DOCUMENT RESUME

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ABSTRACT

This combination progress record and course outline is designed for use by individuals teaching a course in signals and communications. Included among the topics addressed in the course are the following: matter, the nature of electricity, dry cells and batteries, Ohm's law, power, magnetism, measurement instruments, Kirchoff's laws, electromagnetic induction and inductance, capacitance, electric circuits, resonance, transformers, semiconductors, rectifiers, power supplies, transistors, electronic systems, integrated circuits, amplifiers, codes, alarms, cable televisions, safety, customer relations, and business practices. In addition to the theory outline, which includes space for recording information concerning the scheduling and presentation of the lesson material, this record book also contains a list of course objectives and a grid listing each of the individual tasks dealt with in the course, which is designed for use in recording each student's mastery of each specific skill. (MN)

PROGRESS RECORD

AND

THEORY OUTLINE

SIGNAL AND COMMUNICATIONS

DIVISION OF VOCATIONAL-TECHNICAL SCHOOLS

CONNECTICUT DEPARTMENT OF EDUCATION

1983-1984

PREFACE

The objective of the Assignment Book is to reduce unnecessary paper work on the part of the shop instructor.

This Assignment Book will assist the instructor to keep student records up to date.

In shops doing production work it is necessary to devise flexible daily lesson plans well in advance. This Assignment Book will assist the instructor in planning and organizing considerably in advance, thereby increasing his instructional efficiency.

Please note that this book is designed for planning. It has areas for locker assignments, text assignments, notes, etc. Students names are entered only once for the entire course.

SIGNAL AND COMMUNICATIONS

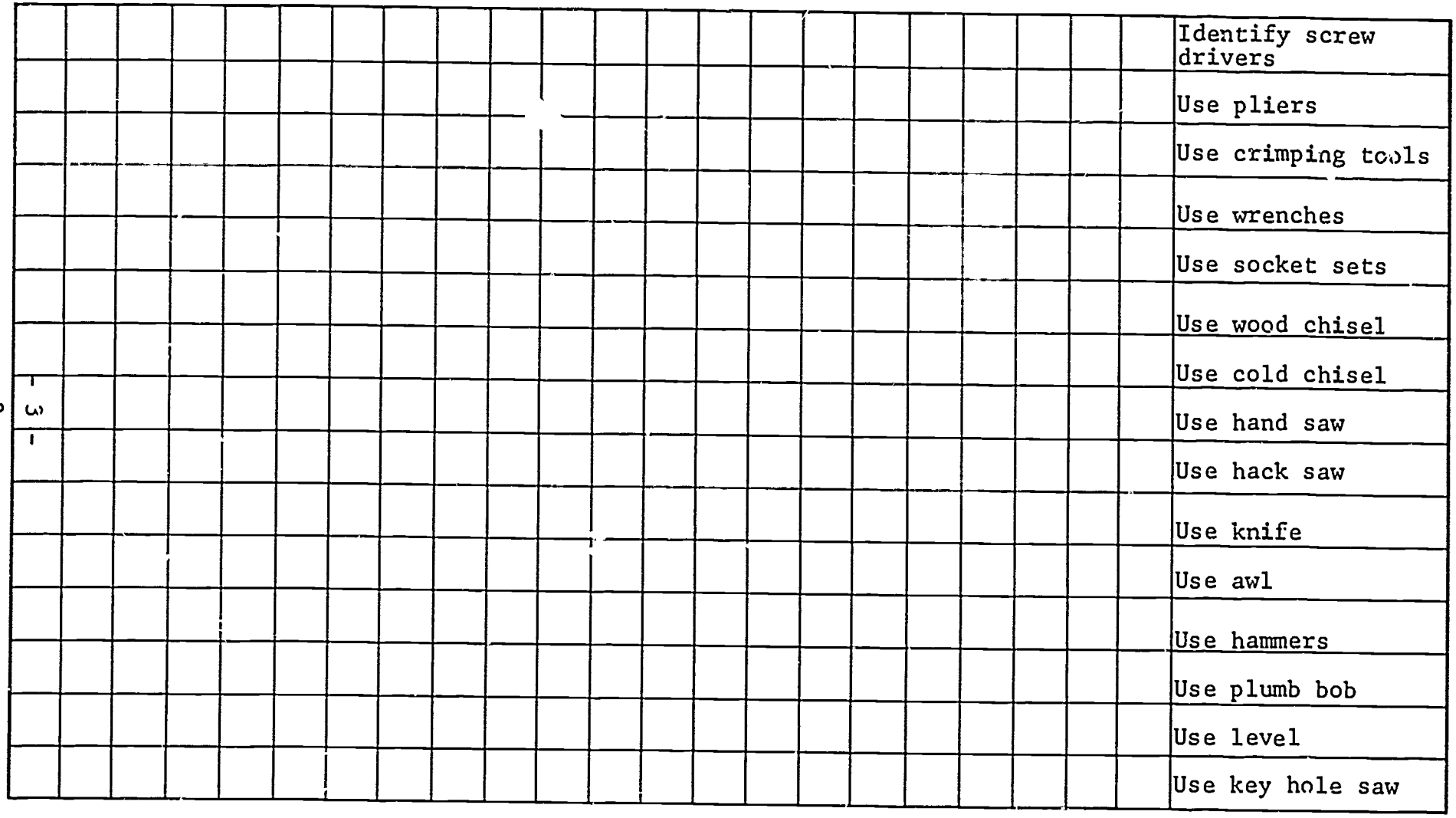
COURSE OBJECTIVES

The Signal and Communications course of study is designed to provide students with advanced standing in the signal and communications program.

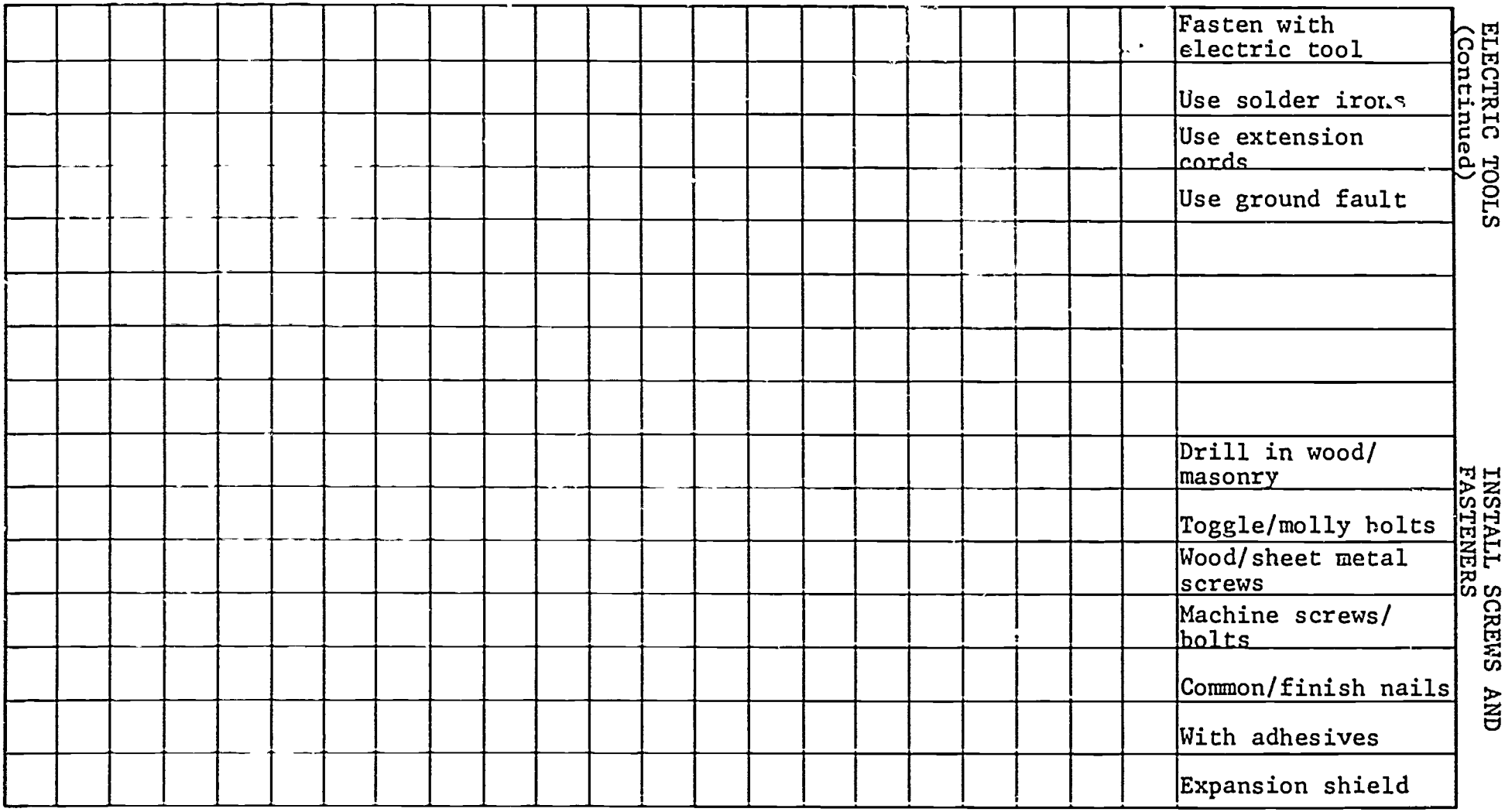
The course will help the student develop a systematic analytical approach to solving trade problems and acquire the appropriate basic theoretical concepts and manual skills of the trade. The student will learn to apply proper trade safety practices.

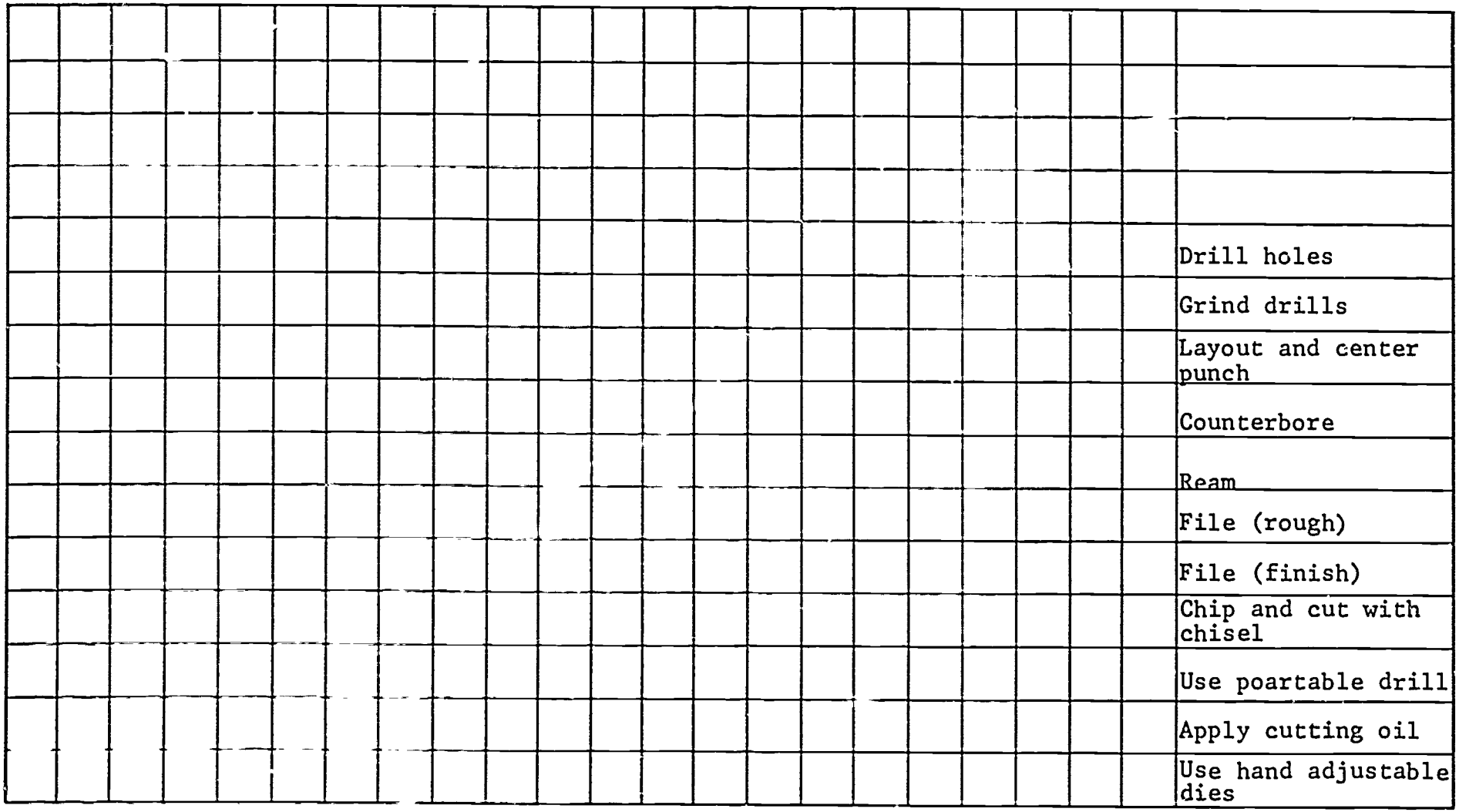
To accomplish this the student will proceed through experiences in shop and theory that will enable them to:

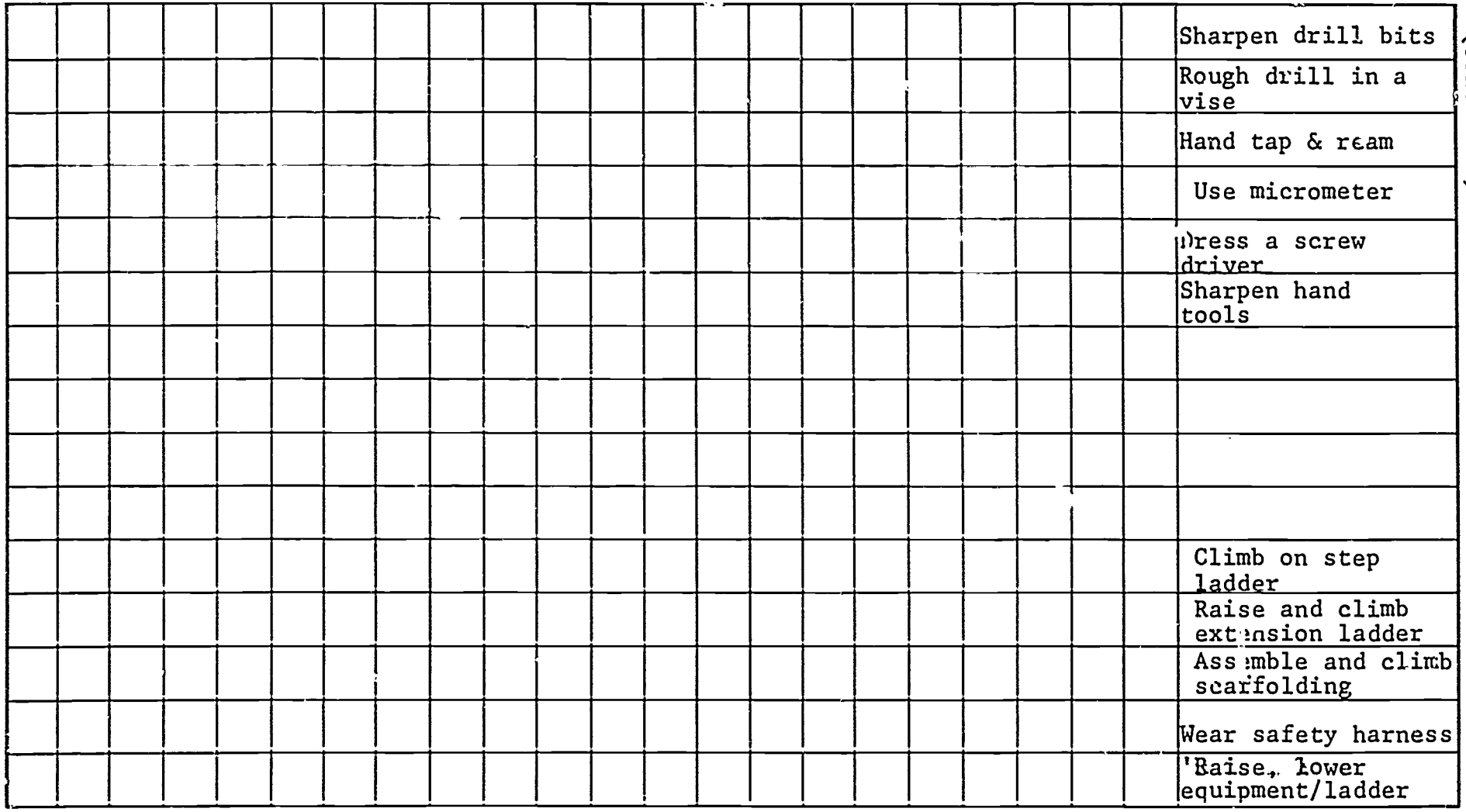
1. Properly select and use basic hand and electric tools of the trade.
2. Apply basic skills in Principles of Direct Current Electricity.
3. Demonstrate the apprentices' ability to work with and install equipment with tools, ladders, fasteners and related construction equipment.
4. Demonstrate knowledge of and ability to select and use proper test equipment.
5. Install materials, wires, wiring methods, and systems related to the signal and communications trade.
6. Demonstrate basic knowledge of signal, communications and alarm systems.
7. Apply basic knowledge of alternating current electricity, the language, the laws, basic components, and basic manual skills.
8. Demonstrate an ability to work with basic solid state circuits and devices.
9. Apply the applicable codes and standards in installing systems.
10. Work with proper business practice and work ethics

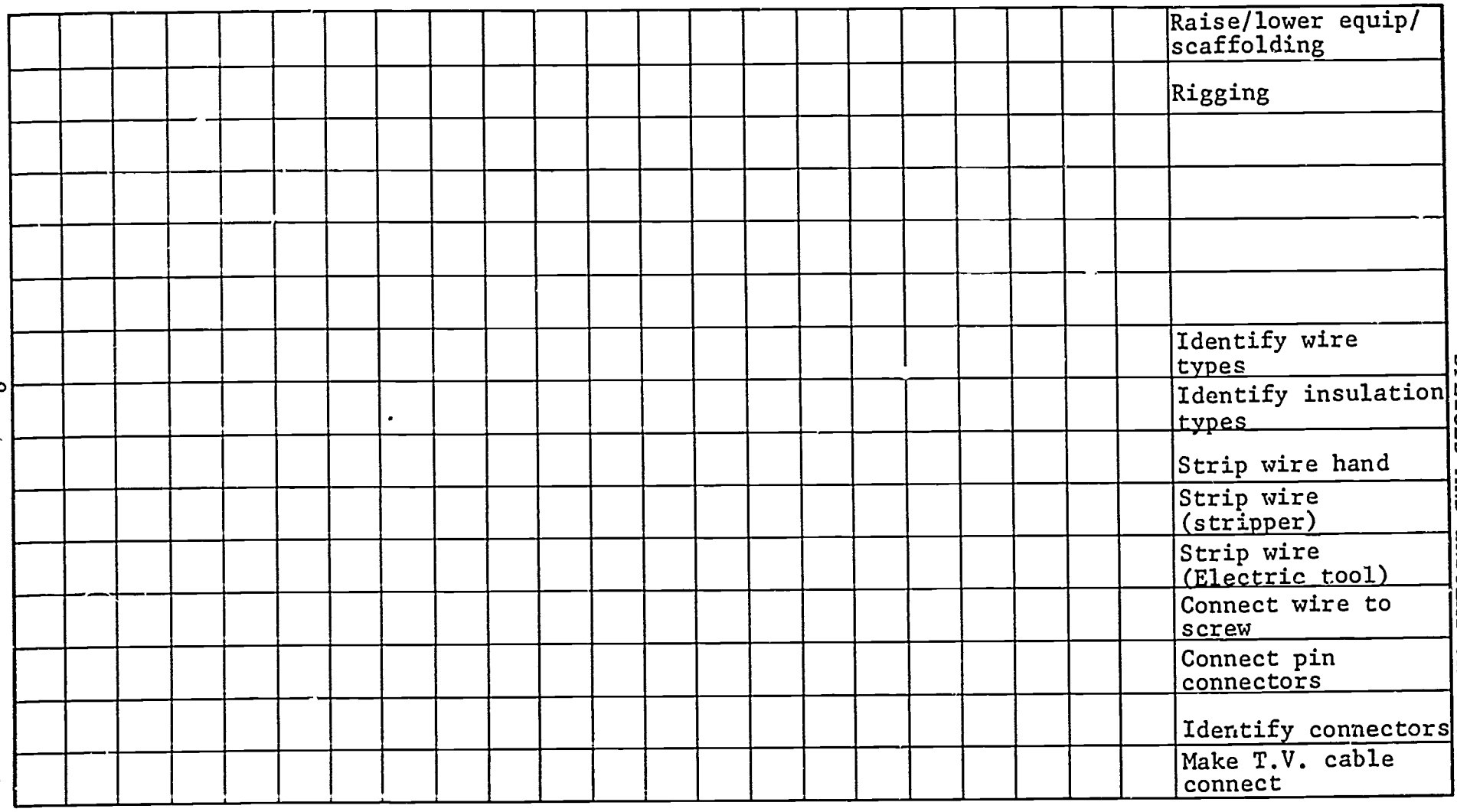

HAND TOOLS
Identify screw drivers
Use pliers
Use crimping tools
Use wrenches
Use socket sets
Use wood chisel
Use cold chisel
Use hand saw
Use hack saw
Use knife
Use awl
Use hammers
Use plumb bob
Use level
Use key hole saw

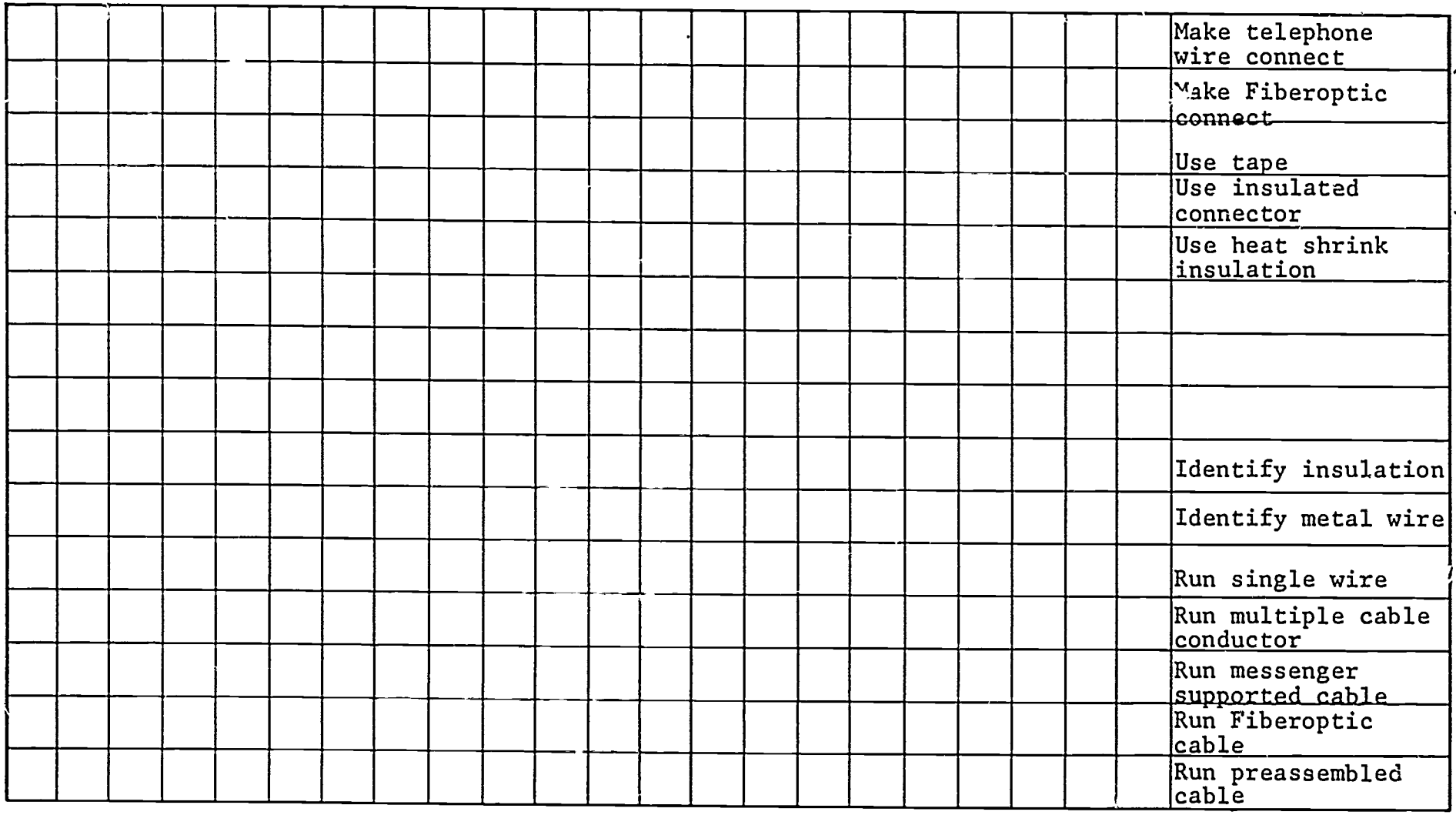
	Use nut drivers
	Cut with circular saw
	Cut with sabre saw
	Cut with reciprocating saw
	Cut with band saw
	Cut with nibbler
	Drill wood
	Drill steel
	Drill masonry
	Drill with hammer drill
	Use drill - heavy duty

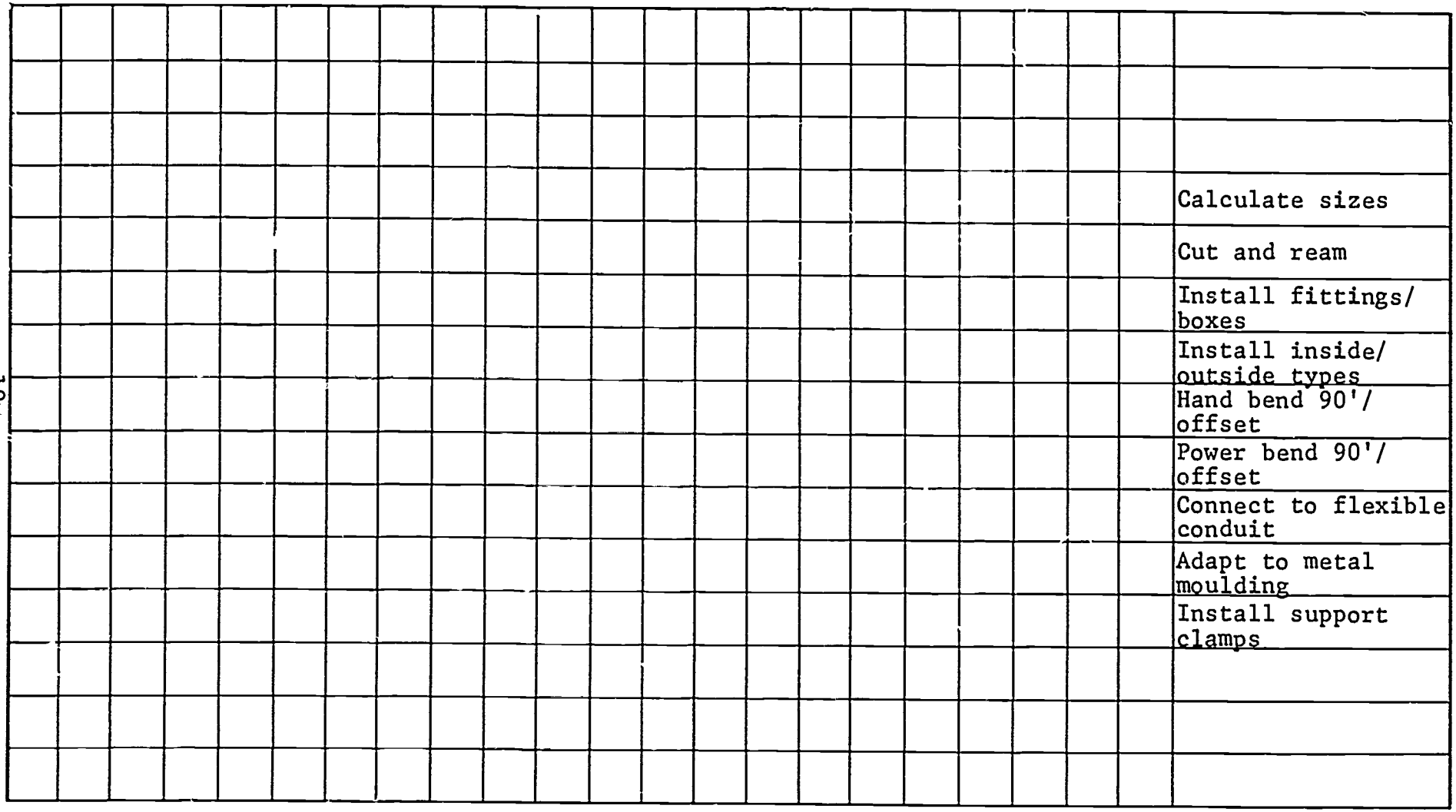

ELECTRIC TOOLS (Continued)
Fasten with electric tool
Use solder irons
Use extension cords
Use ground fault
INSTALL SCREWS AND FASTENERS
Drill in wood/ masonry
Toggle/molly bolts
Wood/sheet metal screws
Machine screws/ bolts
Common/finish nails
With adhesives
Expansion shield


BASIC MACHINE WORK
Drill holes
Grind drills
Layout and center punch
Counterbore
Ream
File (rough)
File (finish)
Chip and cut with chisel
Use poartable drill
Apply cutting oil
Use hand adjustable dies


BASIC MACHINE WORK (Continued)
Sharpen drill bits
Rough drill in a vise
Hand tap & ream
Use micrometer
Dress a screw driver
Sharpen hand tools
CLIMBING AND RIGGING WORK
Climb on step ladder
Raise and climb extension ladder
Assemble and climb scaffolding
Wear safety harness
Raise, lower equipment/ladder

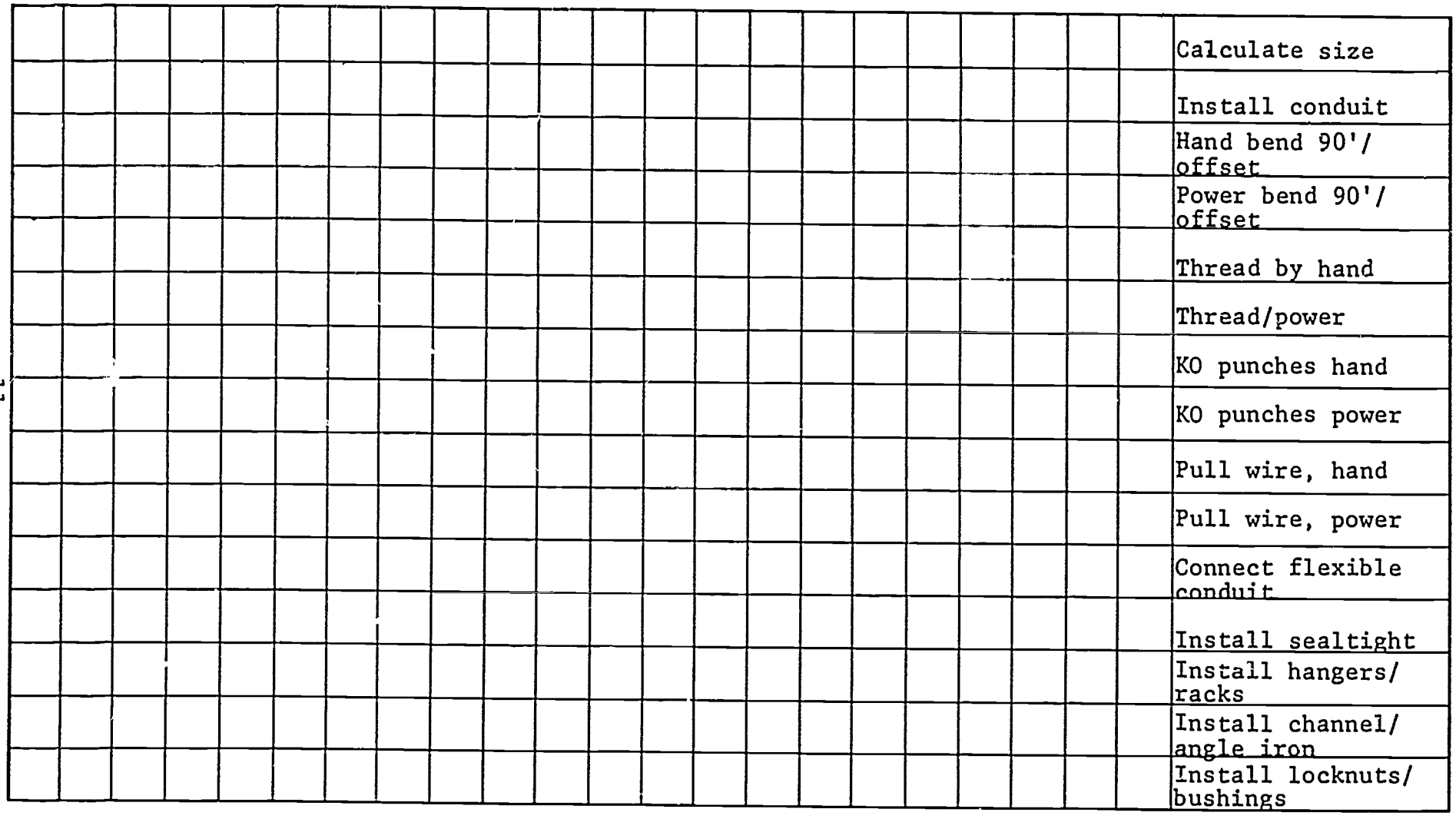

Raise/lower equip/ scaffolding
Rigging
Identify wire types
Identify insulation types
Strip wire hand
Strip wire (stripper)
Strip wire (Electric tool)
Connect wire to screw
Connect pin connectors
Identify connectors
Make T.V. cable connect
SPLICES AND INSULATION
- 8 -
10 / 83

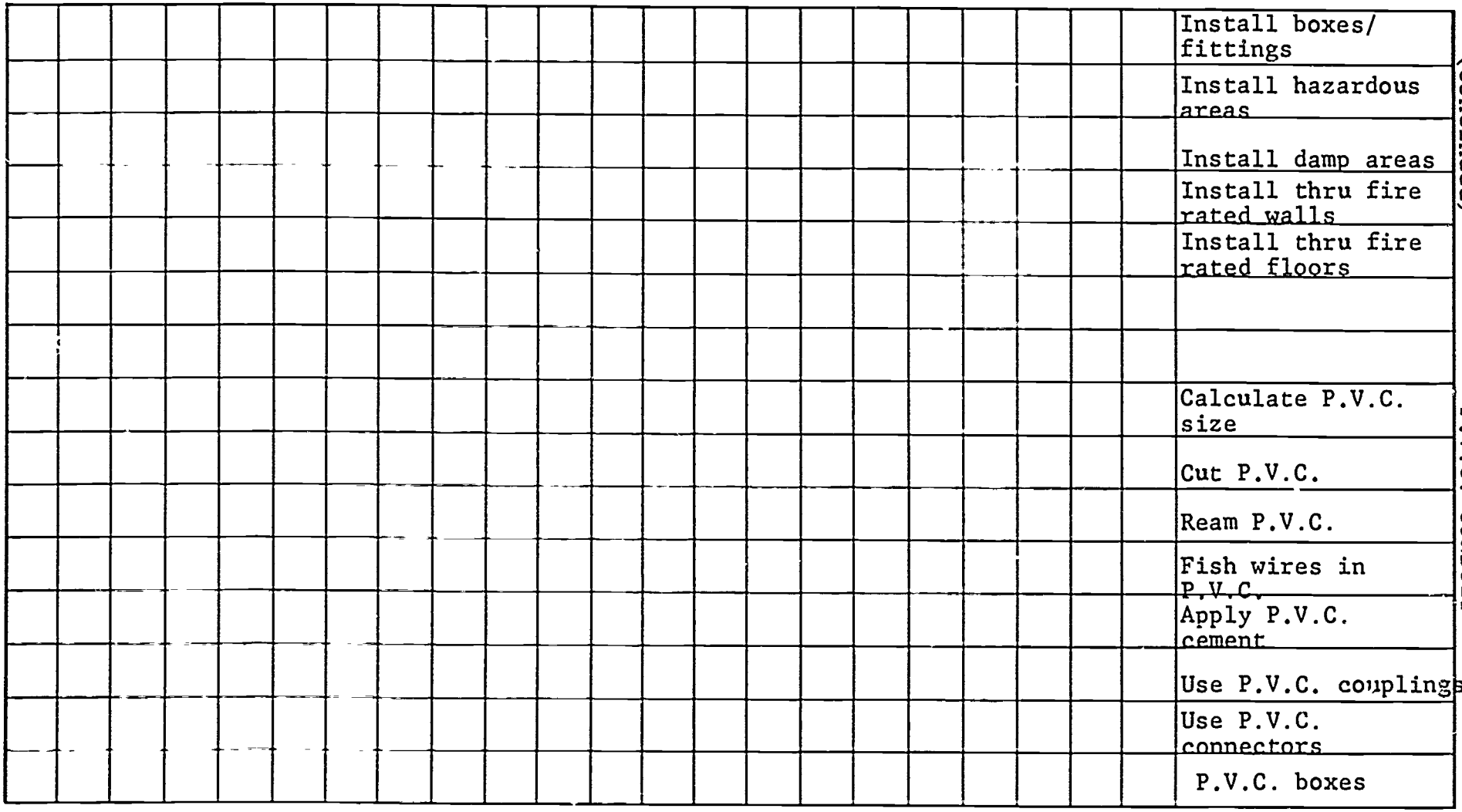

SPLICES & INSULATION (Continued)
Make telephone wire connect
Make Fiberoptic connect
Use tape
Use insulated connector
Use heat shrink insulation
WIRE TYPES
Identify insulation
Identify metal wire
Run single wire
Run multiple cable conductor
Run messenger supported cable
Run Fiberoptic cable
Run preassembled cable

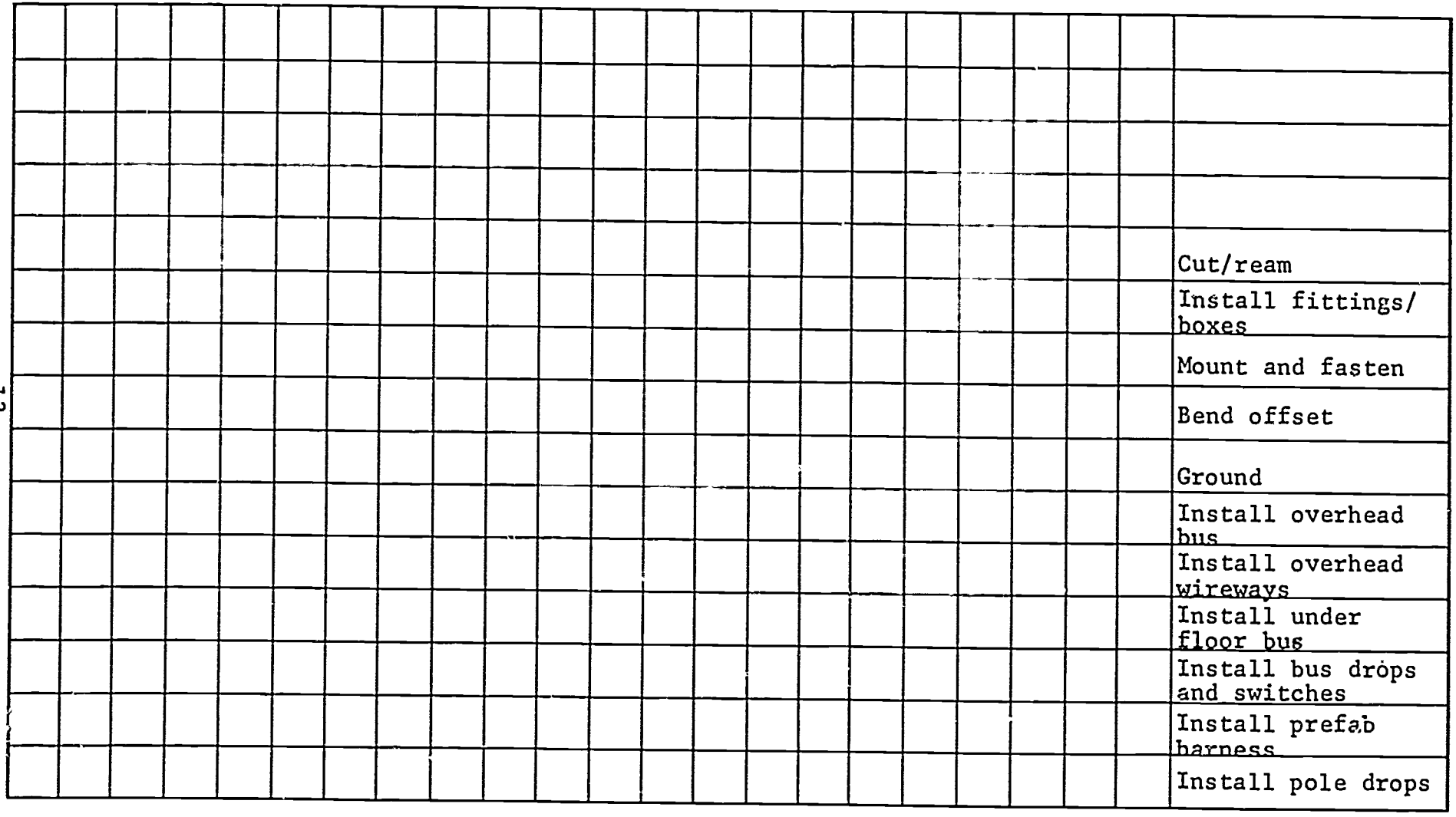

Calculate sizes
Cut and ream
Install fittings/ boxes
Install inside/ outside types
Hand bend 90'/ offset
Power bend 90'/ offset
Connect to flexible conduit
Adapt to metal moulding
Install support clamps

E.M.T. CONDUIT

RIGID IMC CONDUIT



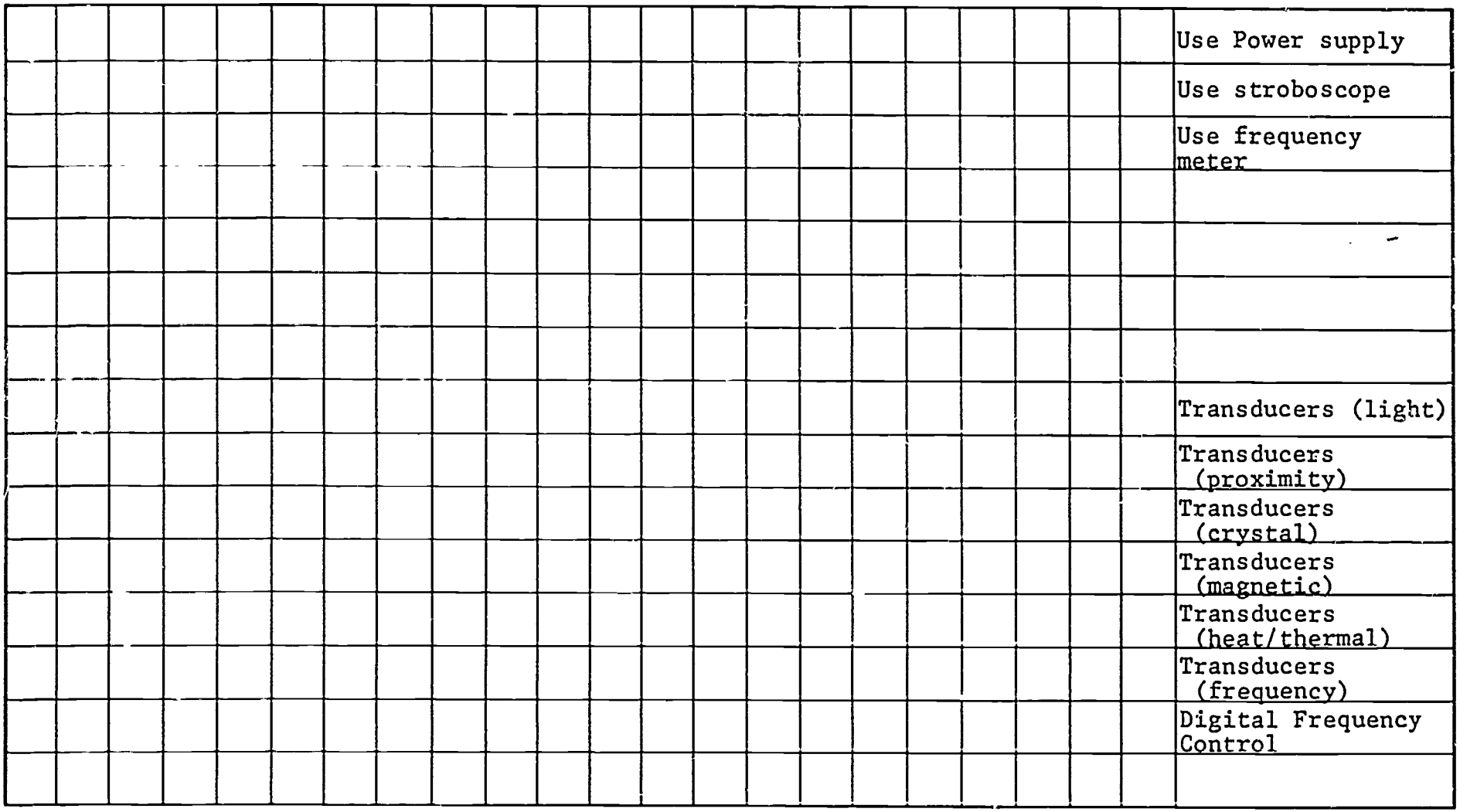

RIGID IMC CONDUIT (Continued)
Install boxes/ fittings
Install hazardous areas
Install damp areas
Install thru fire rated walls
Install thru fire rated floors
P.V.C. CONDUIT
Calculate P.V.C. size
Cut P.V.C.
Ream P.V.C.
Fish wires in P.V.C.
Apply P.V.C. cement
Use P.V.C. couplings
Use P.V.C. connectors
P.V.C. boxes

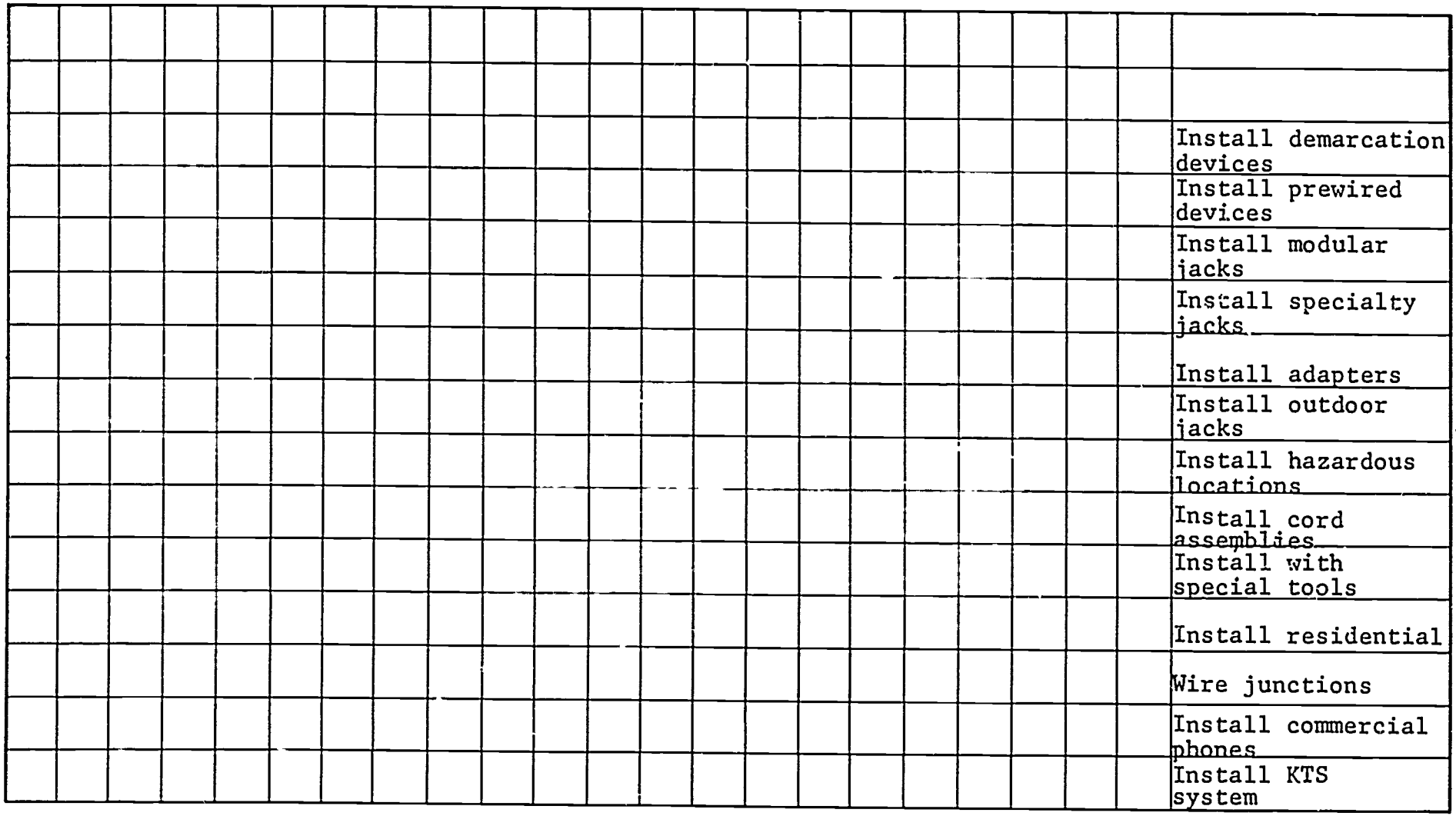


RACEWAYS AND WIREWAYS

TEST EQUIPMENT

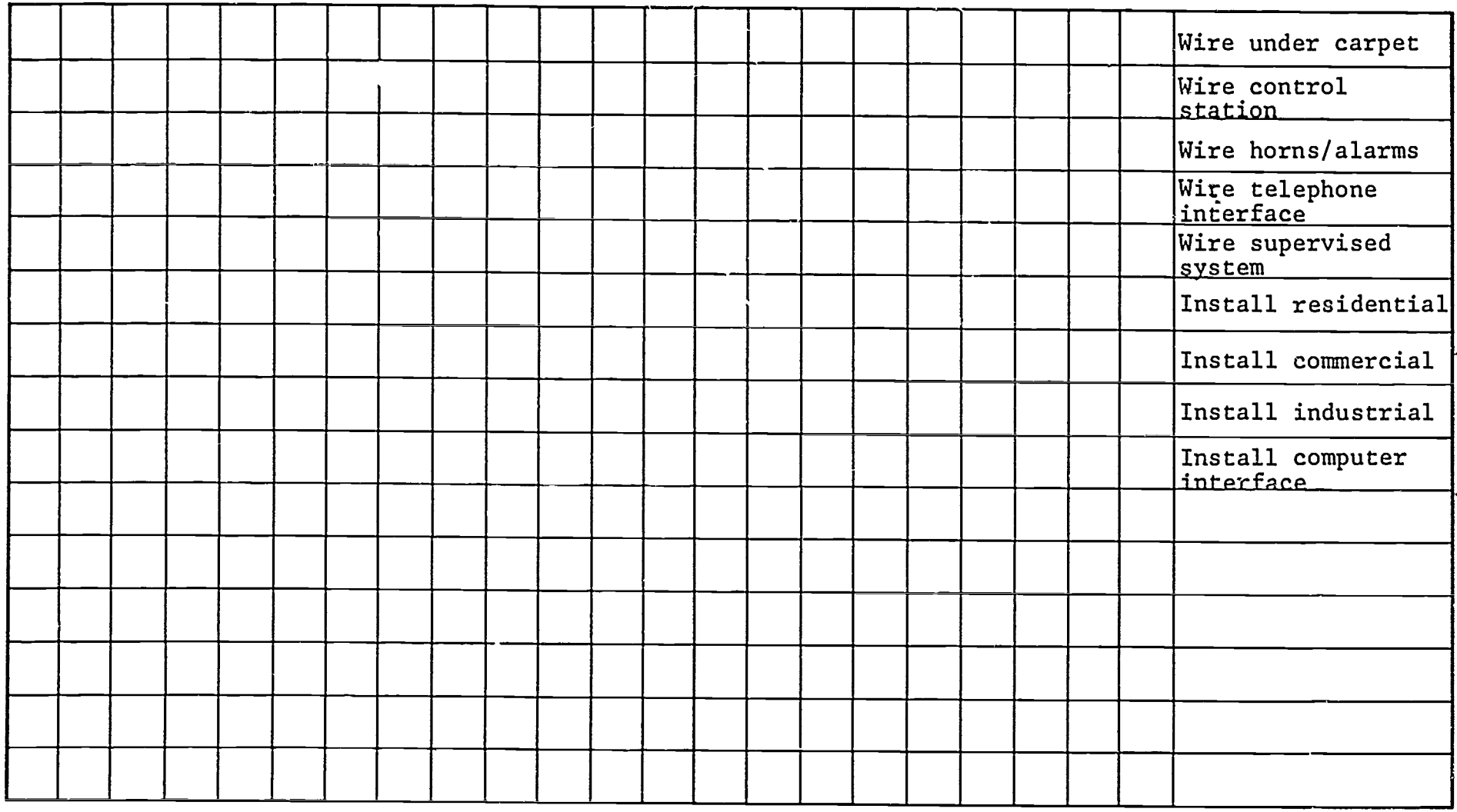
Install prewired partitions
Install computer wiring
Measure Multimeter
Measure T.M.
Measure oscilloscope
Measure audio oscillator
Measure digital readout instruments
Measure differential voltmeter
Construct ammeter
Construct voltmeter
Test tube tester

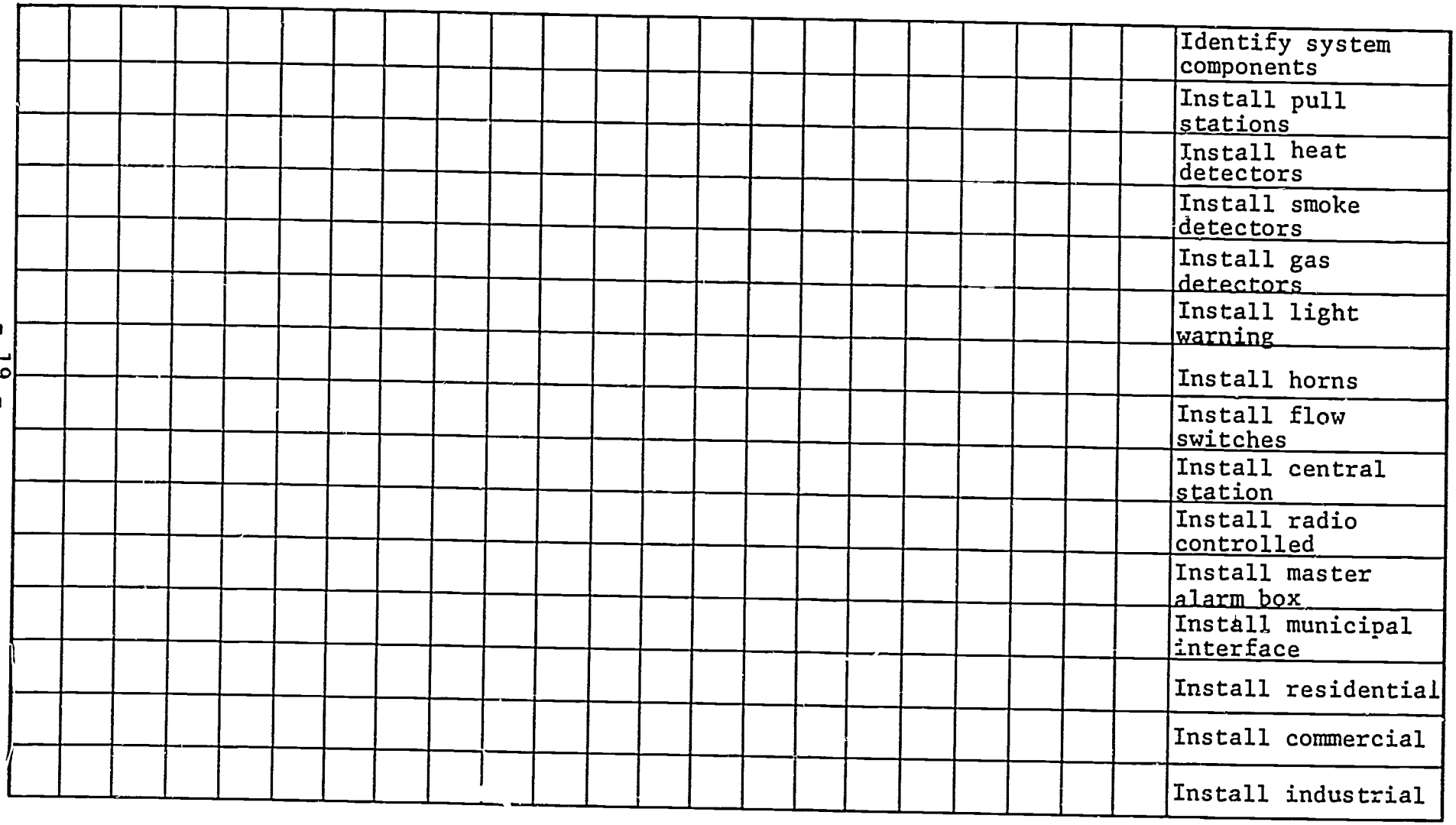

TEST EQUIP. (Continued)
Use Power supply
Use stroboscope
Use frequency meter
TRANSDUCERS CONNECT
Transducers (light)
Transducers (proximity)
Transducers (crystal)
Transducers (magnetic)
Transducers (heat/thermal)
Transducers (frequency)
Digital Frequency Control

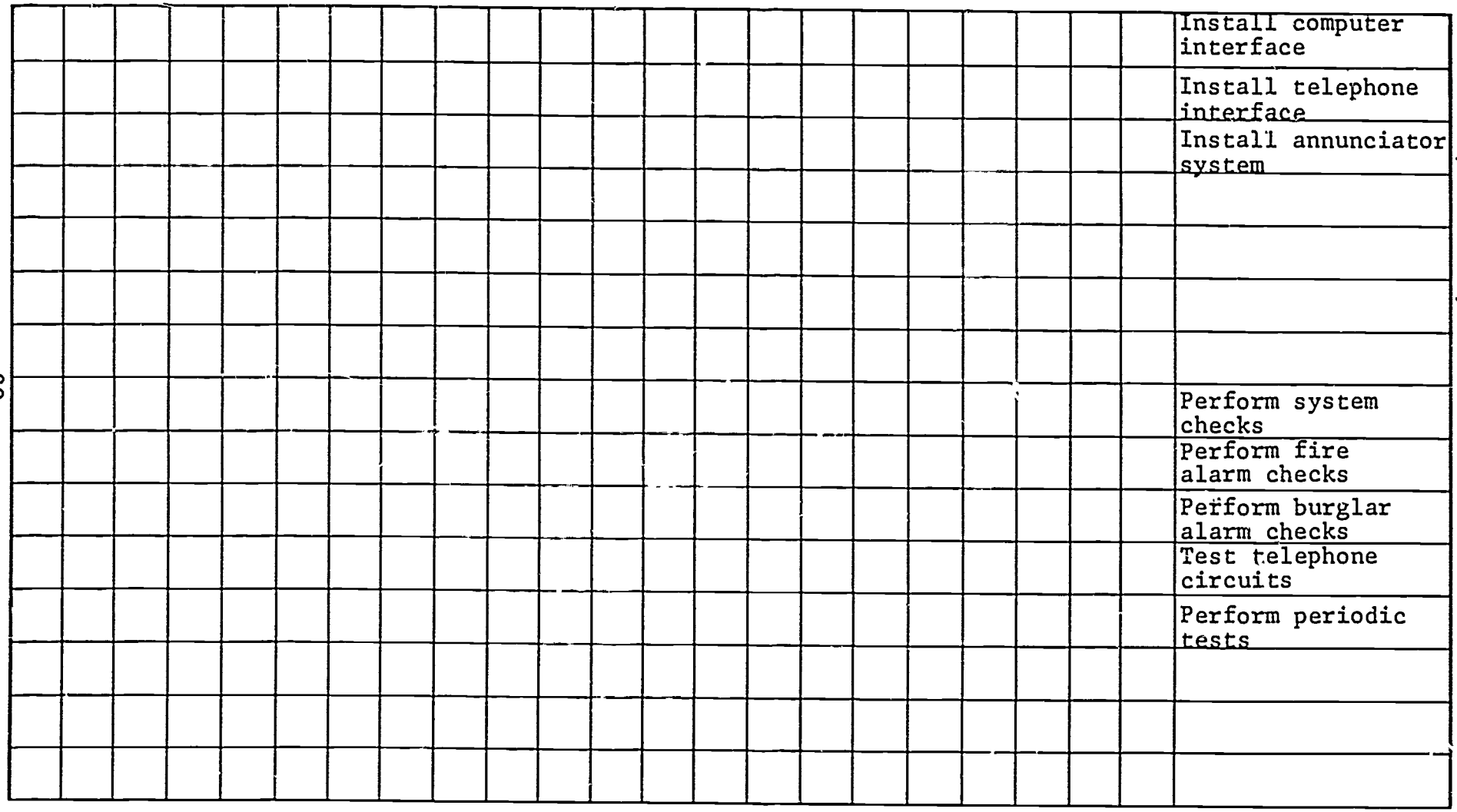


TELEPHONE SYSTEMS/COMPLY WITH CODES

Install cellular radio	TELEPHONE SYSTEMS (Continued)
Install network integration	
Install central systems	
Perform testing	
Install fiberoptic system	
Identify system components	BURGLAR ALARM SYSTEMS
Wire switches	
Wire photoelectric	
Wire sonar system	
Wire capacitance inductance	
Wire sound detector	


BURGLAR ALARM SYSTEMS (Continued)
Wire under carpet
Wire control station
Wire horns/alarms
Wire telephone interface
Wire supervised system
Install residential
Install commercial
Install industrial
Install computer interface


FIRE ALARM SYSTEMS
Identify system components
Install pull stations
Install heat detectors
Install smoke detectors
Install gas detectors
Install light warning
Install horns
Install flow switches
Install central station
Install radio controlled
Install master alarm box
Install municipal interface
Install residential
Install commercial
Install industrial


Install computer interface
Install telephone interface
Install annunciator system
Perform system checks
Perform fire alarm checks
Perform burglar alarm checks
Test telephone circuits
Perform periodic tests

LAB EXPERIMENTS

SIGNAL AND COMMUNICATIONS

GRADES 10, 11, 12

LAB EXPERIMENTS

BASIC ELECTRICITY

1. Electronic Components and their symbols
2. The Schematic Diagram
3. Familiarization with hand tools used in electronics
4. Soldering Techniques
5. VTVM Familiarization
6. Resistor Color Code
7. Dry Cells and Measurement of D-C Voltage

OHM'S LAW

1. The Series Circuit
2. Characteristics of a parallel circuit
3. Characteristics of Series Parallel Circuits
4. Kirchhoff's Laws (For one Generator)
5. Voltage Divider Circuits (unloaded)
6. Voltage Divider Circuits (loaded)
7. Characteristics of a D-C Meter Movement
8. Voltmeter Multipliers
9. Current-Meter Shunts

BASIC ELECTRICITY

1. The Series Ohmmeter
2. Use and Care of the VOM
3. Oscilloscope Operation
4. Oscilloscope Voltage Calibration
5. Characteristics of an Inductance
6. Inductances in Series and in Parallel
7. Capacitor Color Code and Testing Capacitors
8. Characteristics of a Capacitor
9. Total Capacitance of Capacitors in Series and in Parallel
10. Impedance of a Series RL Circuit

LAB EXPERIMENTS
(Continued)

11. Impedance of a Series RC Circuit
12. Characteristics of Series-Resonant Circuits
13. Characteristics of Parallel Resonant Circuits
14. Transformer Characteristics

BASIC ELECTRONICS

1. Semiconductor-Diode Characteristics
2. Zener-Diode Characteristics
3. Vacuum Tubes: Diode Characteristics
4. Half-wave and full-wave Rectification
5. Transformer Power Supply and Filter
6. Silicon and Selenium Half-wave-Rectifier Power Supplies
7. The voltage doubler
8. The Bridge Rectifier
9. Transistor Familiarization
10. Transistor Characteristic Curves and Transistor Data
11. Characteristics of a Cathode-Ray Tube
12. Tube, Transistor, and Solid-StateDiode testing
13. The A-C Amplifier
14. Common-Base Amplifier
15. Cascaded Transistor Amplifiers
16. The Loudspeaker
17. Transistor Phase Inverter
18. Push-Pull Power Amplifier
19. Frequency Response of an audio Amplifier
20. Resistance and voltage analysis of a transistor audio Amplifier
21. Transistor Phase-shift Oscillator
22. Transistor Multivibrator
23. Transistor sawtooth generator
24. Transistor voltage-mode trigger
25. The silicon controlled rectifier
26. Integrated circuits: the linear amplifier
27. Integrated circuits; the audio frequency medium-power amplifier

THEORY OUTLINE INDEX

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

THEORY OUTLINE

I. ORIENTATION

A. Occupational Analysis

1. Development of the Electronics Industry
2. Employment Opportunities
3. Employment Requirements and Trade Practices
4. Safety

B. Shop Practices

1. Care and use of common hand tools
   a. Safety
2. Care and use of power tools
   a. Safety
3. Wire stripping, splicing, and soldering techniques
   a. Safety

II. MATTER

A. What matter is
B. Molecules
C. Atoms
D. Elements and compounds
E. Structure of the atom
   1. Electrons and proton - charge
   2. Nucleus
   3. Neutrons and other particles
   4. Orbits, shells, free electrons, energy levels
   5. Atomic model
F. Ions

III. NATURE OF ELECTRICITY

A. Static electricity
B. Law of electric charges; electric fields
C. Current
   1. Conventional current
   2. Movement of negative charges - electron current
   3. Current in semiconductors - holes and the movement of positive charges

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

D. Electrical potential or emf
E. Electrical units and their symbols
   1. Coulomb
   2. Volt
   3. Ampere
   4. Ohm
   5. Watt

F. Opposition to direct current
   1. Insulators
   2. Resistors
   3. Conductors
   4. EIA resistor color code

G. The electric circuit-control of current
   1. Circuit diagram
      a. The voltage source
      b. The load
      c. The path of current
   2. Mechanical equivalent - the hydraulic system
   3. Measurement in the electric circuit, use of
      a. The voltmeter
      b. The ammeter
      c. The ohmmeter

H. Scientific notation
   1. Operations with exponents
   2. Expressing large and small numbers as powers of 10
   3. Significant figures
   4. Prefixes, their meaning and use in electronics: tera giga, mega, kilo, deca, centi, milli, micro, nano, pico

I. Computations with the calculator
   1. Types of calculators
   2. Nature of the calculator presentations
   3. Reading the presentations
   4. Calculator accuracy
   5. Multiplication
   6. Division
   7. The inverse calculations
   8. Squares and square roots
   9. The trigonometric calculator
   10. The log calculator
   11. The log-log calculator

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

J. Sources of EMF

1. Chemical
2. Mechanical
3. Thermal
4. Peizoelectric
5. Photoelectric
6. Atomic
7. Solar
8. Bionic

IV. DRY CELLS AND BATTERIES

A. Dry cells

1. Construction
2. Chemical action
3. Cell types
4. Rechargeable cells
5. Shelf life for primary cells
6. Combination of cells
7. Applications

B. Dry batteries

1. Construction
2. Types
3. Uses in electronics

C. Secondary cells - lead-acid cell

1. Construction
2. Action
3. Charge and discharge

D. Storage batteries

1. Construction
2. Electrolyte and electrodes
3. Storage Capacity and ratings
4. Recharging and care of batteries
   a. Commerical chargers
   b. Charge and discharge rate

V. RESISTANCE

A. Nature of resistance
B. Factors affecting resistance of metallic conductors of uniform cross-sectional area

1. Resistivity
2. Length
3. Area
4. Temperature and temperature coefficient

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

C. Mil and the circular mil
D. Wire gauge and wire tables
E. Linear resistors
   1. Fixed
      a. Carbon
      b. Wire-wound
   2. Variable
      a. Potentiometer
      b. Adjustable (wire-wound)
      c. Rheostat
F. Nonlinear
   1. Thyrite
   2. Thermistor
   3. Voltage-dependent resistor (VDR)--Varistor
G. Conductance
H. Use of resistors in electronics

VI. OHM'S LAW

A. Quantitative and descriptive statements of OHM's Law
B. Applications
C. D-C Circuits--analysis and computation of E, I, and R
   1. Series circuits
   2. Parallel circuits
   3. Series-parallel circuits
   4. The black box concept
   5. Circuit analysis by assuming a current or voltage
D. Voltage divider circuit
   1. Unloaded
   2. Loaded

VII. POWER

A. Work and energy
B. Power
C. Maximum power transfer
D. Efficiency

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

VIII. MAGNETISM

A. Types and shapes of magnets

1. Natural and artificial
2. Permanent and temporary
3. Electromagnets

B. Molecular theory of magnetism
C. Law of magnetic attraction and repulsion

1. Lines of force--flux
2. Field intensity--flux density
3. Poles of a magnet

D. Magnetic fields
E. Magnetic properties of materials

1. Permeability and relative permeability
2. Reluctance
3. Retentivity

F. Electromagnetism

1. Relation of magnetic field around a conductor carrying current

   a. To direction of current flow
   b. Amount of current flow

2. Magnetic field around a coil
3. Magnetomotive force
4. Magnetic units, systems, and symbols

   a. Mks and cgs systems
   b. Ampere-turn and the Gilbert
   c. Maxwell and the Weber
   d. Gauss
   e. Oersted

5. The magnetic circuit
6. Ohm's law for the magnetic circuit
7. Magnetization (B-H) curves
8. Hysteresis
9. Eddy currents
10. Magnetic shielding

IX. D-C MEASURING INSTRUMENTS

A. Construction of a moving-coild meter
B. Operation of a meter movement
C. Meter-movement sensitivity

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

D. The ammeter

1. Shunts--multirange and ring (Ayrton)-type
2. Shunt calculations
3. Switching circuits for multirange ammeter and miliammeter
4. Circuit-loading effects

E. The voltmeter

1. Multipliers
2. Multiplier calculations
3. Switching circuits for multirange voltmeters
4. Ohms/volt sensitivity
5. Circuit-loading effects

F. The ohmmeter

1. The series ohmmeter
2. The shunt ohmmeter
3. Ohmmeter calculations
4. The ohmmeter scale
   a. Characteristics
   b. Calibrating the ohmmeter scale

G. A commerical VOM

1. Circuit arrangement
2. Sensitivity
3. Scales
4. Use and care of the VOM

H. Wheatstone bridge

X. KIRCHHOFF'S LAWS AND APPLICATIONS

A. Superposition Theorem and Applications
B. Thevenin's Theorem and Applications
C. Norton's Theorem and Applications
D. Delta-Y and Y-Delta Transformations

XI. T, H, AND I NETWORKS

A. Bridge circuits
B. Pads and attenuators

XII. ELECTROMAGNETIC INDUCTION AND INDUCTANCE

A. Nature of the induced emf

1. Factors determining its magnitude, its direction
2. Faraday's law
3. Lenz's law

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

B. Inductance

1. Self-inductance
2. Mutual inductance
3. Calculating total inductance of

   a. Coils in series
   b. Coils in parallel

C. Current rise and fall in an inductive circuit

1. Pure inductance
2. Inductance containing resistance
3. Time constant in inductive circuit

D. Energy stored in a magnetic field

XIII. CAPACITANCE

A. Electric charge and the electric field
B. Capacitance
C. Electron theory of capacitor action on:

1. Charge
2. Discharge

D. Factors affecting capacitance

1. Plate area
2. Separation between plates
3. Dielectric

E. Unit of capacitance
F. Charge (Q) on a capacitor
G. Leakage resistance
H. Types of capacitors

1. Fixed capacitors and their applications in electronics

   a. Paper and molded tubular
   b. Mica
   c. Ceramic, disc, and molded ceramic (temperature coefficient)
   d. Oil
   e. Electrolytic

      1. Principle of operation
      2. Action of dielectric
      3. Forming voltage
      4. Wet and dry electrolytics
      5. Capacitor blocks
      6. A-C electrolytic

   f. Tantalum and other types

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

2. Variable capacitors and their use
   a. Controls
      1. Construction
      2. Capacitance range
      3. Ganged capacitors
   b. Trimmers
      1. Construction
      2. Capacitance range
3. Distributed capacitance of
   a. Wire
   b. Coils
   c. Stray and circuit capacitance

I. Voltage Characteristics of capacitors
   1. Nonelectrolytic
      a. Operating voltage
      b. Breakdown voltage
   2. Electrolytic
      a. DCWV
      b. Peak
      c. Surge
      d. Leakage current
      e. Temperature characteristics

J. Capacitor combinations
   1. Series arrangement
      a. Total capacitance
      b. The capacitive voltage divider
   2. Parallel arrangement--total capacitance
   3. Series-parallel combinations--total capacitance

K. RC time constant
   1. Direct current and voltage change versus time on capacitor charge
   2. Direct current and voltage change versus time on capacitor discharge
   3. Universal time-constant chart

L. Energy stored in a capacitor

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

M. Testing capacitors

1. Static tests (ohmmeter or capacitance bridge)

   a. Capacitance
   b. Shorts
   c. Opens
   d. Leakage

2. Dynamic tests using

   a. Capacitance tester for leadage or
   b. VTVM (voltage function) for leakage
   c. Open-short-intermittent checker

XIV. GENERATING ALTERNATING EMF

A. Simple rotating a-c generator and how it works
B. A-C cycle and how it is plotted
C. The Sine Wave and how it is used

1. Definition, sine of an angle
2. Generated a-c wave and its relation to the sine wave
3. Characteristics of sine wave

   a. Amplitude
   b. Frequency
   c. Period

4. Values of sinusoidal a-c voltage

   a. Instantaneous
   b. Peak and peak-to-peak
   c. Average
   d. RMS

5. Meaning of phase and phase angle
6. Phasor (vector) representation of sinusoidal alternating current

   a. Rotating vector--the phasor
   b. Phase relationships shown by phasors
   c. Vector notation
   d. Vector components
   e. Vector addition

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

D. A C Measurement

1. Oscilloscope operation--use for

a. Observing waveform
b. Measuring voltage (voltage calibration)
c. Checking frequency to

1. Comparison method
2. Lissajous patterns

2. A-C voltmeter, A-C ammeter

XV. RESISTANCE IN A-C CIRCUITS

A. Instantaneous current in a resistance
B. Power in a resistance
C. Inductance, Capacitance, and Resistance in A-C Circuits

1. Phase relationship between voltage and current in a pure inductance
2. Phase relationship between voltage and current in a pure capacitance
3. Nature of reactance and computation of:

a. X_L
b. X_C

4. Power in a reactance
5. Phasor representation of X_L and X_C
6. The j operator and complex algebra notation; use in a-c analysis

D. Impedance, Current, Voltage, and Power in A-C Circuits

1. Characteristics of impedance
2. Impedance diagrams
3. Calculation of impedance, phase current, and voltage series

a. Resistive circuit
b. RL circuit
c. RC circuit
d. RLC circuit

4. Conductance, susceptance, and admittance
5. Parallel a-c circuits--caluclation of:

a. Impedance
b. Current
c. Voltage
d. Equivalent series LCR circuit

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6. Power in a-c circuits
   a. True power
   b. Apparent power
   c. Power factor and power-factor correction
   d. Measuring power in a-c circuits
7. A-C resistance, skin effect
8. Circle diagram in series circuit
   a. With fixed R and variable reactance
   b. With fixed reactance and variable R
   c. Phase-shift circuits

XVI. USE OF A SIGNAL GENERATOR (TEST OSCILLATOR) AS A SIGNAL SOURCE

XVII. COILS IN A-C CIRCUITS

A. Low-frequency coils-relationship of L to number of turns, winding and core
B. High-frequency coils
   1. Air core
   2. Powdered iron core
   3. Variable core
C. Distributed capacitance of windings

XVIII. RESONANCE

A. Series resonant circuit
   1. Definition and resonant-frequency calculation
   2. Frequency-response characteristics of a series LCR circuit. Graph of:
      a. Z versus frequency
      b. I versus frequency
      c. Effect of R on I
   3. The half-power points and definition of bandwidth
   4. Q defined; formula
   5. Effect of Q on bandwidth
   6. Selectivity of a series resonant circuit
B. Parallel resonant circuit
   1. The ideal parallel resonant LC circuit (assuming no resistance)
      a. Resonant-frequency calculation
      b. Variation of Z and I versus frequency
      c. Q defined; formula and application

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2. The practical parallel resonant LCR circuit (with resistance)
   a. Definitions for resonant frequency
   b. Related formulas for resonant frequency
   c. Q of a parallel resonant circuit
   d. Parallel-resonance response curves for Z, E, and I
   e. Bandwidth and Q
   f. Selectivity of parallel resonant circuits

C. Determining the frequency-response characteristics of resonant (tuned) circuits
   1. Point-by-point measurement with a signal generator and oscilloscope
   2. Automatic plotting with a sweep generator and oscilloscope

D. Tuned circuits in electronics
   1. Coil tuned by its own and circuit capacitances
   2. Transmission line as a tuned circuit
   3. Cavity used as a tuned circuit
   4. Antenna as a tuned circuit
   5. Tuned circuits for frequency selection
   6. Tuned filter circuits

XIX. TRANSFORMERS

A. Mutual inductance and transformer action of
   1. Transformer with isolated winding
   2. Autotransformer

B. Characteristics
   1. Stepup and stepdown
   2. Leakage
   3. Reflected impedance
   4. Turns ratio
   5. Transformation ratio for E and I

C. Impedance matching and power transfer

D. Types of transformers--their differences and use in electronics
   1. Core type
   2. Power transformers
   3. A-F transformers
   4. Tuned transformers

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E. Transformer equivalent circuits
F. Frequency response
G. Transformer shielding
H. Transformer losses
I. Testing transformers

XX. PERIODIC NONSINUSOIDAL VOLTAGES AND CURRENTS

A. Harmonic content
B. Waveform characteristics
C. Circuit action

XXI. THREE-PHASE SYSTEM

A. Generation of three-phase voltages
B. Three-phase Y systems
C. Three-phase delta systems
D. Balanced and unbalanced

XXII. CODE AGENCIES AND CODES

A. N.E.C. - National Electric Codes
B. F.C.C. - Federal Communications Commission

1. FCC regulations
2. FCC standards

C. P.U.C. - Public Utilities Regulations
D. National Underwriters Laboratory
E. N.F.P.A. - National Fire Protective Association
F. O.S.H.A. - Occupational Safety and Health Act

XXIII. SEMICONDUCTOR PRINCIPLES

A. Structure of the atom

1. Nucleus and its charge
2. Planetary electrons: electron rings, free electrons and electrical conductivity, valence electrons and chemical activity

B. Energy levels of planetary electrons
C. Use of energy levels to explain electron motion in:

1. Insulator
2. Conductor
3. Semiconductor

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D. Semiconductor materials and structure

1. Germanium
2. Silicon

E. Adding impurities to semiconductors

1. Valence bond structure of pure germanium
2. Holes
3. Doping germanium with donor and acceptor impurities

a. N-type, its characteristics and energy levels
b. P-type, its characteristics and energy levels

F. Current carriers in N- and P-type semi-conductors

1. Majority carriers
2. Minority carriers

G. P-N junctions and potential barrier
H. Motion of current carriers in semiconductors

1. Holes
2. Electrons

I. Avalanche
J. Zener effect
K. Semiconductor Diodes

1. Crystal diodes

a. Construction: circuit symbol
b. Forward and reverse bias
c. Current--voltage characteristics
d. Diode ratings
e. Applications

2. Zener diodes

a. Construction; circuit symbol
b. Current--voltage characteristics
c. Ratings
d. Applications

3. Tunnel diodes

a. Construction; circuit symbol
b. Tunnel effect
c. Current--voltage characteristics
d. Applications

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XXIV. SOLID-STATE-DIODE LOGIC CIRCUITS

A. AND
B. OR

XXV. RECTIFIERS

A. Semiconductor

1. Silicon

a. Construction
b. Theory of operation
c. Characteristic curves

1. Forward current
2. Reverse or leakage current
3. Temperature effects
4. Voltage--resistance characteristic

d. Applications

XXVI. POWER SUPPLIES

A. Power-supply requirements for electronics

1. D-C voltages

B. Power transformers in a-c supplies

1. Current and voltage characteristics of

a. Primary winding
b. Secondary winding

2. Shielding of transformers

C. Rectification using R as load-no filter

1. Half-wave - Comparison of input and output

a. Voltage, waveforms
b. Current
c. Frequency

2. Full-wave - Comparison of input and output

a. Voltage, waveforms
b. Current
c. Frequency

3. Bridge rectifiers

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D. Filtering action and filters

1. Capacitor input

a. Operation
b. Effect of capacitor and inductor (choke) size on filtering action (type)
c. Effect of load on ripple
d. Regulation
e. Effect on regulation of adding more sections to filter (brute force)

2. Choke input

a. Effect on choke input on regulation and output voltage
b. When used

3. RC filters

a. Characteristics
b. When used

4. Bleeder resistor

E. A-C, D-C type power supply

1. Basic rectifier circuits
2. Use of protective resistors
3. Common rectifiers used in a-c, d-c supplies

F. Voltage doubler and tripler circuits and their characteristics

1. Half-wave
2. Full-wave

G. Maintenance problems

1. Common power-supply defects and their effects on output voltage

a. Defective rectifier
b. Defective input and output filter capacitors
c. Open or shorted choke or filter resistor
d. Defective power transformer, when used
e. Defective switch, fuse
f. Open line-cord or protective resistors
g. Short in external load
h. Line-voltage variations

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2. Locating the defect

    a. Voltage resdings
    b. Resistance readings
    c. Use of oscilloscope and a-c meter to detect and measure a-c ripple and voltage

XXVII. SILICON CONTROLLED RECTIFIERS (SCR)

A. Structure and use
B. Theory of operation

    1. Equivalent transistor arrangement
    2. Action of the gate

C. Characteristics and ratings
D. SCR-circuit applications
E. Silicon controlled switch (SCS)

    1. Structure and use
    2. Theory of operation

        a. Equivalent transistor arrangement
        b. Action of the two gates

    3. Characteristics and ratings
    4. Comparison with SCR
    5. Circuit applications

XXVIII. FIELD-EFFECT TRANSISTOR (FET)

A. Structure and use
B. Theory of operation
C. Characteristics, ratings, and applications
D. Unijunction transistor

    1. Structure and use
    2. Theory of operation
    3. Characteristics, ratings and applications

E. Backward diode

    1. Characteristics
    2. Applications

XXIX. INTEGRATED CIRCUITS

A. Need for microelectronic circuits
B. Developments which led to ICs

    1. Planar transistor technology
    2. Epitazial techniques
    3. Thin-film processes

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C. IC fabrication process

1. Processing the silicon wafer
2. Epitazial growth
3. Isolation masking
4. Diffusion cycles
5. Contacts for interconnections
6. Wafer dicing
7. IC packaging

D. Digital logic circuits from ICs

1. Direct-coupled transistor logic (DCTL)
2. Resistor-transistor logic (RTL)
3. Other logic methods

E. RTL logic block and basic logic circuits

1. AND logic
2. OR logic
3. NOT logic
4. NOR logic
5. NAND gate

F. Multivibrators derived from IC NOR gates

1. One-shot multivibrator
2. Schmitt Trigger
3. Ramp-function generator

G. IC linear amplifier circuits

XXX. AN ELECTRONIC SYSTEM--TRANSISTORIZED CATHODE-RAY OSCILLOSCOPE

A. The systems approach
B. From building block to system function
C. Transistorized CRO

1. Block diagram
2. Individual circuit function and operation

a. Vertical amplifier
b. Time-base generator
c. Synchronizing the time-base generator
d. CRT indicator circuits
e. Power supply

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XXXI. TRANSISTORS

A. Junction Transistors

1. Construction
2. Elements, their symbols and their functions
3. Grounded-base configuration
   a. Biasing--NPN and PNP types
   b. Control of current
   c. Current gain: A
   d. Voltage and power gain
   e. Characteristic curves
4. Grounded-emitter configuration
   a. Biasing and control of current
   b. Current gain: B
   c. Voltage and power gain
   d. Characteristic curves
5. Transistor equivalent circuits
6. Transistor as an amplifier
7. Hybrid parameters

B. Point-Contact Transistors

1. Construction
2. Operation
3. Gain
   a. Current
   b. Voltage
   c. Power

C. Transistor Properties

1. Frequency response
2. Noise factor
3. Power handling capabilities
4. Temperature considerations

D. Germanium versus Silicon Transistors

1. Comparison of properties
2. Applications of each

XXXII. TRANSISTOR DATA (MANUFACTURER'S SPECIFICATIONS)

A. Transistor defects and testing of transistors
B. Recent developments in transistor technology

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C. Techniques in handling transistors

1. Tools required
2. Temperature considerations
   a. Operating temperatures
   b. Heat-dissipation methods
3. Soldering in transistor circuits
   a. Preparation
   b. Use of heat sink
   c. Other considerations
4. Precautions in applying power to transistor circuits
   a. Forward biasing of emitter-base circuits
   b. Reverse biasing of collector-base circuits
   c. Preventing runaway
   d. Care in operating transistor within its rated characteristics
5. Measurements in transistor circuits
   a. Use of VTVM for voltage measurements
   b. Precautions in use of ohmmeter for resistance checks of transistor limitations of resistance measurements.
   c. Use of micromilliammeter and milliammeter for current measurements
   d. Use of oscilloscope in observing and measuring signal voltages

D. Transistor Components

1. Miniaturization
2. Capacitors
   a. Electrolytic
   b. Nonelectrolytic
3. Resistors
   a. Wattage
   b. Size
   c. Fixed and variable

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XXXIII. AMPLIFIERS

A. The Transistor Amplifier (grounded emitter)

1. Characteristic curves and transistor specifications
2. Operating point
3. Load line
4. Bias circuits and stablization
5. Equivalent circuit and gain equations
6. Input and output impedance

B. Grounded-Base

1. Circuits and operation
2. Load line and equivalent circuits
3. Characteristics

   a. Gain equations
   b. Input and output impedance
   c. Phase relationship between input and output signal

C. Grounded circuits (emitter-follower)

1. Circuits and operation
2. Equivalent circuits
3. Characteristics

   a. Gain equations
   b. Input and output impedance
   c. Phase relationship between input and output signals

D. Coupled Amplifiers

1. RC coupling
2. Transformer coupling
3. Impedance coupling
4. Direct coupling

E. Frequency-Response characteristics of amplifiers

1. Factors affecting frequency response
2. Equivalent circuits at:

   a. Low frequencies
   b. Mid frequencies
   c. High frequencies

F. Classes of amplifier operations and characteristics

1. Class A, AB, and AB_2
2. Class B
3. Class C

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G. Power Amplifiers

1. Class A operation
    a. Power calculations
    b. Distortion
    c. Push-pull operation and its characteristics
2. Power comparison (decibels)
3. Class B amplifier and its characteristics
4. Class C amplifier and its characteristics

H. Phase-Inverter circuits

I. Inverse feedback

1. Gain equation
2. Inverse feedback in tube amplifiers
3. Inverse feedback in transistor amplifiers
4. Effects of inverse feedback on:
    a. Circuit stability
    b. Distortion
    c. Frequency response
    d. Input impedance

J. Audio-frequency amplifiers (transistors)

1. Representative voltage amplifiers
2. Representative power amplifiers
3. The output transformer and its characteristics for:
    a. Transistors
4. The dynamic loudspeaker and its characteristics
5. Audio-amplifier controls
    a. Volume
    b. Tone
6. Techniques for determining amplifier frequency characteristics
7. Maintenance checks
    a. Transistors as a source of trouble
    b. D-C voltage measurements and interpretation
    c. A-C voltage measurements and interpretation
    d. Resistance analysis, measurements, and interpretation

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e. Signal substitution and signal tracing with:

1. Oscilloscope
2. Output meter

f. Checking distortion with an oscilloscope

g. Precautions in injecting signals into transistor circuits

1. Limitation in amplitude of signal current which may be injected
2. Manner in which signal may be coupled into circuit

8. Audio Amplifier applications-representative circuits

a. For hearing aids
b. For PA systems
c. For phonographs
d. For radio and television receivers

XXXIV. CODES

A. N.E.C. - National Electric Codes
B. F.C.C. - Federal Communications Commission

1. F.C.C. Regulations
2. F.C.C. Standards

C. P.U.C. - Public Utilities Regulations
D. N.U.L. - National Underwriters Laboratory
E. N.F.P.A. - National Fire Protection Association
F. O.S.H.A. - Occupational Safety and Health Act

XXXV. ALARMS

A. Fire alarm basics

1. Control panels
2. Normally-closed and normally-open contacts in initiating devices
3. Audible signal devices
4. Audible signla symbols
5. Audible signal circuits

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B. Types of Systems

1. Noncoded
2. Zoned noncoded
3. Remote station systems
4. Auxiliary services
5. Lock-in circuits
6. Battery standby systems

C. Alarm initiating devices

1. Manual
2. Automatic
3. Automatic fire detectors
4. Thermal detectors (fixed temperatures, rate of rise and rate compensation)
5. Fixed-temperature detectors
   a. Spot type (unit type)
6. Restorable detectors
7. Nonrestorable detectors
8. Line type
9. Rate of rise detectors

D. Combustion products (smoke) detector

1. Photoelectric detector
   a. Spottype (unit type)
   b. Ionization type
   c. Infrared detectors

E. Switches on automatic fire extinguishing systems

1. Water-flow switch on sprinkler system
2. Alarm switches on fixed extinguishing systems

F. Manual stations (breakglass or nonbreak-glass)

1. Boxes, fire alarm (non-coded)
2. Breakglass
3. Audible alarms
4. Bells
5. Horns
6. Chimes

G. Lamp annunciators

1. Back-lighted annunciators
2. Graphic annunciators

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H. Installation Instructions for fire alarm systems

1. Locations of components

a. Manual stations
b. Automatic fire detectors

2. Control panel
3. Alarm indicating devices

a. Audible devices
b. Visual devices

I. Power Supplies

1. Local fire alarm systems

a. Two-wire supplies
b. Three-wire supplies
c. Storage batteries

J. Installation wiring

1. Inside wiring
2. Low voltage applications
3. Limited-energy applications
4. System start-up procedures
5. Check of installation wiring
6. Test for shorts and open
7. Remote line resistor
8. End of line resistor on control panel
9. Alarm indicating device connected in series
10. Alarm indicating devices connected in parallel circuits
11. Polarized diode type alarm indicating devices connected in parallel circuits
12. Annunciator circuit

K. Test for grounds

1. Visual inspection
2. Check of power sources
3. Alternating-current systems
4. Normal operation (supervisory condition)

L. Supervision of circuits

1. Power supply circuits
2. Alarm initiating and indicating circuits
3. Fuses
4. Supplementary circuits
5. Annunciator circuits
6. Alarm operation
7. Jarring test

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M. Burglar Alarms

1. Types of alarms

   a. Rf wireless
   b. Access control
   c. Hard wire systems
   d. Audio monitoring
   e. Beta logic
   f. Sound detection
   g. Mechanical

2. Alarm control

   a. Central station
   b. Telephone
   c. Computor
   d. Local

3. Alarm sensors

   a. Ultrasonic
   b. Magnetic
   c. RF
   d. AF
   e. Motion

4. Component systems

   a. Alarm controls
   b. Dialers and communications
   c. Wireless alarm system
   d. Sensors, passive ultrasonic, mechanical
   e. Accessories and modules
   f. Alarm signals--bells, sirens, lights
   g. Power supplies and batteries
   h. Smoke detectors
   i. Access controls--apartment alarms

XXXVI. CABLE TV

A. Head-end equipment

1. VHF amplifier
2. UHF amplifier
3. All channel amplifier
4. Channel converter
5. Mixer-amplifier
6. Traps and filters

B. Distribution of the signal

1. Splitters
2. Tapoffs
3. Wall outlet
4. Cable termination
5. Balun units

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C. Distribution losses

1. Isolation
2. Insertion
3. Cable loss

D. Calculation of losses

1. Foam cable
2. Splitter
3. Tapoffs
4. Wall outlet
5. Balun unit

E. System with multitaps

1. Attenuation (100' of cable)
2. Insertion loss
   a. 2-way splitter
   b. 2 multitaps
3. Isolation loss
   a. Tapoff loss

F. System with single taps

1. Attenuation (100' of cable)
2. Insertion loss
   a. 4-way splitter
   b. Seven tapoffs
   c. Each tapoff

G. Decibel units

1. Power ratios
2. Voltage ratios
3. Reference levels
4. Adding and subtracting DB
5. Common DB valves
6. Decibel conversion charts

H. Codes

1. N.E.C. - National Electric Codes
2. F.C.C. - Federal Communications Commission
   a. FCC. Regulations
   b. FCC Standards
3. P.U.C. - Public Utilities Regulations
4. N.U.L. - National Underwriters Laboratory
5. N.F.P.A. - National Fire Protection Association
6. O.S.H.A. - Occupational Safety and Health Act

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XXXVII. SAFETY

A. Eye

1. Glasses
2. Shields

B. Correct Dress

1. Shoes
2. Hair
3. Clothing

C. Handling metal
D. Correct use of tools
E. Correct use of machines and equipment
F. Electrical precautions
G. Safety first and last

XXXVIII. CUSTOMER RELATIONS AND BUSINESS PRACTICES

A. Dress and appearance - first impressions

1. Clothing

a. Neat
b. Clean

2. Personal appearance

a. Cleanliness
b. Personal hygiene
c. Manners

1. Polite
2. Tactful

B. Courtesy to the customer

1. Telephone communication

a. Courteous
b. Sincere
c. Listen
d. Never argue, but stand on facts
e. Misunderstanding produces ill will

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2. Association in person

   a. Call customer by name
   b. Pronounce name correctly
   c. Efficient service
   d. Brief, thorough
   e. Satisfy complaint
   f. Enthusiasm about company
   g. Enthusiasm about product

C. Customer psychology

   1. Get the customer's story
   2. Agreement precludes disagreement
   3. Knowledge of product
   4. Ignorance kills customer confidence
   5. Show initiative

D. Business practices

   1. Maintain good records

      a. Customer files
      b. Service calls
      c. Time spent
      d. Parts used
      e. Billings
      f. Correspondence
      g. Inventory
      h. Service bulletins
      i. Cost (all costs)
      j. Taxes (all taxes)
      k. Gross income
      l. Net profit

E. Ethics

   1. Workmanship
   2. Parts cost
   3. Labor cost
   4. Overhead cost
   5. Promptness
   6. Contractual and implied obligations
   7. Customer consideration

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