.	Description of Tools and Equipment	Quantity
1.	DDF Rack	10 Nos.
2.	E1 Patch Panel	15 Nos.
3.	E1 Testers	02 Nos.
4.	Telecom Rectifiers	05 Nos.
5.	RJ-11 Crimping Tools	05 Nos.
6.	RJ-45 Crimping Tools	05 Nos.
7.	Wire Strippers	03 Nos.
8.	DC Power Backup (Batteries)	12 Nos.
9.	AC Power Backup (Gen Set)	01 Nos.
10.	Desktop PC	20 Nos.
11.	KRONE Puncher	10 Nos.
12.	Microwave Towers	02 Nos.
13.	Microwave Radios	10 Nos.
14.	Microwave Parabolic Antenna	04 Nos.
15.	Sector Antennas	01 Nos.
16.	Omni Directional Antennas	02 Nos.
17.	IF Cables	04 Nos.
18.	Path Profiling Software	01 Nos. Each
19.	E1 Traffic Interface Cable	10 Nos.
20.	Management interface cable	10 Nos.
21.	Ethernet Cables	10 Nos.
22.	Multimeter	10 Nos.
23.	Compass	05 Nos.
24.	Loop back cables	10 Nos.
25.	BNC connector (Balun)	10 Nos.

## EMPLOYABILITY OF PASS-OUTS

The pass outs of this course may find job / employment opportunities in the following areas / sectors:

- In industries Can be select as a Microwave technician
- Telecom solution/service providers
- Mobile Network companies
- IT Solution providers
- ISPs and DSL network provider
- Assembler / technician in Telecom product companies.
- Salesman/Technician in shops dealing with telecomequipment.
- Huge market is available outside the Pakistan especially in **Gulf**.

### Reference Books:

1. Microwave communication
2. System Manuals

### Qualification Of teacher:

DAE electronics with 2years' Experience in relevant Field.