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ABSTRACT

This combination progress record and course outline is designed for use by individuals teaching a course in avionics that is intended to prepare students for employment in the field of aerospace electronics. Included among the topics addressed in the course are the following: shop practices, aircraft and the theory of flight, electron physics, fundamentals of electricity, Federal aviation regulations, technical math, graphics, electrical circuits and systems, aircraft static and vacuum systems, aircraft pilot systems, semiconductor devices, power supplies, radios and radio transmission, test equipment and precision measurements, electronics, computers, computer programming, microprocessors, motors and generators, aircraft communication, navigation, flight control systems, and turbulence and flight collision avoidance. 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 for use in recording the individual student's mastery of each specific skill taught in the course. (MN)

PROGRESS RECORD

AND

THEORY OUTLINE

AVIONICS

DIVISION OF VOCATIONAL-TECHNICAL SCHOOLS

CONNECTICUT DEPARTMENT OF EDUCATION

1983-1984

PREFACE

The objective of this Assignment Book is to reduce unnecessary paperwork on the part of the shop instructor.

The Avionics Assignment Book accomplishes this by increasing the instructor's ability to plan and organize in advance and in keeping student records together and up to date.

A list of preferred hands-on exercises and experiments is included to be used at the discretion of the individual instructor.

This outline is not to be construed to be inflexible as to the material content or order of presentation.

GENERAL COURSE OBJECTIVES

Avionics is a program designed to provide vocational preparation for entry into the highly technical field of Aero-Space Electronics.

It provides both the theoretical background and the practical skills of servicing, installation, adjustments and troubleshooting techniques.

The course will develop in the student skills that are necessary to enter the Avionics field at the trainee level.

The program prepares the student for the Federal Communication Commission's General Radio-telephone Licensing examination.

PRIMARY OBJECTIVES

The student should be able to:

1. Demonstrate good safety practices at all times.
2. Use common hand tools and power tools of the trade.
3. Use basic electronic instruments.
4. Apply theories of electricity, electrostatics, electron physics, and magnetism.
5. Demonstrate elementary direct current circuits and their protective devices.
6. Demonstrate basic knowledge of aviation wiring practices and installation procedures.
7. Demonstrate a basic knowledge of technical math associated with Avionics.
8. Demonstrate a basic knowledge of drafting fundamentals, schematics, blueprints, and wiring diagrams associated with Avionics.
9. Know Avionic definitions and abbreviations including FAR Part 1.
10. Demonstrate a knowledge of basic alternating current, inductance, capacitance and resonance.
11. Use basic semiconductor and integrated circuit fundamentals.
12. Demonstrate a basic knowledge of aviation flight instruments.
13. Demonstrate a knowledge of aircraft electrical power generation and distribution.
14. Demonstrate a knowledge of fundamental electronic circuits.

15. Demonstrate a knowledge of fundamental digital circuits.

16. Demonstrate a knowledge of fundamental microprocessor circuits.

17. Demonstrate a knowledge of fundamental microprocessor interfacing.

18. Demonstrate a knowledge of operation of aviation type receivers and transmitters.

19. Demonstrate a basic knowledge of operation of aircraft electronics navigation devices.

20. Demonstrate a basic knowledge of operation of aircraft pulse and microwave systems.

21. Apply FAR PART 43.

22. Apply FCC regulations in regard to aviation.

23. Demonstrate a knowledge of aircraft flight control systems.

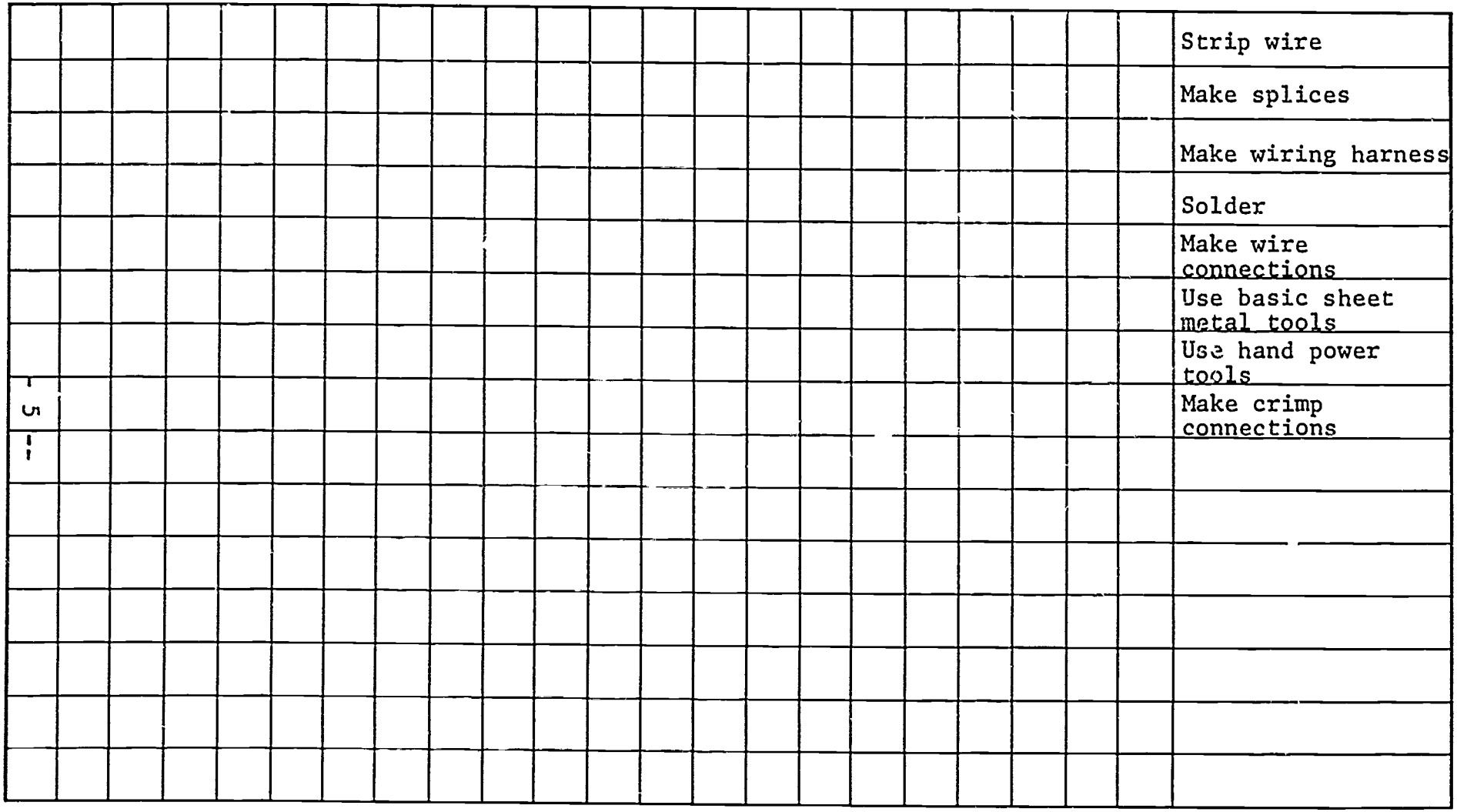
24. Demonstrate knowledge of emergency location transmitters.

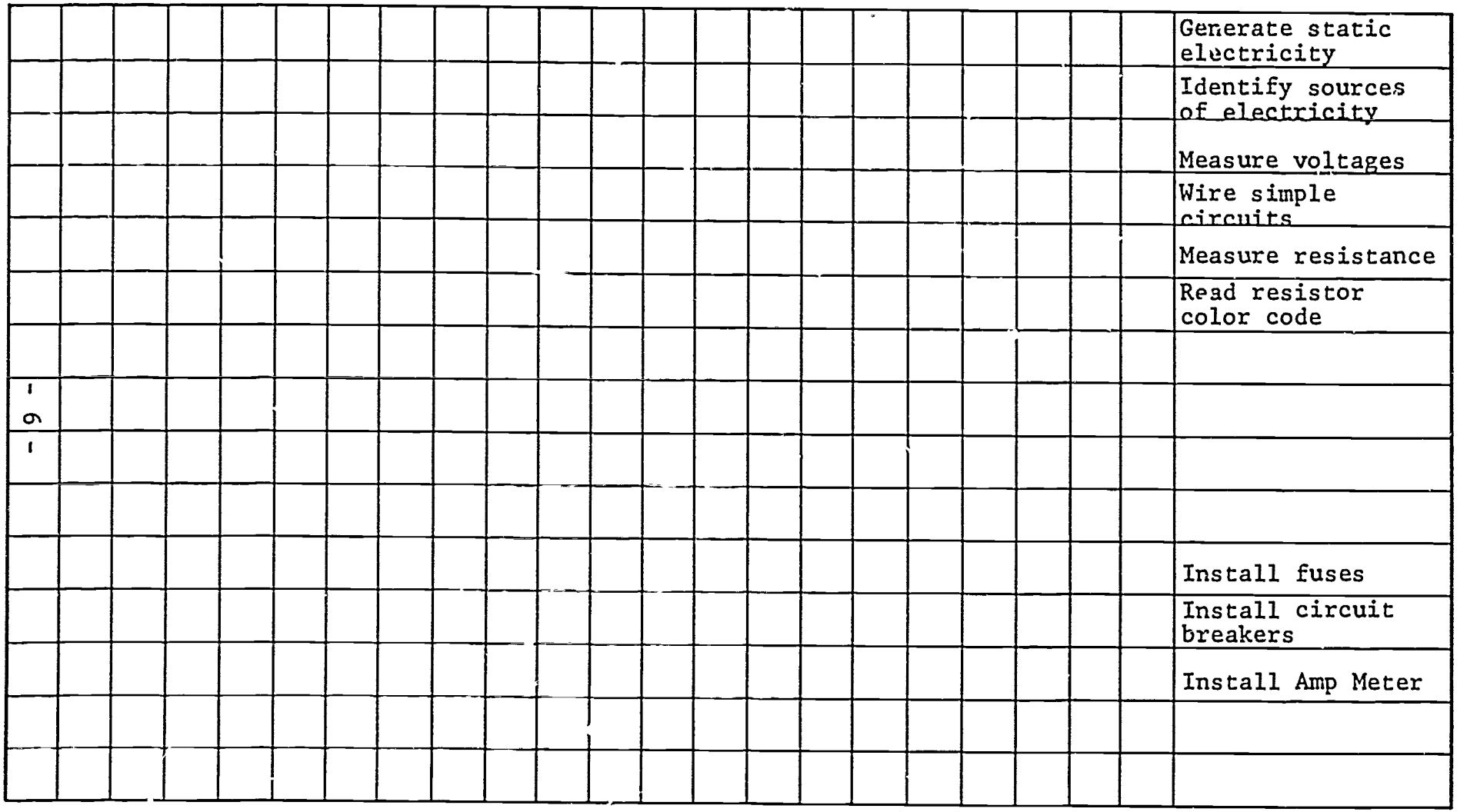
25. Demonstrate knowledge of VLF, LF and Loran Navigation systems.

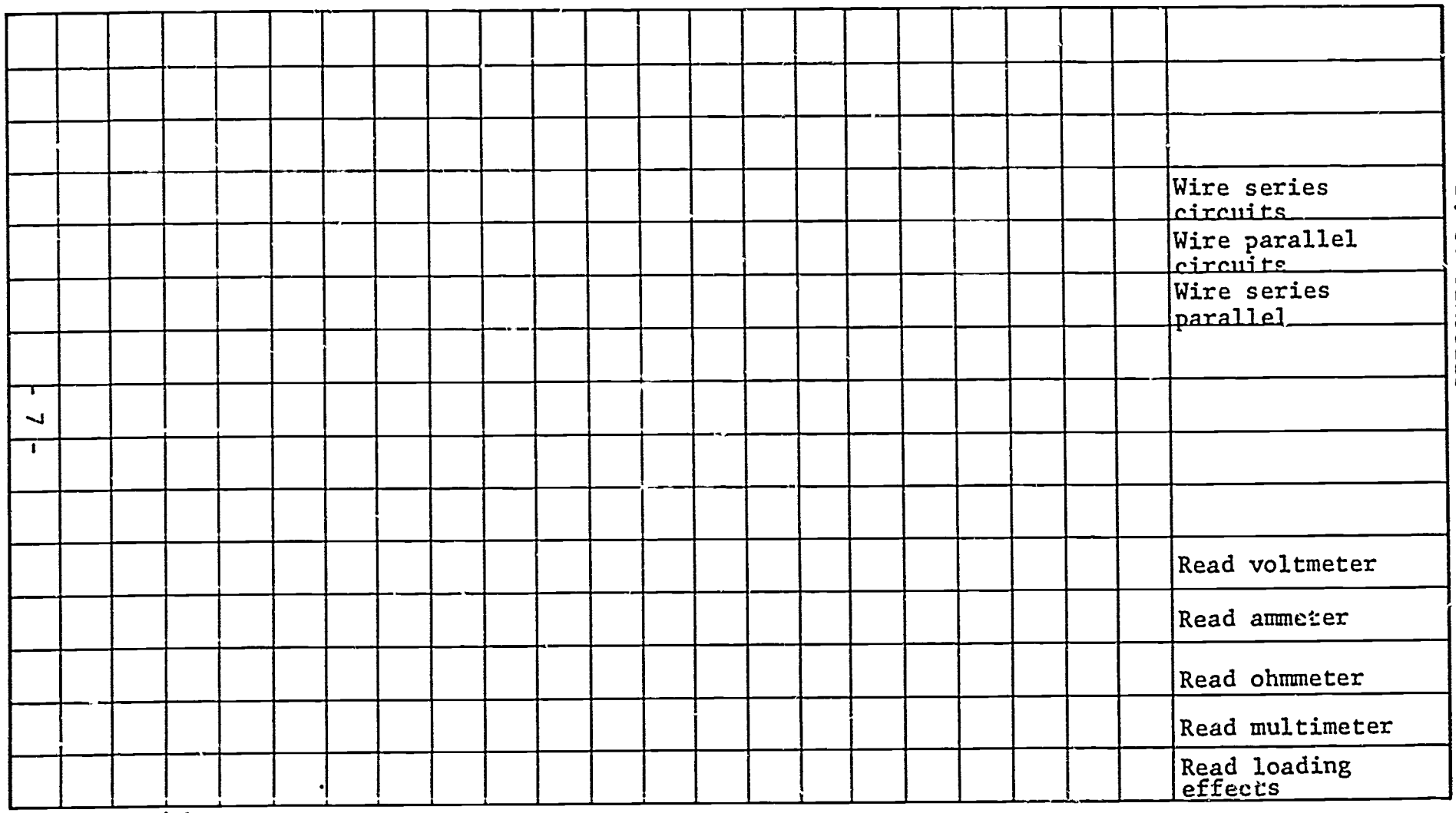
26. Demonstrate knowledge of Turbulance Avoidance Systems.

27. Demonstrate knowledge of Avionic transmission lines and antenna systems.

28. Demonstrate knowledge of air traffic control procedures for both VFR and IFR Flying.

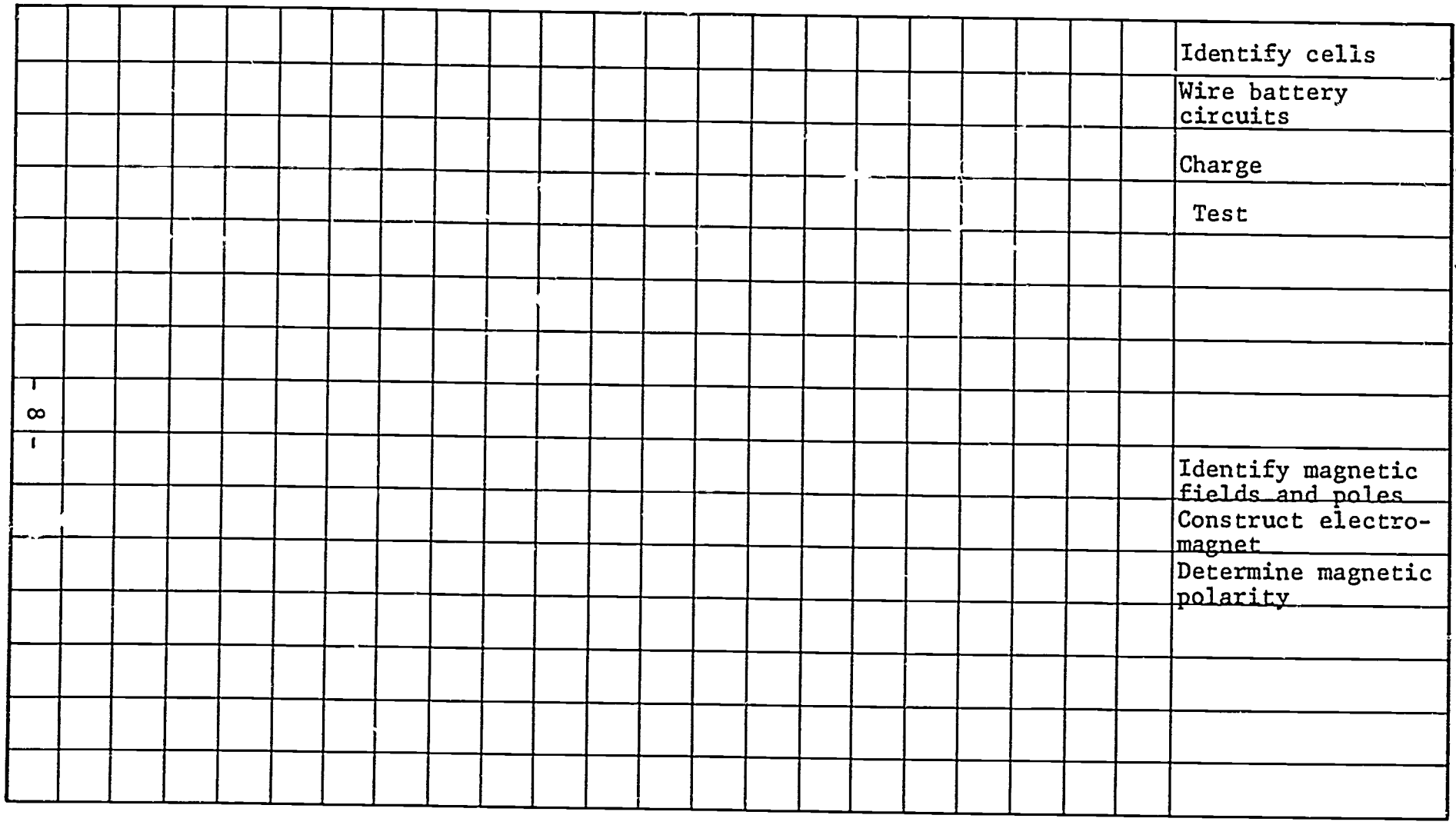

HAND SKILL
Strip wire
Make splices
Make wiring harness
Solder
Make wire connections
Use basic sheet metal tools
Use hand power tools
Make crimp connections
5

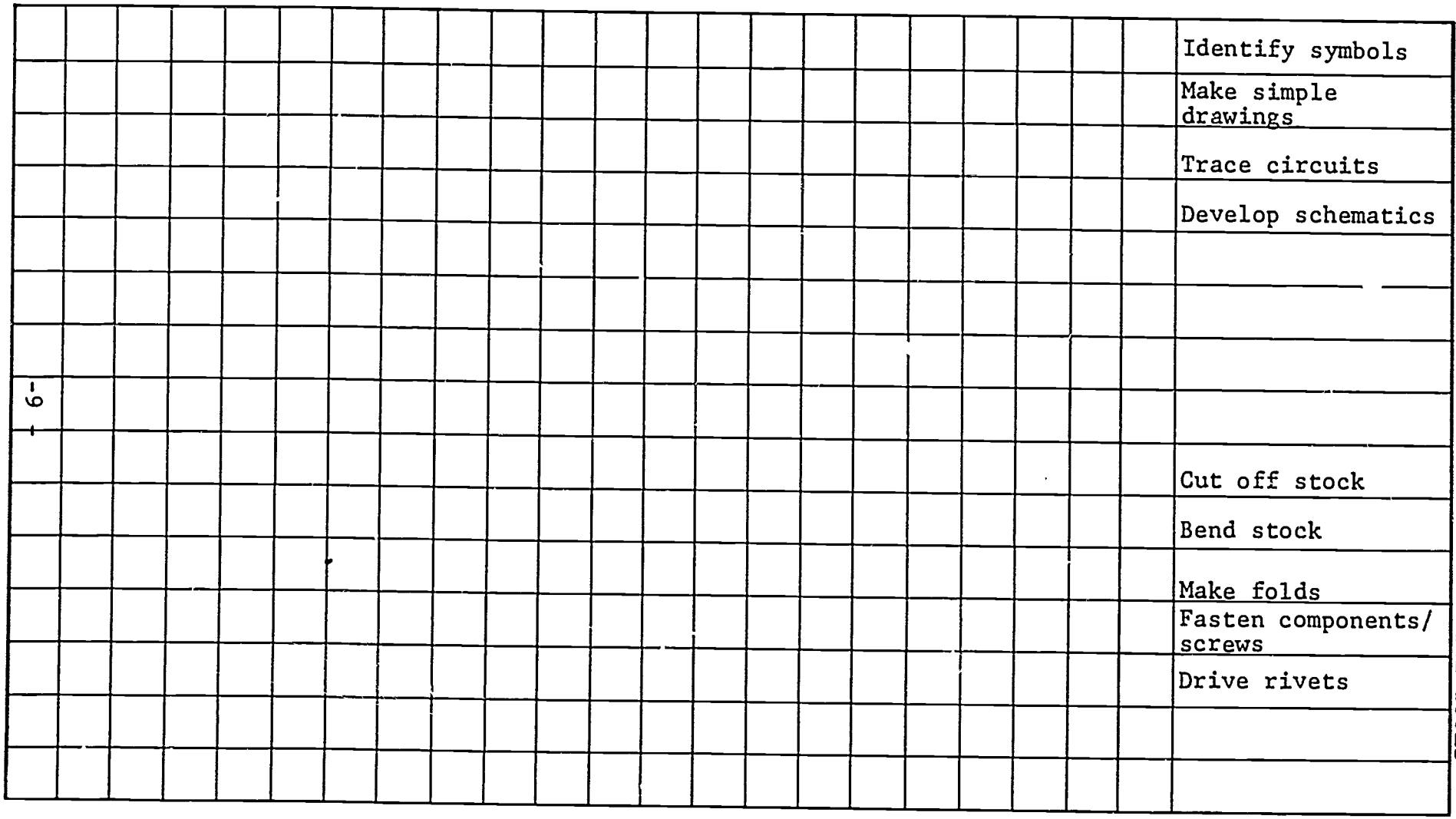

BASIC ELECTRICITY
Generate static electricity
Identify sources of electricity
Measure voltages
Wire simple circuits
Measure resistance
Read resistor color code
OVERCURRENT DEVICES
Install fuses
Install circuit breakers
Install Amp Meter

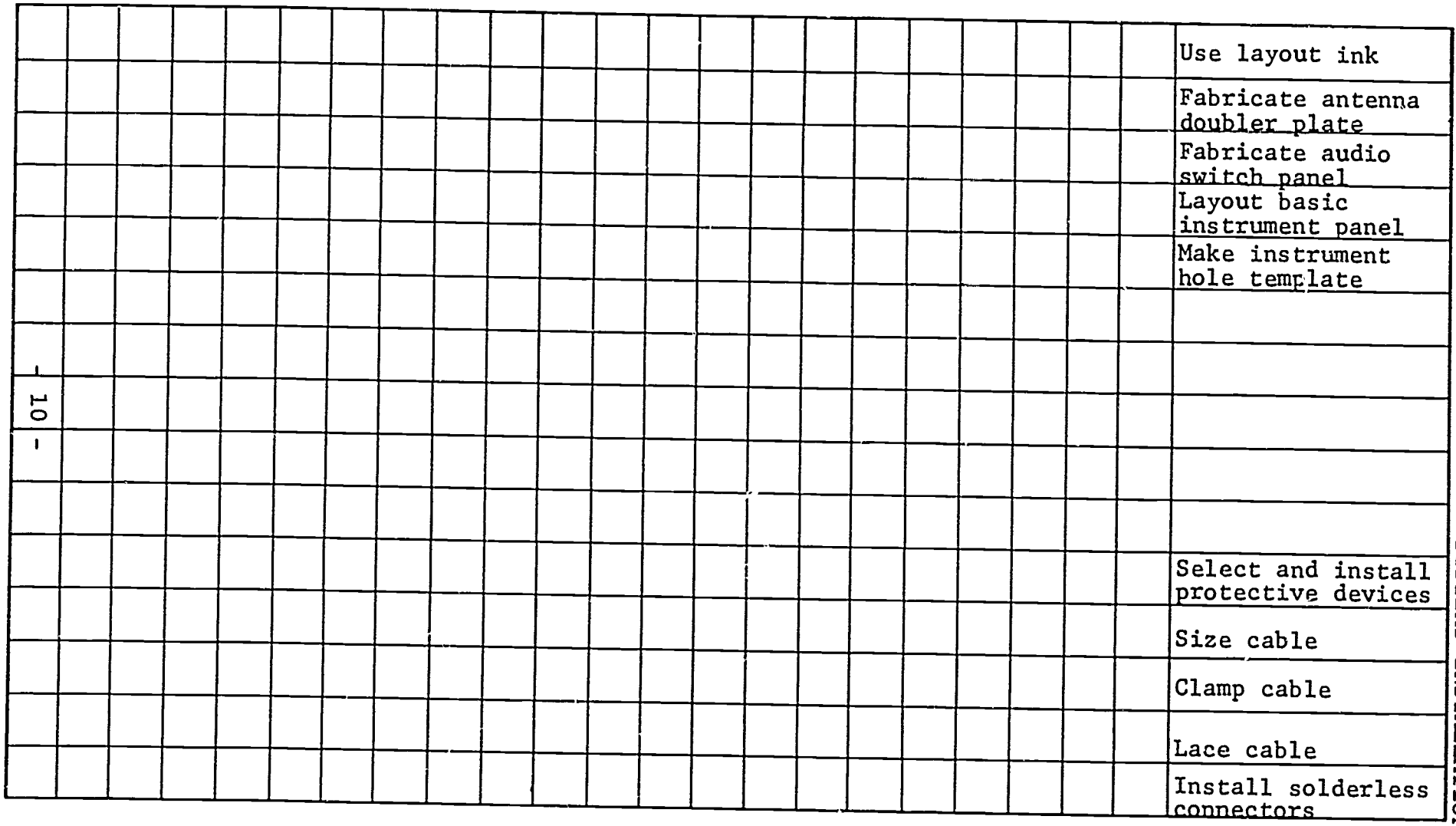

Wire series circuits
Wire parallel circuits
Wire series parallel
Read voltmeter
Read ammeter
Read ohmmeter
Read multimeter
Read loading effects
D. C. CIRCUITS
METERS

11

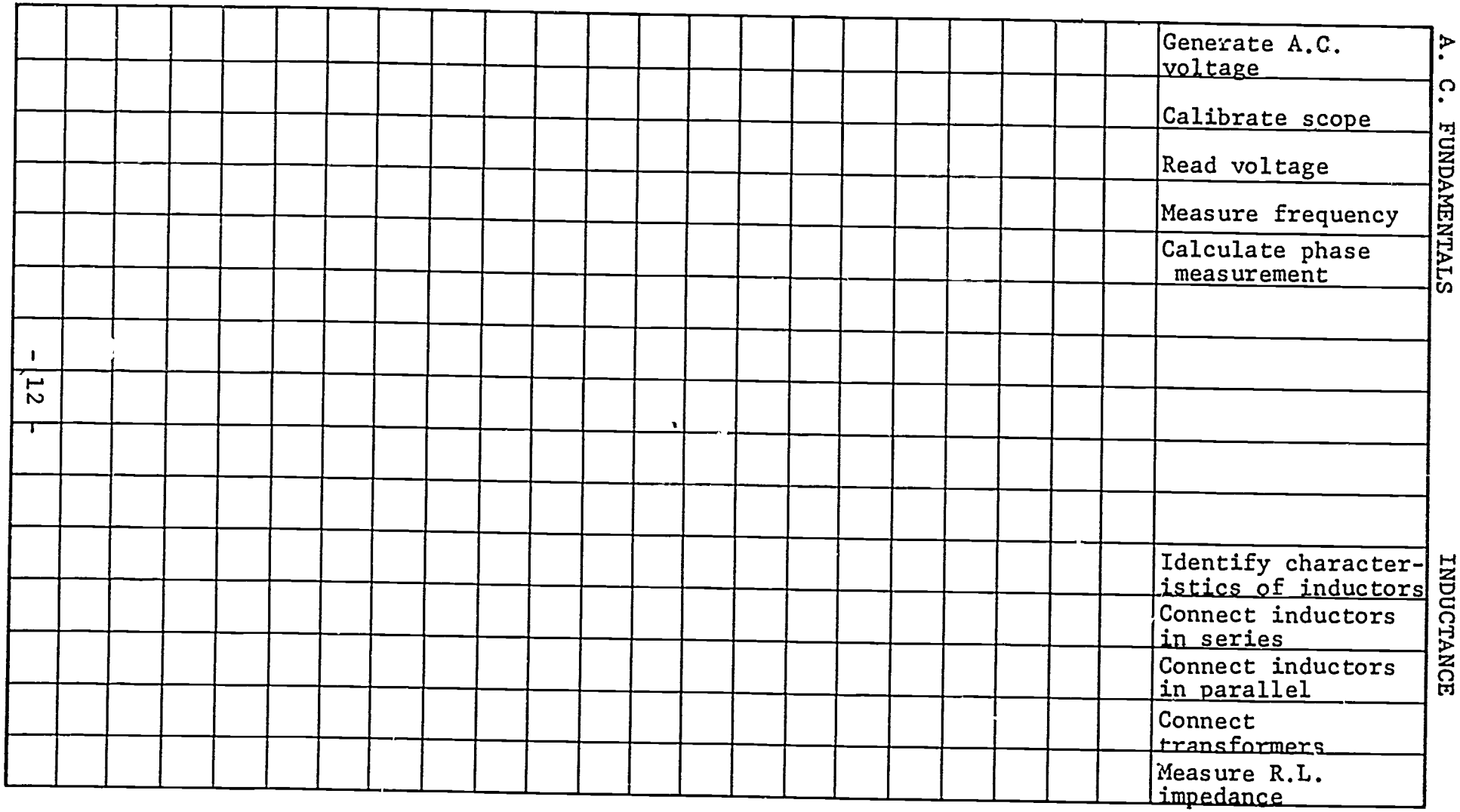
12

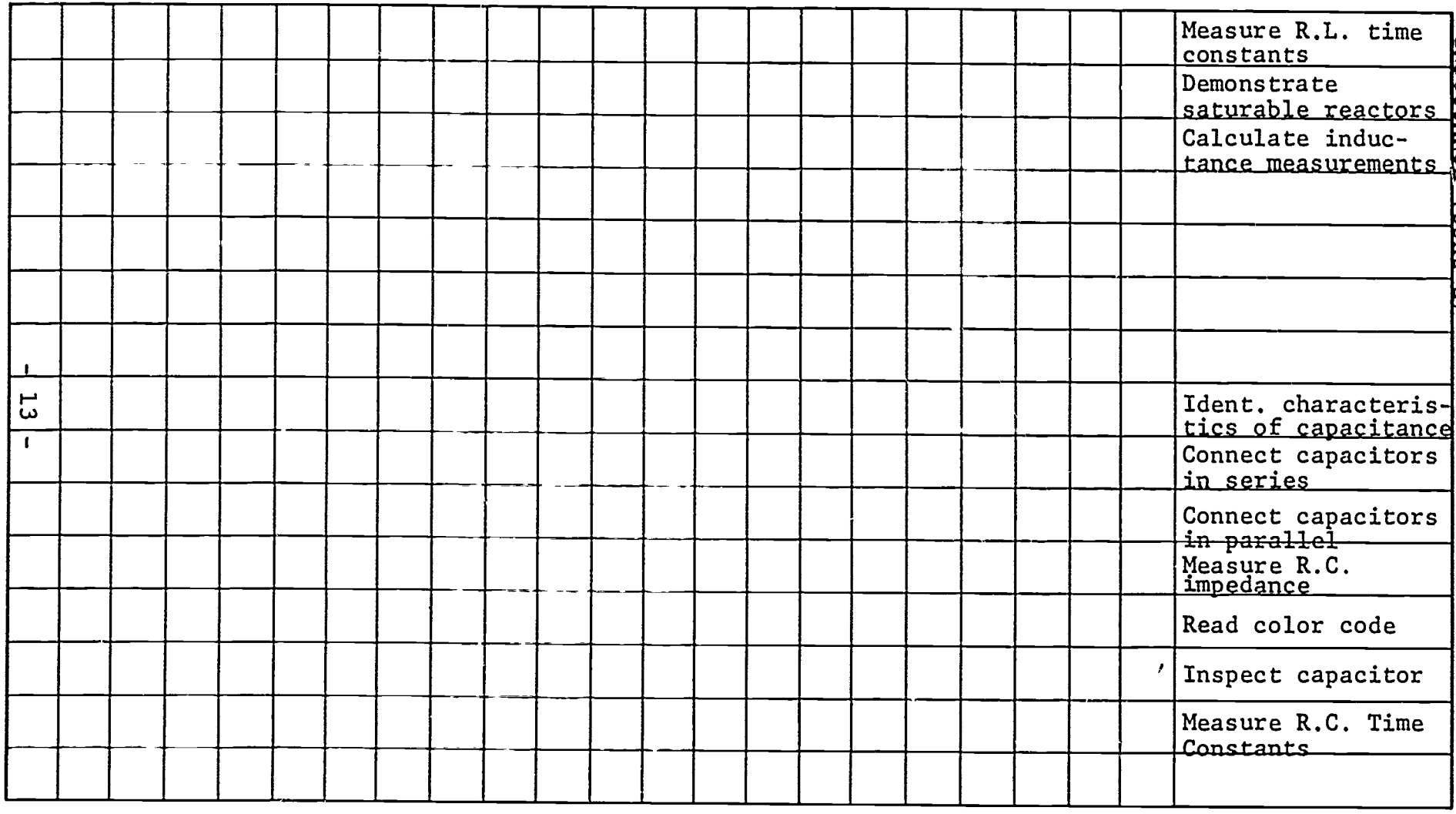

METERS (Cont'd)
Identify cells
Wire battery circuits
Charge
Test
MAGNETISM
Identify magnetic fields and poles
Construct electro-magnet
Determine magnetic polarity

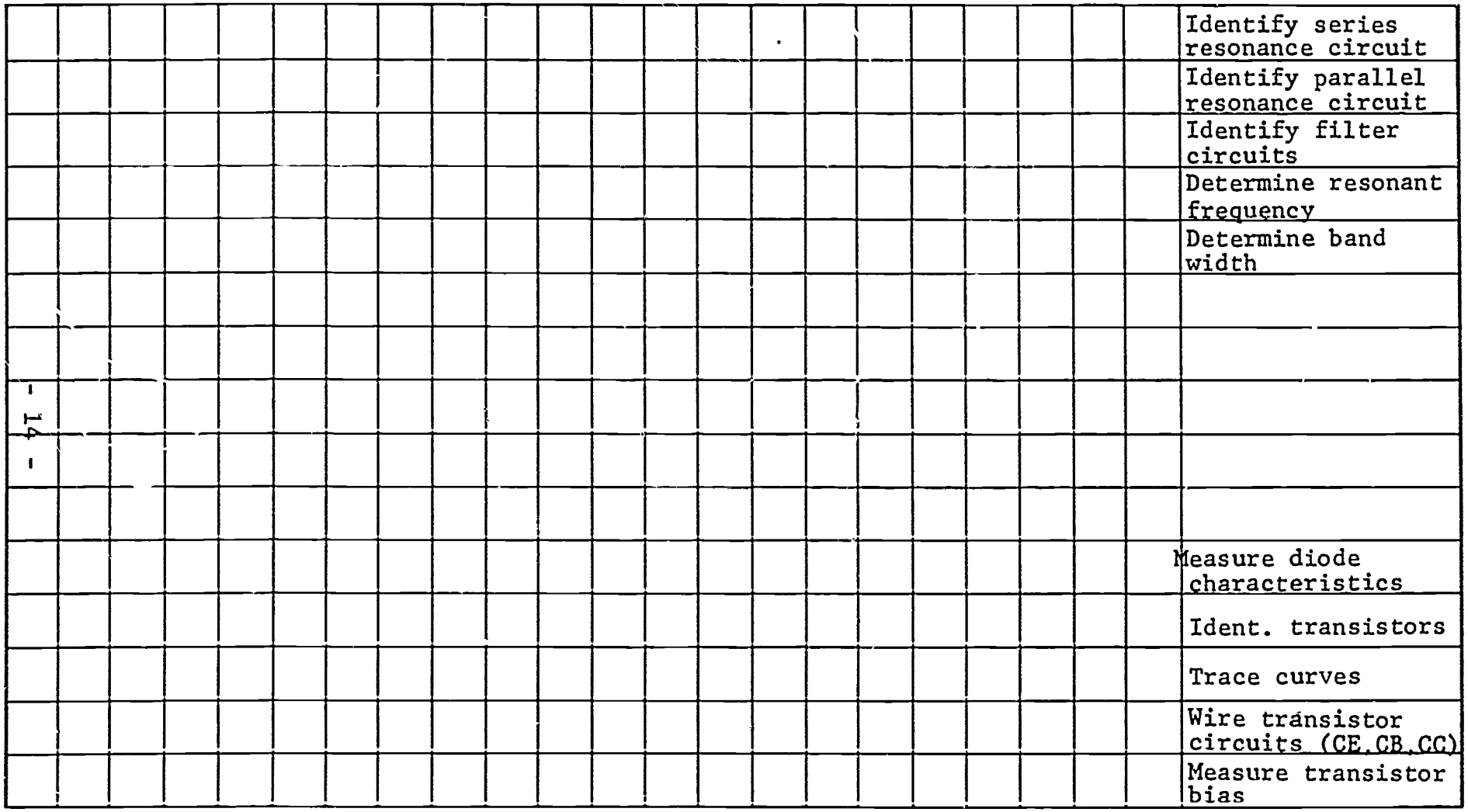

GRAPHICS
Identify symbols
Make simple drawings
Trace circuits
Develop schematics
AIRCRAFT SHEET METAL TOOLS
Cut off stock
Bend stock
Make folds
Fasten components/ screws
Drive rivets


AIRCRAFT SHEET METAL FABRICATION
AIRCRAFT ELECTRICAL SYSTEMS INSTALLATION
- 10 -
Use layout ink
Fabricate antenna doubler plate
Fabricate audio switch panel
Layout basic instrument panel
Make instrument hole template
Select and install protective devices
Size cable
Clamp cable
Lace cable
Install solderless connectors

Solder connections
Mount terminal strips
Install and remove crimp pins
Pot
Install switches
Bond
Shield
Make aircraft electrical ground connections


A. C. FUNDAMENTALS
INDUCTANCE
Generate A.C. voltage
Calibrate scope
Read voltage
Measure frequency
Calculate phase measurement
Identify characteristics of inductors
Connect inductors in series
Connect inductors in parallel
Connect transformers
Measure R.L. impedance

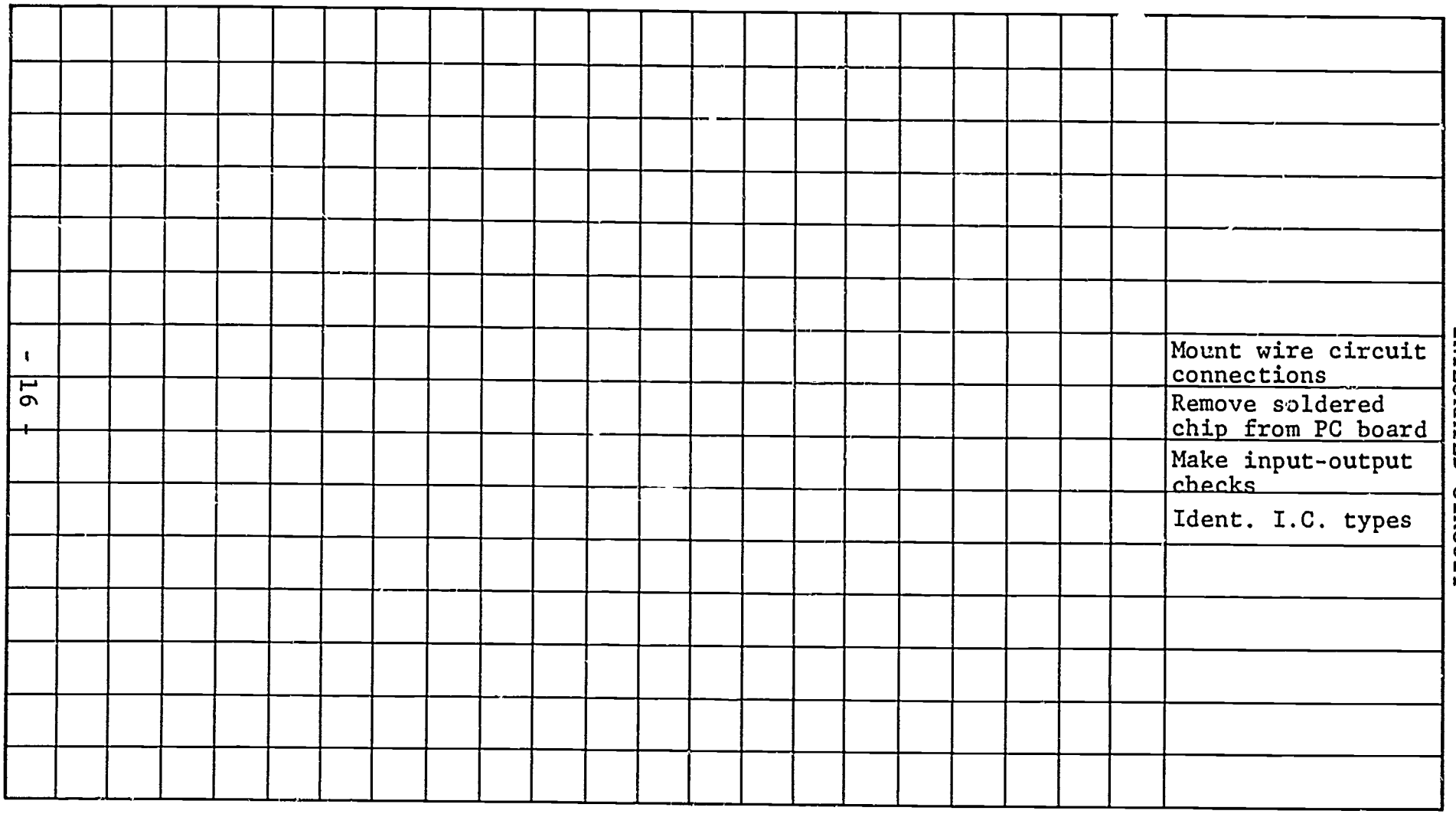

INDUCTANCE (Cont'd)
Measure R.L. time constants
Demonstrate saturable reactors
Calculate inductance measurements
CAPACITANCE
Ident. characteristics of capacitance
Connect capacitors in series
Connect capacitors in parallel
Measure R.C. impedance
Read color code
Inspect capacitor
Measure R.C. Time Constants



RESONANCE

SEMI-CONDUCTORS

																						Measure bias stabilization	SEMI-CONDUCTORS (Cont'd)
																						Field effect transistor	
																						Unijunction transistor	
																						Photo transistor	
																						Photo diode	OTHER SEMI-CONDUCTOR DEVICES
																						Tunnel diode	
																						SCR	
																						TRIAC	
																						Zener diode	
																						Thermistor	


- 16 -
Mount wire circuit connections
Remove soldered chip from PC board
Make input-output checks
Ident. I.C. types
INTEGRATED CIRCUIT

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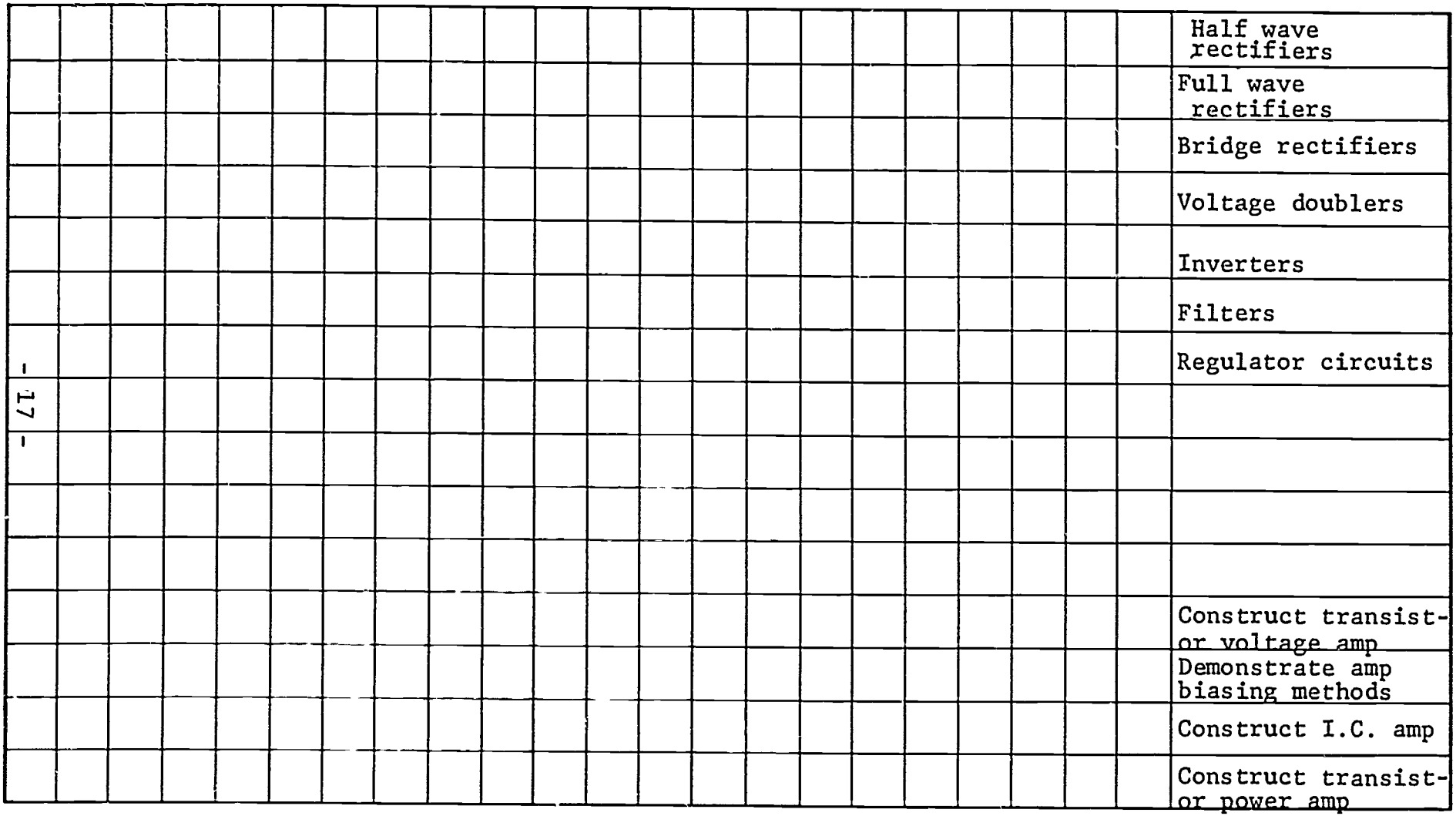
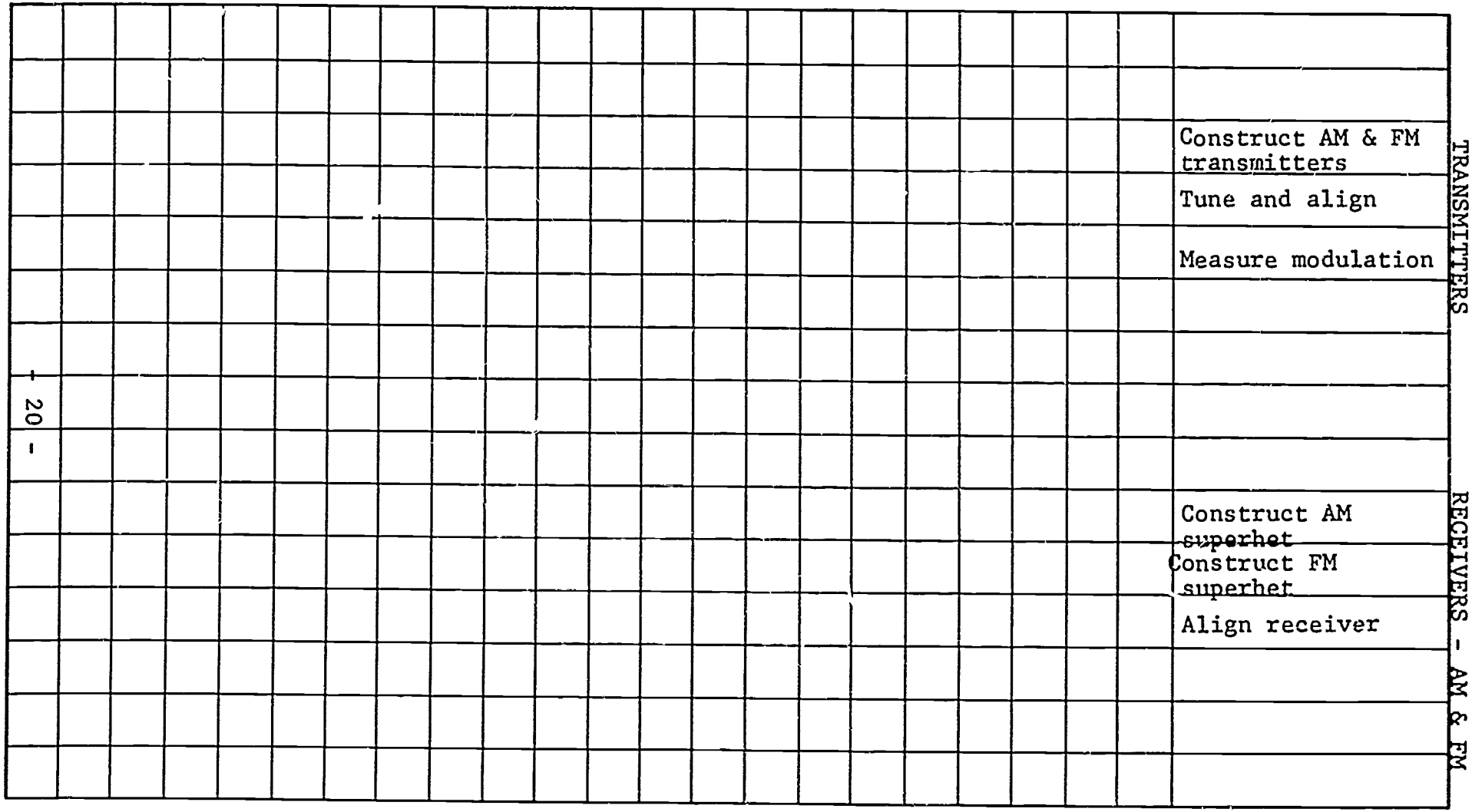

POWER SUPPLIES - CONSTRUCT
AUDIO AMPLIFIERS
Half wave rectifiers
Full wave rectifiers
Bridge rectifiers
Voltage doublers
Inverters
Filters
Regulator circuits
Construct transistor voltage amp
Demonstrate amp biasing methods
Construct I.C. amp
Construct transistor power amp

Demonstrate coupling methods
Construct phase splitters
Construct push/pull amp
Construct complimentary output stage
Construct symmetry type output stage
Construct R.F. amplifiers
Determine gain and frequency response
of R.F. amp.
Construct I.F. amp
Deter. band width & gain of I.F. amp.

																						Audio Frequency Oscillator	SINE WAVE OSCILLATORS = CONSTANT
																						P.F. Oscillator	
																						Determine wave length of antennas	ANTENNA-WAVE PRODIGATION
																						Test field strength	
																						Install V.O.R. antenna	
																						Install V.H.F. antenna	
																						Install ADF antenna	
																						Install glide slope antenna	


TRANSMITTERS
Construct AM & FM transmitters
Tune and align
Measure modulation
RECEIVERS - AM & FM
Construct AM superhet
Construct FM superhet
Align receiver
+ 20 -

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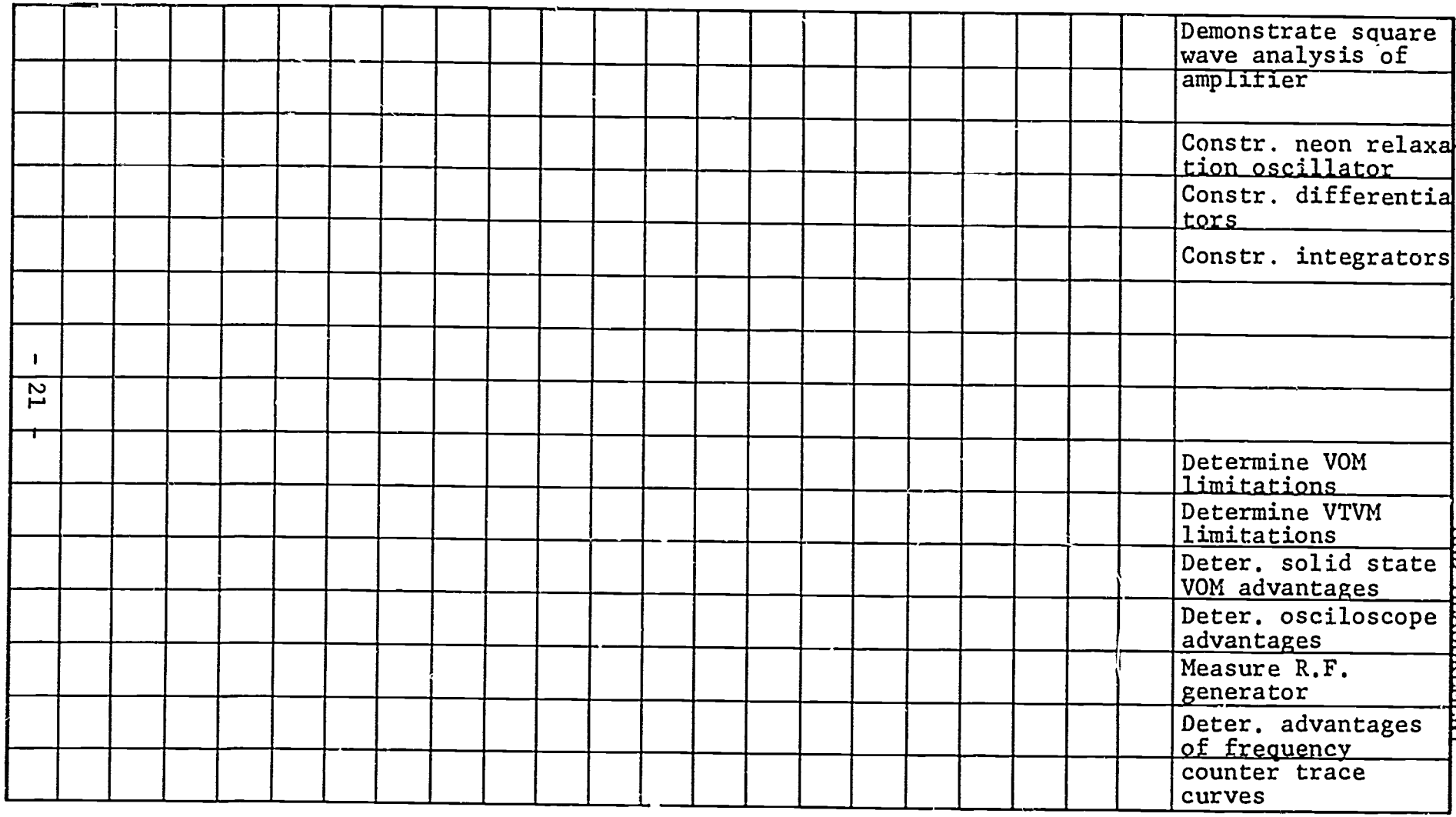
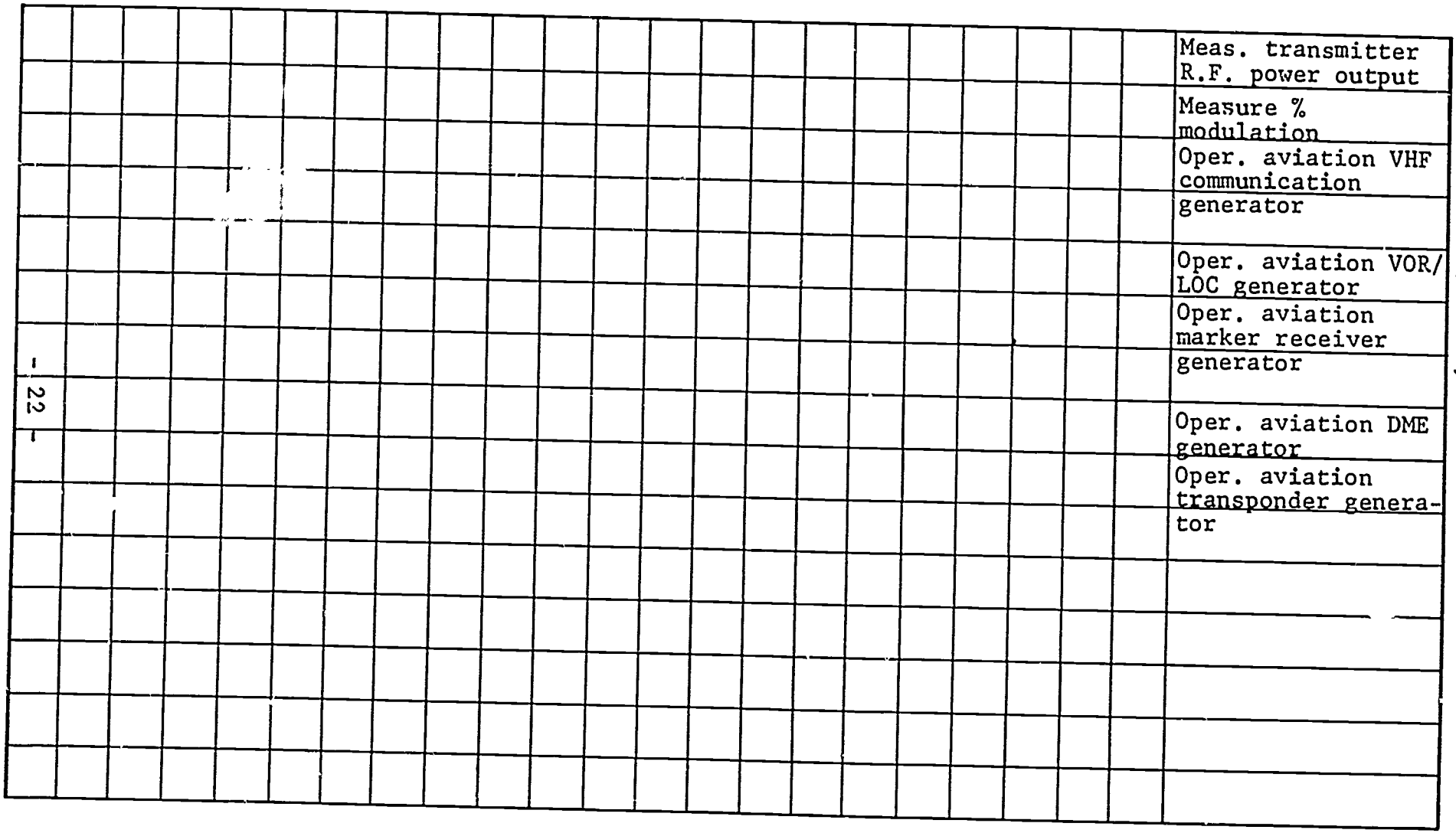
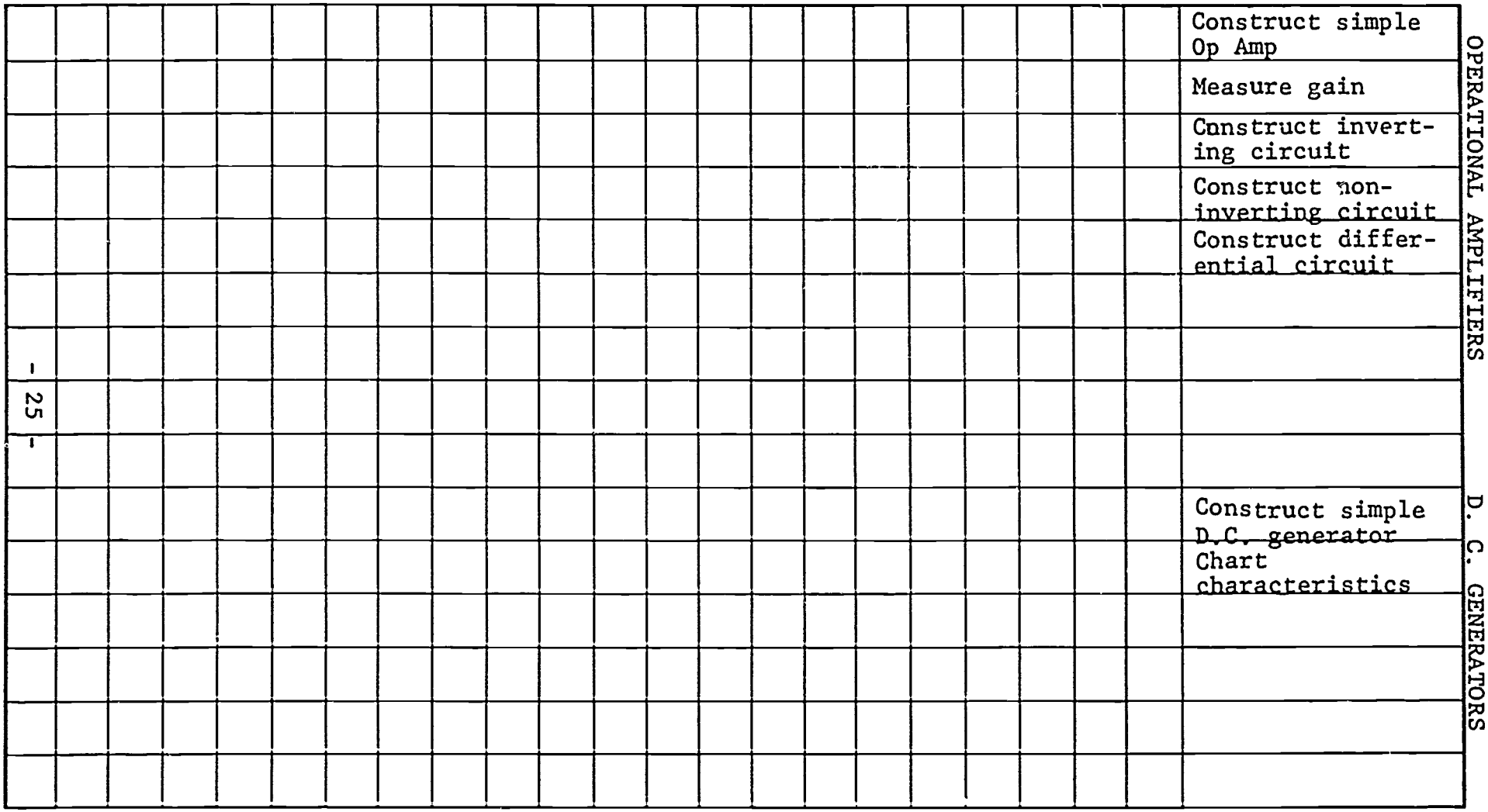
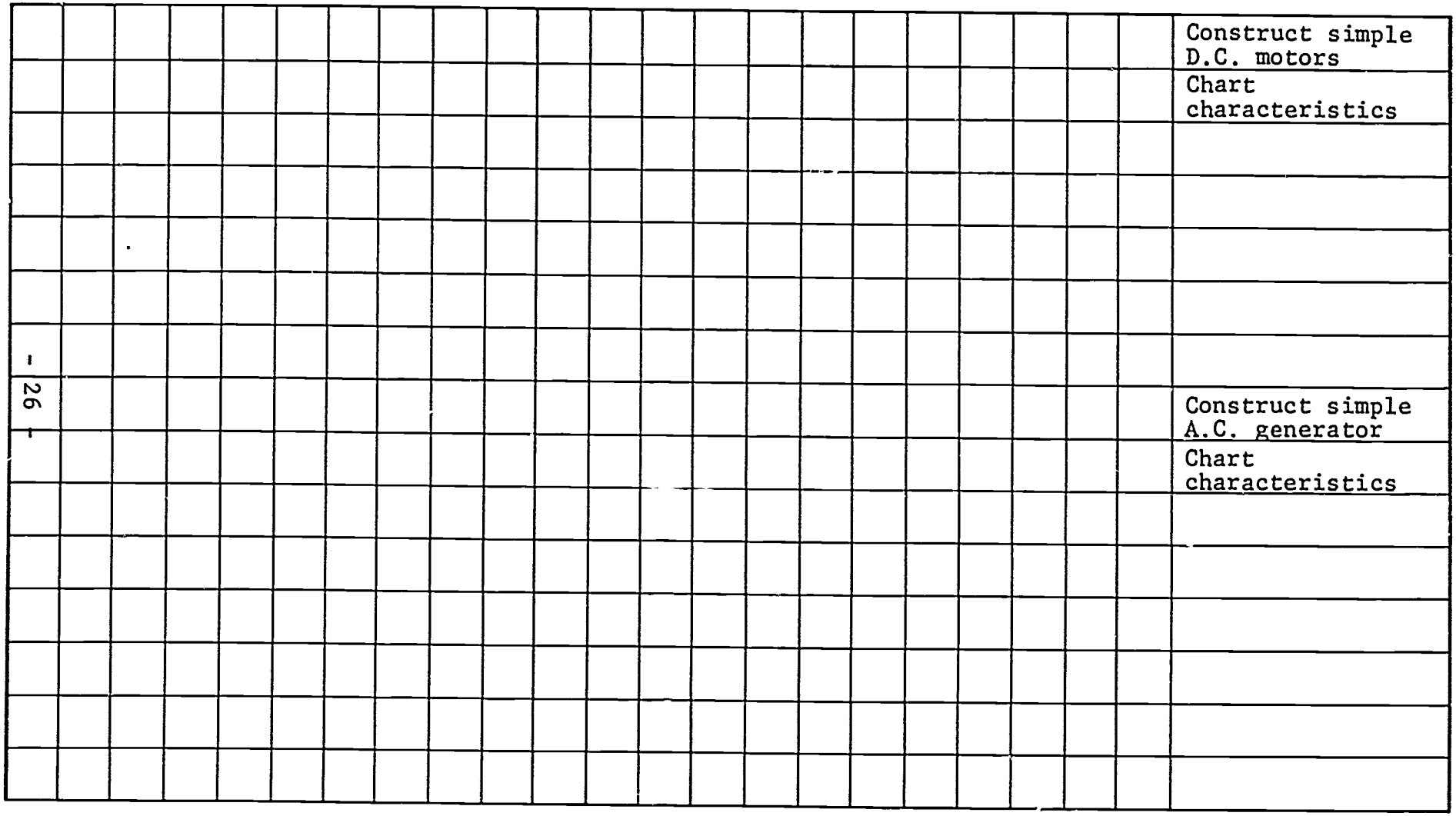

NON-SINUSOIDAL WAVE FORMS
TEST EQUIPMENT AND MEASUREMENT
Demonstrate square wave analysis of amplifier
Constr. neon relaxation oscillator
Constr. differentiators
Constr. integrators
Determine VOM limitations
Determine VTVM limitations
Deter. solid state VOM advantages
Deter. osciloscope advantages
Measure R.F. generator
Deter. advantages of frequency counter trace curves


TEST EQUIPMENT AND MEASUREMENT (Cont'd)
Meas. transmitter R.F. power output
Measure % modulation
Oper. aviation VHF communication generator
Oper. aviation VOR/LOC generator
Oper. aviation marker receiver generator
Oper. aviation DME generator
Oper. aviation transponder generator
- 22 -

Demonstrate saturated switch
Construct inverter circuit
Construct OR gate circuit
Construct NOR gate circuit
Construct NAND gate circuit
Construct astable multi-vibrator circuit
Construct mono stable multi-vibrator circuit
Construct bistable multi-vibrator cir.
Cemonstrate trig-gering techniques

	Recognize
	Apply digital-integrated circuits
	Apply input-output devices
	For future use, dependent on available training equipment


OPERATIONAL AMPLIFIERS
Construct simple Op Amp
Measure gain
Construct inverting circuit
Construct non-inverting circuit
Construct differential circuit
D. C. GENERATORS
Construct simple D.C. generator
Chart characteristics


D. C. MOTORS
A.C. GENERATORS
Construct simple D.C. motors
Chart characteristics
Construct simple A.C. generator
Chart characteristics
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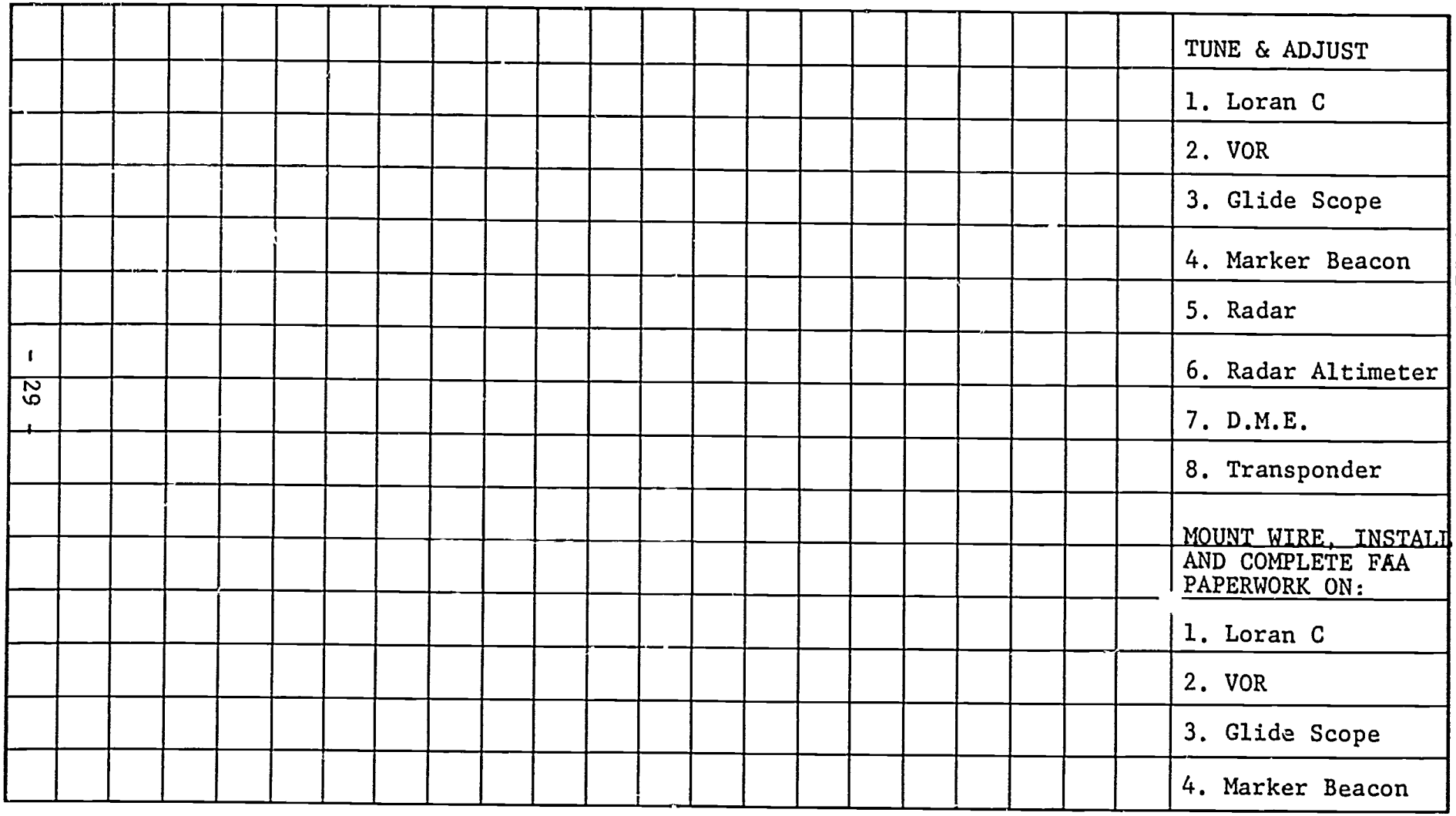
Construct simple A.C. motors
Chart characteristics
Tune & adjust VHF transmitter
Tune & adjust VHF receiver
Tune & adjust singlesideband transmitters
Tune & adjust singlesideband receiver

Mount wire, install and
complete FAA paperwork on:
1.VHF transmitter
2.VHF receiver
3. Singlesideband transmitter
4. Singlesideband receiver


TUNE & ADJUST
1. Loran C
2. VOR
3. Glide Scope
4. Marker Beacon
5. Radar
6. Radar Altimeter
7. D.M.E.
8. Transponder
MOUNT WIRE, INSTALL AND COMPLETE FAA PAPERWORK ON:
1. Loran C
2. VOR
3. Glide Scope
4. Marker Beacon

																						5. Radar	AIRCRAFT NAVIGATION (Cont'd)
																						6. Radar altimeter	
																						7. D.M.E.	
																						8. Transponder	
																						Adjust auto-pilot	FLIGHT CONTROL SYSTEMS
																						Adjust integrated flight systems	

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MAJOR UNITS OF THEORY

I. ORIENTATION
II. SHOP PRACTICES
III. AIRCRAFT FAMILIARIZATION
IV. THEORY OF FLIGHT
V. ELECTRON PHYSICS
VI. FUNDAMENTALS OF ELECTRICITY
VII. FEDERAL AVIATION REGULATIONS
VIII. TECHNICAL MATH
IX. GRAPHICS
X. D. C. CIRCUITS
XI. METERS
XII. BATTERIES
XIII. MAGNETISM
XIV. AIRCRAFT SHEETMETAL PRACTICES
XV. INSTALLATION OF ELECTRICAL SYSTEMS
XVI. A. C. FUNDAMENTALS
XVII. BASIC TRIGONOMETRY
XVIII. INDUCTANCE
XIX. CAPACITANCE
XX. RESONANCE
XXI. AIRCRAFT STATIC SYSTEM
XXII. AIRCRAFT PITOT SYSTEM
XXIII. AIRCRAFT VACUUM SYSTEM
XXIV. SEMICONDUCTOR DEVICES
XXV. OTHER SEMICONDUCTOR DEVICES
XXVI. POWER SUPPLIES
XXVII. AUDIO AMPLIFIERS
XXVIII. RADIO FREQUENCY AMPLIFIERS
XXIX. SINE WAVE OSCILLATORS
XXX. NON-SINOUSIDAL WAVEFORMS
XXXI. TRANSMITTERS
XXXII. RECEIVERS: AM AND FM
XXXIII. TEST EQUIPMENT AND PRECISION MEASUREMENTS
XXXIV. ANTENNAS AND WAVE PROPAGATION
XXXV. FCC REGULATIONS
XXXVI. INTEGRATED CIRCUITS
XXXVII. DIGITAL ELECTRONICS

XXXVIII. COMPUTERS

XXXIX. INTRODUCTION TO PROGRAMMING (SOFTWARE)

XXXX. MICROPROCESSORS (HARDWARE AND SOFTWARE)

XXXXI. OPERATIONAL AMPLIFIERS

XXXXII. TRANDUCERS

XXXXIII. MOTORS AND GENERATORS

XXXXIV. AIRCRAFT COMMUNICATIONS

XXXXV. AIRCRAFT NAVIGATION

XXXXVI. PULSE AND MICROWAVE SYSTEMS

XXXXVII. FLIGHT CONTROL SYSTEMS

XXXXVIII. TURBULANCE AVOIDANCE

XXXXIX. FLIGHT COLLISION AVOIDANCE

L. AIR TRAFFIC CONTROL PROCEDURES

THEORY OUTLINE

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

I. ORIENTATION

A. Occupational Analysis

1. Development of the Avionics Industry
2. Employment opportunities
3. Employment requirements and trade practices
4. Federal Aviation Administration
5. Federal Communication Commission

II. SHOP PRACTICES

A. Care and Use of Common Hand Tools

1. Safety

B. Care and Use of Air and Electric Power Tools

1. Safety

C. Wire Stripping, Splicing and Soldering Techniques

1. Safety

D. Safety Around Aircraft

1. Propeller
2. Fuel
3. Jet intake and exhaust
4. Helicopter blades and tail rotor
5. Aircraft wing and tail surfaces
6. Retractable gear

III. AIRCRAFT FAMILIARIZATION

A. Types

1. Fixed wing

a. Single
b. Multi
c. Glider
d. Ultra light

2. Rotor Craft

a. Helicopter
b. Autogyro

3. Lighter than air

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

B. Construction

1. Metal
2. Wood
3. Fabric
4. Fiberglass

C. Cockpit

1. Instrument panel
2. Controls
3. Cockpit safety

D. Power Plants

1. Piston
2. Turboprop
3. Turbine
4. Safety

IV. THEORY OF FLIGHT

A. Aircraft Controls

B. Forces on Airplane in Flight

C. Load Factors and Safety

V. ELECTRON PHYSICS

A. The Nature of Matter

1. States and forms of matter

a. Molecule
b. Atom
c. Compound
d. Element

B. Atomic Structure

1. Sub-atomic particles

a. Charges
b. Physical arrangement

2. Differences between atoms

a. Conductors and non-conductors
b. Stable and unstable atoms
c. Neutral atoms and ions

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

VI. FUNDAMENTALS OF ELECTRICITY

A. Electrostatics

1. Law of charges
2. Effect of distance on two charges
3. Electrostatic fields

B. Dynamic Electricity

1. Sources
2. Fundamental circuit factors
   a. EMF
   b. Current
   c. Resistance
   d. Power
3. Electrical units
   a. Coulumb
   b. AMP
   c. Volt
   d. Ohm
   e. Watt
   f. Mho
4. Use and care of meters
   a. Safety
   b. Volt meter
   c. Ohmmeter
   d. Ammeter
5. Fundamental Laws
   a. Ohm's Law
   b. Joule's Law
6. Simple circuits
   a. Shorts
   b. Opens
   c. Overloads
7. Resistance
   a. Types of resistors
   b. Power ratings
   c. Effects of length, diameter, material, temperature
   d. Circular mil foot
   e. Wire table
   f. Color code
   g. Tolerance

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

VII. FEDERAL AVIATION REGULATIONS

A. Part 1

B. Part 43

C. Part 65

D. Part 91

E. Part 145

VIII. TECHNICAL MATH

A. Signed Numbers

1. Addition
2. Subtraction
3. Multiplication
4. Division

B. Power of Ten

1. Positive and negative exponents
2. Common electronic prefixes

a. MEG, KILO, MILLI
b. MICRO, NANO, PICO

3. Multiplication and division

C. Electronic Calculator

1. Multiplication
2. Division
3. Square roots
4. Trig functions
5. Memory

IX. GRAPHICS

A. Drafting Fundamentals

1. Aircraft electrical symbols
2. Blueprints
3. Wiring diagrams

X. D. C. CIRCUITS

A. Series Circuits

1. Definition
2. Basic rules

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

B. Parallel Circuits

1. Definition
2. Basic rules
3. Effects on opens and shorts

C. Complex Circuits

1. Definition
2. Kirchoff's Law
3. Superposition
4. Bridge circuits

XI. METERS

A. Fundamentals of Meter Movements

B. D. C. Meter Circuits

1. Voltmeter circuits
2. Ammeter circuits
3. Ohmmeter circuits
4. Single and multi-range
5. Calculations of multiplier and shunt resistors

C. Loading Effects

XII. BATTERIES

A. Cells

1. Primary
2. Secondary

B. Types

1. Advantages
2. Disadvantages

C. Use and Care

1. Charging
2. Testing
3. Connecting in series and parallel

XIII. MAGNETISM

A. Fundamentals

1. Magnet and non-magnetic materials
2. Basic laws of magnetism
3. Strength
4. Magnetic fields
5. Coulomb's Law
6. Classification of materials

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

B. Electromagnetism

1. Definition
2. Fundamentals

a. Strength and direction
b. Left hand rule

XIV. AIRCRAFT SHEETMETAL PRACTICES

A. Tools

1. Floor and bench

a. Shears
b. Nibbling machine
c. Breaks
d. Band saw
e. Drill press

2. Hand air and electric power tools

a. Drills
b. Screwdrivers
c. Sheetmetal shears
d. Sabre saws
e. Grinders
f. Rivet tools

3. Hand tools

a. Hammers
b. Hand snips and shears
c. Mallets
d. Punches
e. Hand rivet set
f. Chisels
g. Dividers
h. Pliers
i. Rulers
j. Wire and sheetmetal gages
k. Hacksaw
l. Scribe
m. Files

4. Riveting

a. Types
b. Rivet code
c. Temper designation
d. Installing rivets

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

5. Riveting Practices

   a. Sizes
   b. Spacing
   c. Number of rivets required
   d. Dimensions
   e. Bucking bar
   f. Use of rivet gun
   g. Sheet fasteners
   h. Removing rivets

6. Special Rivets

   a. Need
   b. Types

XV. INSTALLATION OF ELECTRICAL SYSTEMS

A. Electrical System Requirements

1. General
2. Protective devices
3. Safety and emergency
4. Electrical load

B. Electrical Wiring

1. Cable characteristics
2. Cable size
3. Current carrying capacity
4. Requirements for open wiring
5. Cable lacing
6. Cable clamping
7. Routing of electrical cable
8. Electrical conduit

C. Connecting Devices

1. Cable terminals

   a. Crimp terminals
   b. Solder terminals
   c. Advantages and disadvantages

2. Connectors

   a. Solder connectors
   b. Crimp connectors
   c. Advantages and disadvantages

3. Electrical terminal strips

   a. Solder type
   b. Screw lug type
   c. Punch pin type

4. Potting

LESSON PLAN NO.	DATE SCHEDULED	DATE PRESENTED	DATE TESTED

D. Switches and relays

E. Circuit protecting devices

1. Fuses
2. Circuit breakers
3. Over voltage cutouts

F. Bonding and sheilding

G. Wire identification

1. Adhesive tape
2. Heat shrink tubing labels
3. Hot stamp labeling

H. Typical systems

1. Simple electrical systems
2. Alternator circuits
3. Battery and starter circuits

XVI. A. C. FUNDAMENTALS

A. Definition

B. Generation of AC

1. Lenz's Law
2. Left hand rule
3. Fundamental factors needed to generate a voltage
4. Factors determining the strength of induced E.M.F.
5. Terms

   a. Cycle, alternation, period
   b. Frequency, Hertz, wavelength
   c. Instantaneous, peak, and adverage
   d. Phase angle

6. Introduction to Oscilloscopes

   a. Basic operation
   b. Voltage measurements
   c. Frequency measurements
   d. Lissajous patterns
   e. Calibration
   f. Phase angle measurements

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XVII. BASIC TRIGONOMETRY

A. Angles
   1. Definition
   2. Types

B. Triangle
   1. Definition
   2. Types

C. Right Triangle
   1. Definition
   2. Hypotenuse
   3. Pythagorean Thorem
   4. Trigonometric functions
   5. Problem solving

D. Vectors
   1. Definition
   2. Use in electronics
   3. Problem solving

XVIII. INDUCTANCE

A. Inductance by AC

B. Lenz's Law

C. Impedance and reactance

D. Inductance in Series and Parallel

E. Mutual Inductance

F. R. L. Circuits, Series and Parallels

G. Power Factor

H. Time Constants

I. Q

J. Losses in Coils
   1. D.C. Resistance
   2. Effective Resistance
   3. Radiation Losses
   4. Effect of coil shields

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K. Transformers

1. Losses in transformers

a. Hysteresis
b. Eddy currents
c. Copper losses
d. Flux leakage

2. Efficiency

a. Coupling

L. Saturable Reactor

XIX. CAPACITANCE

A. Definition

B. Theory of Operation

1. Unit of measurement
2. Phase relation
3. Reactance
4. Dielectric constant

C. RC Circuits Series and Parallels

1. Impedance
2. Power factor

D. Losses in Capacitors

1. Resistance losses
2. Leakage
3. Dielectric hysteresis
4. Dielectric absorption

E. Time Constants

F. Capacitors in Series and Parallel

1. Total capacitance
2. Working voltage

G. Types of Capacitors

1. Advantages
2. Disadvantages

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XX. RESONANCE

- A. Series and Parallel
- B. Vector Analysis
- C. Q
- D. Bandwith
- E. Applications
  - 1. Filter circuits
    - a. Highpass
    - b. Lowpass
    - c. Pi type
    - d. Band pass
    - e. Band elimination

XXI. STATIC SYSTEMS

- A. Static ports
- B. Plumbing techniques
- C. Instruments
  - 1. Altimeter
  - 2. Vertical air speed
  - 3. Encoding altimeter
  - 4. Autopilot altitude hold chamber
  - 5. Air speed
  - 6. Alternate air source
  - 7. Required tests
- D. Safety

XXII. PITOT SYSTEM

- A. Pitot tube
  - 1. Function
  - 2. Pitot tube heat
- B. Plumbing techniques
- C. Instruments
  - 1. Airspeed
  - 2. Flight directors
- D. Safety

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XXIII. VACUUM SYSTEMS

A. Sources

1. Venturi
2. Pump

B. Instruments

1. Attitude gyro
2. Directional gyro
3. Turn coordinator

C. Warning Indicators

1. Gauges
2. Mechanical indicators
3. Lights

XXIV. SEMICONDUCTOR FUNDAMENTALS

A. Introduction

B. Atomic Structure

C. Conductors, Insulators and Semiconductors

D. Introduction to Crystals

E. Semiconductor materials

F. Current Carriers

G. The PN Junction

H. Diode Action

I. Introduction to Transistors

J. Manufacturing Process

K. Transistor

L. Forward and Reverse Bias

M. Comparison to Vacuum Tubes

N. Transistor Testers

1. Use and care of
2. Limitations
3. Transistor troubles

O. Transistor Curve Tracers

1. Use and care of
2. Interpreting manufacturer's specifications

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P. Common Base Amplifier
Q. Common Collector Amplifier
R. Common Emitter Amplifier
S. Transistor Circuit Parameters
T. Transistor Bias Stabilization
U. Power Transistors
V. Other Transistor Types
    1. FET
    2. Surface Barrier
    3. Unijunction
    4. MESA
    5. Epitaxial
    6. Photo

XXV. OTHER SEMICONDUCTOR DEVICES

A. Photo Diodes
B. Tunnel Diodes
C. Silicon Controlled Rectifiers
D. Triacs
E. Zener Diodes
F. Thermistors

XXVI. POWER SUPPLIES

A. Half-wave
B. Full-wave
C. Bridge
D. Voltage Doublers
E. Positive and Negative Supplies
F. Filters
G. Voltage Dividers
H. Voltage Regulator Circuits
I. Voltage Regulator Devices
J. DC to AC Inverters

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XXVII. AUDIO AMPLIFIERS

A. Voltage Amplifiers

1. Basic operation
2. Classes of operation
3. Coupling methods
4. Biasing methods
5. Response curve
6. Distortion
7. I. C. Amplifiers

B. Power Amplifiers

1. Purpose
2. Output stages
3. Tone controls
4. Decibles

XXVIII. RADIO FREQUENCY AMPLIFIERS

A. R. F. Losses
B. Functions of R.F. Amplifiers
C. Typical RF Amplifiers
D. Coupling methods
E. Shunt damping
F. Grounded base
G. Cascode
H. Cascade
I. Wire Band Amplifiers
J. Mechanical Filters
K. Crystal Filters
L. I. F. Amplifiers

XXIX. SINE WAVE OSCILLATORS

A. Oscillator Requirements
B. Oscillator Operation
C. Phase-shift Oscillators
D. Tickler-coil Oscillators
E. Colpitts Oscillator
F. Electron-coupled Oscillator
G. Tuned-grid, Tuned-plate Oscillator
H. Crystal Oscillator

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XXX. NON-SINOUSIDAL WAVEFORMS

A. Harmonics
B. Square Wave
C. Rectangular Wave
D. Wawtooth Wave
E. Triangular Wave
F. Trapezoidal Wave
G. Staircase Wave
H. Differentiated Waveforms
I. Intergrated Waveforms
J. Transients
K. Pulses

XXXI. TRANSMITTERS

A. Transmitters Requirements
B. Buffer Amplifiers
C. Frequency Multiplier Circuits
D. Transmitter Tuning
E. Neutralization and Parasitic Suppression
F. Transmitter Keying
G. Amplitude Modulation
H. Frequency Modulation
I. Pulse Modulation
J. R-F Power Amplifiers

XXXII. RECEIVERS, AM and FM

A. General Requirements
B. TRF Receiver
C. AM Superhetrodyne Receiver
D. FM Superhetrodyne Receiver
E. Receiver Alignment

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XXXIII. TEST EQUIPMENT AND PRECISION MEASUREMENTS

A. Introduction to Standardized Calibration

1. National Bureau of Standards

a. Measurement Nomenclature

1. Absolute
2. Secondary
3. Working standards

B. Basic Standards and Measurements

C. Operational Standards and Calibration

1. Volt-Ohm-Milliameter
2. Vacuum tube voltmeter
3. Solid state voltmeter
4. L-C-R Measurements
5. Oscilloscopes
6. All purpose signal generators
7. Aviation signal generators
8. Tube and semiconductor testers
9. Miscellaneous test instruments

XXXIV. ANTENNAS AND WAVE PROPAGATION

A. Electromagnetic Waves

1. Frequency Spectrum

B. Antenna Types

1. Longwire
2. Whip
3. Broadband
4. Electronic

XXXV. FCC REGULATIONS

A. Licensing Requirements

1. Personnel
2. Station

B. Performance Standards

1. Frequency tolerance
2. Percent modulation

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XXXVI. INTEGRATED CIRCUITS

A. Introduction

B. Circuit Density

1. Medium scale integration (MSI)
2. Large scale integration (LSI)
3. Very large scale integration (VLSI)

C. Classification

1. Linear
2. Digital

D. Types

1. Bipolar
   a. TTL
   b. Schottky
   c. ECL
2. Unipolar
   a. MOS
   b. NMOS
   c. PMOS
   d. CMOS

E. Physical Characteristics

1. Pin out
   a. TO-5
   b. DIP
   c. Flat pack
2. Handling
   a. Mechanical
   b. Soldering
   c. Static

F. Circuit Characteristics

1. Maxium ratings
2. Typical ratings

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XXXVII. DIGITAL ELECTRONICS

A. Introduction

B. Basic Concepts

1. Number systems
    a. Decimal
    b. Binary
    c. Octal
    d. Hexadecimal
2. Coding
    a. BCD
        1. 8 4 2 1
        2. Excess 3
    b. Gray
    c. Hollerith
    d. ASCII
3. Arithmetic Functions
    a. Binary addition
    b. Binary subtraction
    c. Binary multiplication
    d. Binary division
4. Fundamental Rules and Laws
    a. "OR" and "AND" logic
    b. Boolean Algebra Expressions
    c. Inversion ("NOT") logic
    d. "NOR" and "NAND" logic
    e. "EXCLUSIVE OR" logic
    f. Logic simplification
        1. Karnaugh Map
        2. Veitch and Venn diagrams
        3. Demorgan's Theorem

C. Logic Circuits

1. "OR" gate
2. "NOR" gate
3. "AND" gate
4. "NAND" gate
5. "EXCLUSIVE OR" gate
6. "NOT" gate
7. Tri-state Buffer

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D. Logic Circuit Characteristics

1. Logic
2. Power dissipation
3. Transient Response
4. Propagation time
5. Fan-out

E. Regenerative Switching Circuits

1. Astable multivibrator (clock)
2. Monostable multivibrator (one-shot)
3. Bistable multivibrator (flip-flop)
   a. T flip-flop
   b. RS and RST flip-flop
   c. Clocked RD flip-flop
   d. D flip-flop
   e. J-K Flip-flop

F. Applications

1. Counters
   a. Ripple counter
   b. Modulo N
   c. Synchronous
   d. Up-down
   e. Preset and self-stopping
   f. Ring
   g. Frequency dividers

2. Shift registers
   a. Serial load
   b. Parallel load
   c. Shift left- shift right
   d. Rotate left/right
   e. Arithmetic

3. Arithmetic Circuits
   a. Adders
      1. Half
      2. Full
   b. Subtractors
      1. Half
      2. Full

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3. Adders as subtractors
    a. Two's complement
    b. Sign bit
    c. Multipliers
    d. Dividers
    e. Serial adders
    f. Parallel adders

G. Converters
1. Digital/Analog (D/A)
2. Analog/Digital (A/D)

H. Memories
1. Memory Types
    a. RAM
        1. Static
        2. Dynamic
        3. Bubble
    b. ROM
        1. ROM
        2. PROM
        3. EPROM
        4. EEPROM
2. Bulk Storage Devices
    a. Magnetic
        1. Core
        2. Tape
        3. Drum
        4. Disc
            a. Floppy
            b. Hard
    b. Mechanical
        1. Punch card
        2. Paper tape

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XXXVIII. COMPUTERS

A. Introduction

1. Analog
2. Digital
3. Hardware
4. Software

B. Terms and Conventions

1. Microprocessor vs Microcomputer
2. Stored program concept
3. Computer words
4. Word length
   a. Byte
   b. Nibble
5. Baud rate
6. Bi-directional busing
   a. Tri-state buffers
   b. Timing
   c. Shared address and data bus

C. Basic Computer System

1. Block diagram
   a. CPU
   b. Periperal devices
      1. Definition (I/O)
      2. CRT display
      3. Keyboard
      4. Memory
      5. Sensors
      6. Printers

D. Elementary Microcomputer

1. Microprocessor Unit (MPU)
2. Memory
3. Executing a program
   a. Fetch phase
   b. Execute phase
   c. Fetch/Execute a typical instruction

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XXXIX. INTRODUCTION TO PROGRAMMING (SOFTWARE)

A. Introduction

B. Languages

1. Low order

a. Machine
b. Assembly

C. Flow Charting

1. Purpose
2. Symbols used
3. Logical sequences

a. Straight-line programs
b. Branching programs

1. Unconditional
2. Conditional

XXXX. MICROPROCESSORS (HARDWARE AND SOFTWARE)

A. Introduction

B. Microprocessor Architecture

1. CPU Block diagram (Programming model)
2. Characteristics
3. Typical microprocessors

C. Instruction Set

1. Addressing Modes

a. Immediate
b. Direct
c. Relative
d. Inherent or implied
e. Indexed
f. Extended

2. Data Handling

a. Moving Data

1. Into CPU Registers
2. Into memory locations
3. Out of CPU registers
4. Out of memory locations

b. Arithmetic operations
c. Logic operations
d. Stack operations

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e. Condition Code or Flag register operation
f. Branching

1. Unconditional
2. Conditional
3. Subroutines

a. Jump to Sub
b. Conditional jump
c. Nested subroutine

g. Interrupts

1. Reset
2. Non-maskable
3. Return from interrupt
4. Interrupt request
5. Interrupt mask
6. Wait for interrupt

h. Input-Output (I/O)

1. Input
2. Output
3. I/O Programming
4. Program control of I/O
5. Interrupt control of I/O

D. Interfacing

1. Fundamentals

a. Buses
b. Tri-state logic
c. MPU interface lines
d. Instruction timing
e. Timing of program segment
f. Data sheet

2. Interfacing Memory

a. RAM

1. Static
2. Dynamic

b. ROM
c. Configurations of RAM

1. 128-word by 8-bit
2. 256-word by 4-bit

d. Connecting RAM to MPU
e. Address decoding

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3. Interfacing with Displays

   a. The 7-segment display
   b. Driving the 7-segment display
   c. Using an addressable latch
   d. Multiplexing displays

4. Interfacing with Switches

   a. Interfacing requirements
   b. A typical keyboard

5. The Peripheral Interface Adapter (PIA)

   a. I/O diagram
   b. PIA registers
   c. Addressing the registers in the PIA
   d. Initializing the PIA
   e. Addressing the PIA

6. Using the PIA

   a. Driving 7-segment displays
   b. Decoding keyboards
   c. Decoding a switch matrix

E. Troubleshooting Microcomputer Circuits

1. Trouble Symptom Analysis

   a. Block diagram
   b. Diagnostic program
   c. Chip location guide
   d. Schematic

2. Changing Chips

   a. Extraction techniques
   b. Insertion techniques
   c. Static electricity precautions
   d. Soldering precautions

3. Common Problems

   a. Power Supply

      1. Low or missing voltages
      2. Excessive ripple

   b. Clock

      1. No clock pulses
      2. Clock pulses out of phase

   c. Defective buses
   d. Memory chips

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F. Microprocessor Applications

1. Transmitters
2. Receivers
3. Test equipment
4. Navigation aids
   a. RNAV
   b. DME
   c. Transponder
   d. Loran C
   e. Radar
5. Autopilot

XXXXI. OPERATIONAL AMPLIFIERS

A. Fundamental Circuit Theory

1. Operational model
2. Symbols
3. Idealized characteristics

B. Electrical Specifications

1. Minimum and maximum vs. typical
2. Definitions
   a. Rated output
   b. Open loop gain
   c. Unity gain bandwidth
   d. Slew rate
   e. Full power response and settling time
   f. Voltage offset
   g. Noise
   h. Input and output impedance
   i. Common mode rejection

C. Linear Circuits

1. Inverting amplifier
2. Non-inverting amplifier
3. Voltage follower
4. Mixers
5. Current amplifier
6. Differential amplifier

D. Digital Circuits

1. Comparator
2. Inverting adder
3. Non-inverting adder

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E. Special Applications

1. Voltage to current converter
2. Current to voltage converter
3. Constant current source
4. Phase shifter

F. Generator Circuits

1. Free running multivibrator
2. One shot multivibrator
3. Ramp generator
4. Triangular wave generator
5. Saw tooth generator
6. Voltage to frequenty converter
7. Adjustable timer

G. 555 Timer

1. Introduction
2. Terminals
3. Free running
4. One shot
5. Timer
6. Programmable timer

XXXXII. TRANSDUCERS

A. Introduction

B. Motion Sensors

C. Force Sensors

D. Fluid Sensors

1. Pressure
2. Differential-pressure
3. Flow
4. Level

E. Temperature Sensors

1. Fluid temperature
2. Resistive
3. Bimetallic
4. Thermocouple
5. Radiation pyrometers

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F. Radiation Sensors
   1. Light
   2. X-ray
   3. Radioactivity
G. Thickness Sensors
H. Proximity Sensors
I. Moisture-content Sensors
J. Density Sensors
K. PH Sensors

XXXXIII. MOTORS AND GENERATORS
A. D. C. Generators
B. A.C. Generators
C. D.C. Motors
D. A.C. Motors
E. Motor Controls

XXXXIV. AIRCRAFT COMMUNICATIONS
A. VHF Transmitters
B. VHF Receivers
C. HF Transmitters
D. HF Receivers
E. LF Transmitters
F. LF Receivers
G. SSB
H. ELT
I. P.A. Systems

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XXXXV. AIRCRAFT NAVIGATION

- A. VLF Frequency / LF
  - 1. Omega
  - 2. INS
- B. Loran C
- C. Inertial Guidance
- D. Very High Frequency
  - 1. VOR
  - 2. ILS
    - a. Localizer
    - b. Glide Scope
    - c. Marker Beacon
  - 3. Area navigation
- E. Magnetic Compass System
- F. Directional Gyro

XXXXVI. PULSE AND MICROWAVE SYSTEMS

- A. Radar Systems
- B. Radar Altimeter
- C. D. M. E.
- D. Transponders
- E. Encodering Altimeter

XXXXVII. FLIGHT CONTROL SYSTEMS

- A. Automatic Pilots
- B. Altitude Gyros
  - 1. Wing levelers
  - 2. 2 axis
  - 3. 3 axis
- C. Integrated Flight Systems
  - 1. Artificial Horizon
  - 2. Horizontal situation indicator

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XXXXVIII. TURBULANCE AVOIDANCE

A. Weather radar

B. Low Frequency Static Discharge

XXXXIX. FLIGHT COLLISION AVOIDANCE

A. Radio altimeter

B. Air to air

L. AIR TRAFFIC CONTROL PROCEDURES

A. History

B. Function

1. VFR
2. IFR