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ABSTRACT

This document is a curriculum guide for a course for electronics mechanics for use in vocational-technical education. The course outline includes the following units: adjusting/aligning/calibrating electronic circuitry, replacing components, maintaining electronic devices, designing equipment and circuitry, performing environmental tests, and administering personnel. Each unit contains a performance objective with a task, conditions, standard, and source for standard; a performance guide; enabling objectives; learning activities; resources; evaluation/questions and answers; practical applications; methods of evaluation; and checklists for performance objectives. Extensive appendixes to the guide contain cross-reference tables of duties, tasks, and performance objectives; definitions of terms; tools and equipment lists; sources for standards; a reference list of state-of-the-art literature; a bibliography; and written evaluation questions and answers. (KC)

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V-TECS GUIDE

FOR

ELECTRONICS MECHANIC

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Upon completion of the writing of the Electronics Mechanics V-TECS Guide, five educators were selected to field review the materials for validity and reliability. These educators are to be commended for their thoroughness in providing their expertise in modifying and approving this guide for classroom use. The field reviewers are: A.C. Davis (Florence Vocational Center), W.A. Hicks (Kershaw County Vocational Center), Danny R. Medlin (Pickens Vocational Center), Harvey Quattlebaum (Columbia High School) and Edward Wichousky (Hartsville Career Center).

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INTRODUCTION

V-TECS guides are an extension or continuation of the V-TECS catalogs. While the V-TECS catalog is a composition of duties, tasks, performance objectives, and performance guides, it deals only with the psychomotor aspect of an occupation. It is a blueprint of an occupation. It deals only with the identification of the "hands on" aspect of the occupation. It does not take into consideration such things as the background information surrounding a task, how to make inferences, generalizations and decisions from a body of knowledge, nor does it deal with attitudes, job seeking skills, safety or energy conservation practices. V-TECS guides take these aspects of teaching and learning into consideration.

Experience has shown that the art of learning can also be taught while teaching subject matter. People need to learn how to learn. V-TECS guides take into consideration how students learn and are an efficient way for instructors to assist them to learn.

V-TECS guides are centered around all three domains of learning: psychomotor, cognitive, and affective. The following is a brief explanation of each.

Psychomotor

Any manipulative skill such as tightening a nut, replacing a hubcap, sharpening a pencil, machining a key slot in a steel shaft, or replacing a SCR in a solid state control panel are examples of manipulative or psychomotor skills. Tasks such as these are identified in V-TECS catalogs. V-TECS catalogs also group tasks by duties and objectives. Each performance objective has a performance standard which must be met to prove student proficiency in the manipulative aspect of the task. The V-TECS catalog, however, does not include any suggestions as to how to learn to do these tasks.

V-TECS guides are developed around psychomotor tasks which are worker oriented.

Cognitive

To perform psychomotor tasks, students must think. To tighten a nut they must know which way to turn it and when to stop turning it so that they won't strip the threads or shear the bolt off. If replacing a hubcap, there is a certain technique that may vary from one car to another. For example, start the hubcap by placing the cap in a tilted position and tapping it all the way around until it is properly seated. On a different model, it may be necessary to position the hubcap and snap it all at once. At any rate, students must think about what is being done. This is cognition or a mental activity. Cognition is what goes on in the mind about any job being done. V-TECS guides provide both the collateral knowledge and the impetus to apply cognition to psychomotor tasks.

Students gain cognition through both real and vicarious experiences. They may read, view tapes, memorize or practice a process or procedure until they are certain of it. To test their knowledge, students may be required to decide the proper procedure, method or sequence for performance. This decision making process or cognitive activity provide the basis for higher thinking skills.

Cognition, then, is that process by which information is stored and used. That voice that warns one of potential dangers is cognition. Anything that goes on in the mind is cognition. Students may become the best workers in their job; but if they fail to think a process through and apply their experience, they may become just one more statistic. It is cognition that tells them to lock and tag out the power supply to an electrical apparatus before starting to repair it. However, cognition does not apply only to safety. Good cognition or thinking can help employees do a job better and quicker. V-TECS guides provide for the cognitive aspects of learning.

Affective

Curriculum writers, supervisors, and instructors often fail to assist students in acquiring a positive attitude toward themselves, their jobs, their school, or their fellow students. V-TECS guides seek to provide assistance to the instructor in achieving this. It is difficult for the instructor to identify little bits and pieces of desirable behavior for every unit and often harder yet to teach them. In this area, students might be judged as to how well they clean up their work area, whether they show up to do the job on time, or whether they must be told several times to do something. Potential employers are interested in student attitude because persons angry at themselves or uncertain of themselves are often poor workers.

A student's ability to succeed on the first job and every job thereafter depends largely on attitude. If, for example, students have the attitude of "let someone else do it," they could be in trouble. Students using V-TECS guides will have activities dealing with how to get along with other students, supervisors, or staff members both in large and small groups.

USE OF V-TECS GUIDE

The guide is designed to provide job-relevant tasks, performance objectives, performance guides, resources, learning activities, evaluation standards and achievement testing in selected occupations.

A V-TECS guide is designed to be used with any teaching methods you may choose. If a lecture/demonstration method is best for you, you will find sufficient help to meet your needs. If you prefer to use discussions or other methods that require student participation, you will find ample help. Regardless of which method is successful for you, a V-TECS guide can save preparation time and offer innovative methods and procedures. For example, students may work either alone or in teams while in class and learn skills in direct relation to what is actually done on the job. This work also takes into consideration student attitudes, thinking skills, and mathematical reading skills.

The use of small groups in teaching can be helpful in two ways: (1) many students may feel inadequate due to their lack of background information in mechanical things; and (2) some students may feel that they are physically incompetent or lack the necessary background experiences. A successful program (course) can provide students with a sense of security by reinforcing positive attitudes while improving skill and knowledge of the subject. By allowing students to interact on a personal level, this task/learner-centered approach can achieve this. As students gain confidence and discover that they are an essential part of a team engaged in the learning-teaching process, their confidence increases. Too, the student in this setting can learn to work without direct supervision. In addition, use of the small-group method permits the instructor to vary instructional routines away from lecture or other full-class methods to activities for single students, pairs of students or any number so desired.

You will find suggestions for specific classroom activities. The activities are not meant to restrict you or your students, but only to suggest a variety of learning activities for each task statement. Please do not feel that you must take your students through all the activities. Although the Guide is comprehensive, teachers will be able to select the content which is applicable to the instructional offering in their schools. Teachers are encouraged to use creativity as they adopt the materials to meet the particular needs of their students.

ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 01

TASK: Adjust AC Generator Output.

CONDITIONS: AC generator whose output is out of tolerance and the following equipment: Screwdriver (assorted blades and assorted phillips head), wrench (socket set of assorted nut drivers), AC voltmeter, AC current meter, frequency meter, and generator (input, signal).

STANDARD: The generator output (voltage, current, or frequency) must be adjusted to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
Kubla. **Circuit Concepts: Direct and Alternating Current.**
National Cash Register Company. **Data Communications Concepts.**

PERFORMANCE GUIDE
1. Deenergize equipment.
2. Gain access to generator output controls.
3. Connect meter (volt, frequency, current) to output.
4. Apply dummy load to circuit.
5. Energize circuit.
6. Manipulate controls for desired output.
7. Check meter readings.
8. Deenergize circuit.
9. Remove dummy load.
10. Disconnect equipment.
11. Replace access panels.

ENABLING OBJECTIVES
1. Identify and describe the principles of RL circuits.
2. Read schematic wiring diagrams.

LEARNING ACTIVITIES
1. Explain the purpose of the adjustment.
2. Show how the magnetic field is effected by adjusting the varactor.
3. Demonstrate magnitude and speed adjustment, by adjusting the rheostat.
4. Explain that either of these adjustments effect the circuit frequency, voltage and current relationship.
5. Define HZ to the students.
6. Demonstrate these effects with the oscilloscope.

RESOURCES
Gerrish, et al., **Electricity and Electronics**, chapter 5, pages 64-67.

EVALUATION
Written Questions
1. What is the regulation percentage with no load voltage 25V and full load voltage 24V?
2. How may the output of the constant speed generator be controlled?
3. Define: cycle, frequency, period, and amplitude of an AC wave.

Answers

1. 4.1%
2. Increasing resistance in series with the source and field windings.
3. a. Set of events occurring in sequence.
   b. Number of complete cycles per second.
   c. Time for one complete cycle.
   d. Extreme range of varying quantity.

Practical Application

Utilize the generator module, prepare test equipment and make necessary adjustments.

Method of Evaluation

Use Checklist Performance Objective 01 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 01 EVALUATION

PERFORMANCE TEST FOR ADJUSTING AC GENERATOR OUTPUT

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set up test bench with generator, frequency meter, electronic volt-meter and proper tools for adjustment. Adjust calibration potentiometer for proper voltage and frequency.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure all items to be evaluated are on hand. Be sure the student follows sequence for making the adjustments. The voltages and frequency should be within specified tolerances as indicated on the decal.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The test bench is prepared.	______	______
2. The student has diagnosed the problem.	______	______
3. The student has removed the protective covers.	______	______
4. The student has prepared the calibration potentiometer for adjustment.	______	______
5. The student makes proper calibrations.	______	______
6. The student secures the potentiometer lock nut.	______	______
7. The student replaces protective covers.	______	______
8. The student does the documentation.	______	______
9. The student leaves work areas clean.	______	______
10. The student follows all safety procedures.	______	______

APPROVED: Yes _____ NO _____

Evaluator's Signature ______________________ Date __________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 02

TASK: Adjust Amplifier Gain.

CONDITIONS: Amplifier in need of adjustment and the following equipment: signal generator, output measuring device, adjustment tool, and isolation transformer.

STANDARD: The amplifier gain must be adjusted so that it is within range of the design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
U.S. Army. **Digital Computers: Communications Electronics Fundamentals. FM 11-72.**

PERFORMANCE GUIDE
1. Identify amplifier gain specifications.
2. Deenergize equipment.
3. Connect calibrated signal generator to amplifier input.
4. Connect test equipment to amplifier output.
5. Energize amplifier and test equipment.
6. Adjust gain control to input/output specifications.
7. Turn off amplifier, disconnect test equipment.

ENABLING OBJECTIVE(S)
1. Operate a signal generator.
2. Use voltmeter.
3. Read schematic diagrams.

LEARNING ACTIVITIES
1. Explain the operation of an amplifier circuit.
2. Demonstrate use of an A.C. voltmeter and a signal generator.
3. Show how to connect signal generator and A.C. voltmeter into circuit.
4. Compare the signal input with the output indicated by the A.C. voltmeter.
5. Plot a graph to denote the amplitude of the output for the A.-F. band.

RESOURCES
Hickey, et al., **Elements of Electronics**, 3rd edition, pp. 496-497.

EVALUATION
Questions
1. For what purposes are signal generators used in troubleshooting amplifiers?
2. Explain how the frequency response of an amplifier may be determined.
3. How is it possible to isolate a defective amplifier stage with a signal generator?
4. What is the most commonly used method of controlling the gain of a transister stage?

PERFORMANCE OBJECTIVE V-TECS 02 (Continued)

Answers

1. Signal generators are used to generate a signal of frequencies within the audio range.
2. If the volume control on the signal generator is set for a definite value, the amount of amplification can be determined by comparing the signal input of an amplifier with the output as indicated by the A.C. voltmeter. By plotting a graph denoting amplitude, the range of the amplifier will be indicated by the portion of the graph with a flat response.
3. By beginning at the input of the last stage and progressing to the input of the first stage, any inoperative stage may be this isolated.
4. Volume controls, potentiometers are placed in either the input or output circuits of a stage to control gain.

Practical Application

Utilize amplifier, prepare equipment and make necessary adjustments.

Method of Evaluation

Use Checklist Performance Objective 02 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 02 EVALUATION

PERFORMANCE TEST FOR ADJUSTING AMPLIFIER

Student's Name ______________________________ Date __________

DIRECTIONS TO STUDENT: Set up test bench with amplifier. Adjust calibration signal for appropriate voltage and frequency.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure all items to be evaluated are on hand. Be sure the student follows the sequence for making the adjustments. The voltages and frequency should be within specified tolerances as indicated on the decal for amplifier used.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Test circuit is prepared.	______	______
2. Test equipment is connected.	______	______
3. Determine the location of adjustment points.	______	______
4. Properly energize test circuits and equipment.	______	______
5. Determine if amplifier output is out of specifications.	______	______
6. Properly adjust amplifier to be within specifications.	______	______
7. Secure power in the correct method.	______	______
8. Disconnect test equipment and replace covers as needed.	______	______
9. Leave work area neat and clean.	______	______
10. Follows all safety precautions.	______	______

APPROVED Yes ______ NO ______

Evaluator's Signature ______________________________ Date __________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 03

TASK: Adjust Armature Field Voltage.

CONDITIONS: A motor/generator with an out of adjustment armature/field voltage and the following equipment: screwdrivers (assorted blade and assorted phillips head), wrenches (assorted open end and socket set of assorted nut drivers), voltmeter, and ammeter.

STANDARD: When adjusted the armature/field voltage will be within the range of the design specifications.

SOURCE FOR STANDARD:
Writing Team, State of Georgia.
______________________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**

PERFORMANCE GUIDE
1. Deenergize equipment.
2. Gain access to armature/field connection.
3. Connect test equipment to output line.
4. Locate armature/field voltage adjustment control.
5. Energize circuit and test equipment.
6. Adjust armature/field voltage.
7. Deenergize equipment and test equipment.
8. Disconnect test equipment.
9. Replace access devices.

ENABLING OBJECTIVE(S)
1. Identify the impedance circuit.
2. Calculate the reluctance of the motor circuit.

LEARNING ACTIVITIES
1. Explain the purpose of the adjustment.
2. Show how the adjustment effects current in the circuit.
3. Demonstrate the effect of an unbalanced calibration.
4. Explain frequency changes by the calibration.
5. Display these outputs on the oscilloscope.

RESOURCES
Gerrish, et al., **Electricity & Electronics**, Chapter 9, pages 134-136.
Gerrish, et al., **Transistor Electronics**, Chapter 11, pages 163-172.
Kaiser: **Electrical Power, Motors, Controls, Generators, Transformers.**

EVALUATION
Questions
1. Hysteresis is the result of _____________.
2. The TRIAC is primarily _____________.
3. Phase control means _______________.
4. Varying the phase of the trigger voltage, controls the:

Answers

1. Misalignment of ON-OFF trigger voltage.
2. An AC power control device.
3. Limiting conduction time by controlling the phase of the trigger voltage.
4. Conduction angle.

Practical Application

Set up the TRIAC-DIAC control and demonstrate by adjusting the calibration rheostat. Show on the oscilloscope and electronic voltmeter the phase and current changes.

Method of Evaluation

Use Checklist Performance Objective 03 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 03 EVALUATION

PERFORMANCE TEST FOR ADJUSTING ARMATURE FIELD VOLTAGE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up test bench, with control, motor generator, frequency meter, oscilloscope, EVOM and necessary tools for the adjustment. Adjust calibration for proper voltage, current and frequency. Record pre-post adjustment voltage.

DIRECTIONS TO EVALUATOR: Observe the student, making sure all items to be evaluated are on hand. Be sure the student follows correct sequence when making the adjustments. The voltage, current and frequency should be within specified tolerance indicated on the decal.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The test bench is prepared.	______	______
2. The student has diagnosed the trouble.	______	______
3. The student has prepared the control for the adjustment.	______	______
4. The student has loosened the lock nut for this adjustment.	______	______
5. The student makes the calibration.	______	______
6. The student secures the lock nut after the calibration is completed.	______	______
7. The student replaces the protective cover.	______	______
8. The student completes the documentation.	______	______
9. The student cleans up work area.	______	______
10. The student follows all safety precautions.	______	______

APPROVED: YES ______ NO ______

Evaluator's Signature ______________________ Date ____________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 04

TASK: Adjust Audio Intensities.

CONDITIONS: An audio circuit with the audio intensity in need of adjustment and the following equipment: adjustment tools, screwdrivers (assorted blades and assorted phillips heads), audio signal generator, and audio output detector.

STANDARD: When adjusted the audio intensities will conform to the design specifications of the circuit.

SOURCE FOR STANDARD:

Writing Team. State of Georgia.

Department of the Navy. **Fundamentals of Electronics: Alternating Current, Vol. 1B.**

U.S. Army. **Digital Computers: Communications Electronics Fundamentals.** FM 11-72.

PERFORMANCE GUIDE

1. Deenergize system.
2. Obtain access to circuit.
3. Locate audio intensity adjustment controls.
4. Connect audio input signal.
5. Connect audio output detector.
6. Energize system and test equipment.
7. Adjust audio intensity control.
8. Deenergize equipment.
9. Disconnect test devices.
10. Replace access covers, panels, etc.

ENABLING OBJECTIVE(S)

Identify and describe the principles of the audio amplifier circuit.

LEARNING ACTIVITIES

1. Explain the principles and operation of the audio system.
2. Explain proper connections of signal generators and other test equipment.
3. Demonstrate signal and voltage measurements.
4. Show proper output on oscilloscope.
5. Calculate maximum undistorted power output.

RESOURCES:

Gerrish, et al., **Electricity and Electronics**, Chapter 16, pages 243-240.

EVALUATION

Questions

1. When is the audio stage properly adjusted?
2. What should the undistorted output measure?
3. What should the bias of the pre-amp measure?
4. Are the output stages in phase?
5. What does increasing the AF generator frequency prove?
6. Calculate the output power (EO/RL).

PERFORMANCE OBJECTIVE V-TECS 04 (Continued)

Answers
1. Maximum current flows
2. 4.4 volts pk-pk
3. 0.6 volts
4. 180 degree out
5. The amplifier circuit is working.
6. 61.5 millivolts

Practical Application
Utilize trainer and set-up audio section of the superheterodyne receiver, using the appropriate test equipment, adjust the audio circuit for proper intensities.

Method of Evaluation
Use Checklist Performance Objective 04 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 04 EVALUATION

PERFORMANCE TEST FOR ADJUSTING AUDIO INTENSITIES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set up trainer with audio pre-amplifier circuit board. Make connections for adjusting output stages, using the oscilloscope, electronic digital multimeter and the DC millimeter.

DIRECTIONS TO EVALUATOR: Observe the student. See that all items to be evaluated are on hand. Be sure the student makes proper connections. Check the oscilloscope signal to insure that the amplifier is not being overdriven.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The trainer is prepared.	______	______
2. The proper test instruments are used.	______	______
3. The oscilloscope is calibrated.	______	______
4. The student uses a step by step process when making adjustments.	______	______
5. The student makes the voltage checks.	______	______
6. The student calculates power output.	______	______
7. The student is able to determine if the amplifier is overdriven.	______	______
8. The work area is left in neat order.	______	______
9. The student follows all safety precautions.	______	______

APPROVED: YES _____ NO _____

Evaluator's Signature Date

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 05

TASK: Adjust Automatic Gain Control (AGC) Circuit.

CONDITIONS: An AGC circuit in need of adjustment and the following equipment: adjustment tools, screwdrivers (assorted blades and assorted phillips heads), RF signal generator, and RF output detector.

STANDARD: When adjusted the AGC circuit will conform to circuit design specifications.

SOURCE FOR STANDARD: Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to AGC circuit.
3. Locate AGC controls.
4. Connect input signal.
5. Connect output detector.
6. Energize system/equipment.
7. Manipulate controls to proper output signal.
8. Deenergize system/equipment.
9. Disconnect test equipment.
10. Replace access covers, panels, etc.

ENABLING OBJECTIVE(S)

Use test instruments and read schematic diagrams.

LEARNING ACTIVITIES

1. Identify television related circuitry.
2. Discuss the advantages of feedback circuits.
3. Explain how the detector output is rectified and a negative voltage is returned to the previous amplifier stages.
4. Explain regenerative feedback.
5. Demonstrate controlling the output gain by varying the AGC control.

RESOURCES

Gerrish, et al., **Electricity and Electronics**, page 263.
A set of SAM'S for the TV chassis used.

EVALUATION

Questions

1. The AGC in television serves the same purpose as the ____________ in radio receivers.
2. The purpose of AGC is to provide a constant output from the ________________.
3. This is accomplished by rectifying the ____________ signal to produce a ___________ voltage.
4. The voltage is applied to the Bias of the previous amplifier stages to change their _________________.

PERFORMANCE OBJECTIVE V-TECS 05 (Continued)

Answers
1. AVC
2. Detector
3. Video, negative
4. Gain

Practical Application
Set-up a circuit and demonstrate proper power supply, test equipment and make adjustments.

Method of Evaluation
Use Checklist Performance Objective 05 to determine if the assignment has been accomplished within 90 percent of accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 05 EVALUATION

PERFORMANCE TEST FOR ADJUSTING AUTOMATIC GAIN CONTROL (AGC) CIRCUIT

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Given a set of SAM'S, and a television receiver: The student will align the AGC circuit using appropriate alignment procedures. The adjustment will be within proper amplitude and signal.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Described the purpose of the alignment.	______	______
2. Was a sequencial procedure followed in the alignment?	______	______
3. Safety procedures were followed.	______	______
4. The control was secured after the adjustment.	______	______
5. Limitations of the adjustment were stated.	______	______
6. Proper test equipment was selected.	______	______
7. Evaluated the adjustment by selecting several channels.	______	______
8. Secured the work area after completion of the assignment.	______	______
9. The student followed all safety precautions.	______	______

APPROVED: Yes ______ No ______

Evaluator's Signature ______________________ **Date** __________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 06.

TASK: Adjust Bias Network.

CONDITIONS: A bias network and the following equipment: screwdrivers (assorted blades and assorted phillips heads), wrenches (assorted open end and socket set with nut drivers), input signal generator, and output indicator.

STANDARD: When adjusted the voltage, current and the impedance of the bias network will conform to design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
____________________. **Fundamentals of Electronics: Vol. 3.** Transmitter **and Circuit Applications.**
National Cash Register Company. **Data Communications Concepts.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to bias network.
3. Locate bias network adjustment controls.
4. Connect input signal generator.
5. Connect output detector to bias network.
6. Energize system/equipment.
7. Make adjustments.
8. Deenergize system/equipment.
9. Disconnect test equipment.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
Distinguish and describe the different biasing procedures.

LEARNING ACTIVITIES
1. Explain the desired output from the circuit.
2. Explain the importance of a proper biased amplifier.
3. Explain methods of obtaining proper bias.
4. Show with the EVOM how to measure bias network.
5. Demonstrate how to adjust the network for proper bias.
6. Measure voltage drop across the load resistor to show that the amplifier is working.

RESOURCES
Gerrish, et al., **Transistor Electronics**, Chapter 14, pp. 210-224.

EVALUATION
Questions
1. What should the bias of a silicon transistor be?
2. What is the status of the NPN transistor if 1.5 volts is applied to the base and 0.9 volts at the emitter?
3. What should the bias of the germanium transistor be?
4. With PNP transistor has $V_e = 1.8V$, $V_B = 1V$, $V_C = 15V$, what is its status?
5. The collector voltage is the same as Voc, one cause could be:

PERFORMANCE OBJECTIVE V-TECS 06 (Continued)

Answers

1. 0.5 - 0.7 volts
2. Conducting
3. 0.2 - 0.5 volts
4. Conducting
5. Emitter open

Practical Application

Set-up a circuit and demonstrate proper power supply, test equipment and make adjustments.

Method of Evaluation

Use Checklist Performance Objective 06 to determine if the assignment has been accomplished within 90 percent of accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 06 EVALUATION

PERFORMANCE TEST FOR ADJUSTING BIAS NETWORK

Student's Name **Date**

DIRECTIONS TO STUDENT: Set up trainer for Bias stabilization. Use proper test instruments and adjust for proper voltages at base, emitter and collector of the transistor.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure the circuit has been properly identified. Make sure the student obtains the proper Bias voltage for the transistor used.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The trainer is prepared.	____	____
2. The voltages have the polarity.	____	____
3. The student demonstrates, measuring operating voltages.	____	____
4. The student shows effect of current flow when adjusting proper Bias.	____	____
5. The student shows voltage drop across the lo~d circuit.	____	____
6. The student leaves the area in a clean and neat order.	____	____
7. The student follows all safety precautions.	____	____

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 07

TASK: Adjust Capacitance.

CONDITIONS: An electronic circuit with capacitance not within circuit, design specifications and the following equipment: screwdrivers (assorted blades and assorted phillips heads), wrenches (assorted open end and socket set with nutdriver), adjustment tools, capacitance meter, output indicator, and input signal generator.

STANDARD: When adjusted, the capacitance will be within the range of design specifications.

SOURCE FOR STANDARD:
Writing team. State of Georgia.
Lockhart and Rice. **AC Circuit Analysis.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to capacitor.
3. Locate adjustment controls.
4. Identify tuning specifications.
5. Connect input signal generator.
6. Connect output indicator.
7. Energize system/equipment.
8. Make adjustments.
9. Deenergize system.
10. Disconnect test equipment.
11. Replace covers, panels, etc.

ENABLING OBJECTIVE
Read a schematic.

LEARNING ACTIVITIES

1. Recognize from a schematic a variable capacitor.
2. Explain the most common dielectric in a variable capacitor.
3. Describe the various types of adjustable capacitors.
4. Point out two adjustable capacitors.
5. Review what safety measures must be taken when adjusting a variable capacitor.

RESOURCES
Lemons. **Learning Electronics Through Troubleshooting.** pp. 329-331.

EVALUATION
Questions

1. What does the term Dielectric Material mean?
2. What does an adjustable capacitor do in a simple radio receiver?
3. How many microfarads are there in a variable capacitor that is rated at 350 picofarads?

PERFORMANCE OBJECTIVE V-TECS 07 (Continued)

Answers

1. The insulating material between the plates.
2. Tune the radio in on station.
3. .000350 microfarads.

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 08

TASK: Adjust Core of Slug Tuned Circuits.

CONDITIONS: A slug tuned circuit with a core requiring adjustment and the following equipment: screwdrivers (assorted blades and assorted phillips heads), assorted open end wrenches, adjustment tools, output indicator, and input signal generator.

STANDARD: When adjusted, the output of the slug tuned circuit will meet circuit design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to circuit.
3. Locate slug tuned cores.
4. Connect output indicator.
5. Energize system/equipment.
6. Make adjustments.
7. Deenergize system/equipment.
8. Disconnect test equipment.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE

None

LEARNING ACTIVITIES

1. Relate where you would find slug tuned circuits.
2. Show a slug tuned circuit.
3. Explain the purpose of a RF transformer.
4. Describe the "Q" of the circuit.
5. Review what safety measures must be exercised when working on a slug tuned circuit.

RESOURCES

Lemons. **Learning Electronics Through Troubleshooting.** pp. 348-349.

EVALUATION

Questions

1. An antenna transformer would be considered a slug tuned circuit. (True or False)
2. What does the term "loose coupling" mean?
3. An intermediate-frequency transformer can be considered as a slug tuned circuit. (True or False)
4. A high-voltage "flyback" transformer can be considered as a slug tuned circuit. (True or False)

PERFORMANCE OBJECTIVE V-TECS 08 (Continued)

Answers

1. True
2. That the coupling between the coils is decreased so only the signals tuned by the secondary can reach the circuit.
3. True
4. False

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 09

TASK: Adjust DC Generator Output.

CONDITIONS: A DC generator requiring adjustment and the following equipment: screwdrivers (assorted blades and assorted phillips heads), socket set of wrenches with assorted nut drivers, voltmeter, current meter, and input signal generator.

STANDARD: When adjusted, the generator output level for current and voltage will be within the circuit design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
National Cash Register Company. **Data Communications Concepts.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to generator controls.
3. Connect voltmeter and/or current meter to output.
4. Apply dummy load to generator.
5. Energize circuit.
6. Make adjustments.
7. Deenergize circuit.
8. Remove dummy load.
9. Connect generator output to circuit.
10. Energize circuit.
11. Check generator output.
12. Deenergize system.
13. Disconnect voltmeter.
14. Replace access panels, covers, etc.

ENABLING OBJECTIVES

Read schematic diagrams.
Interpret metering devices.

LEARNING ACTIVITIES

1. Explain the operation of a DC generator.
2. Show the series, shunt, and compound type connections that may be used.
3. Demonstrate the operation of a generator.
4. Measure the voltage output of a generator.
5. Show how to adjust the voltage output by varying load and interchanging series and shunt field windings.

RESOURCES

Hickey, et al., **Elements of Electronics**, 3rd edition, pp. 343-344.
Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 153-154.

PERFORMANCE OBJECTIVE V-TECS 09 (Continued)

EVALUATION

Questions

1. In a series-connected generator the __________, __________, and external circuit are connected in series.
2. In a shunt-connected generator the __________ are placed directly across the full output voltage of the __________.
3. The compound-connected generator employs both the __________ and __________ fields.
4. In the compound-connected generator the __________ field provides the main magnetic field for the generator, while the __________ field acts as a controlling device that determines the characteristics of the output voltage under load conditions.
5. In the shunt type, the __________ decreases as the __________ increases.

Answers

1. Armature, field coils
2. Fields, armature
3. Series, shunt
4. Shunt, series
5. Voltage, load

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 10

TASK: Adjust Drive Gear.

CONDITIONS: A drive gear that is out of adjustment and the following equipment: assorted blade screwdrivers, wrenches (assorted open end, adjustable, and hex), punch set, hammer, safety glasses, and machine oil.

STANDARD: When adjusted, the drive gear will not slip, rattle and the gear teeth will mesh without binding or chipping.

SOURCE FOR STANDARD:

Writing Team. State of Georgia.

________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**

________. **Soldiers Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to the drive gear.
3. Locate adjustment controls.
4. Make adjustments.
5. Energize system.
6. Check system operation.
7. Deenergize system.
8. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)

Use tools correctly.

LEARNING ACTIVITIES

1. Explain how gears are used in industry and homes.
2. Identify equipment using gears.
3. Demonstrate the use of gears in a universal motor portable electric drill.
4. Show how to remove and adjust the gear assembly.
5. Explain the operation of the gear being used in the portable drill.

RESOURCES

Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, p. 292.

EVALUATION

Questions

1. Name the essential parts of a portable electric drill.
2. Gears are used in equipment to provide speed __________ and __________.
3. Ball bearings are used on gear assemblies to reduce __________.

PERFORMANCE OBJECTIVE V-TECS 10 (Continued)

Answers

1. a. Chuck
   b. Universal motor
   c. Gear assembly
   d. Electric power cord and switch
2. Ratio, torque
3. Friction

Practical Application

Set up equipment and demonstrate proper assembly, test equipment and make adjustments.

Method of Evaluation

Use Checklist Performance Objective 10 to determine if the assignment has been accomplished within 90 percent of accuracy.

CHECKLIST PERFORMANCE OBJECTIVE V-TECS 10 EVALUATION

PERFORMANCE OBJECTIVE FOR ADJUSTING DRIVE GEAR

Student's Name ______________________ **Date** ________

DIRECTIONS TO STUDENT: Check out drill motor from supply room. Disassemble drill motor. Locate gear assembly. Remove gear assembly and check for freedom of movement. Check bearings and lubricate. Reinstall gear assembly. Check unit for operation. Follow safety rules. Clean work area and store tools properly.

DIRECTIONS TO EVALUATOR: Provide access to tools, equipment, and materials needed for the student to remove gear assembly from drill motor. Observe the student. Accuracy of 90 percent is required.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Removed gear assembly from drill motor.	______	______
2. Used tools properly.	______	______
3. Did not damage other parts of assembly.	______	______
4. Area was clean and orderly when completed.	______	______
5. Followed safety rules.	______	______
6. Completed activity in 30 minutes.	______	______

APPROVED: Yes _____ NO _____

Evaluator's Signature ______________________ **Date** ________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 11

TASK: Adjust Focus Control.

CONDITIONS: An out-of-focus video screen and the following equipment: screwdrivers (assorted blades and assorted phillips heads), adjustable wrench, adjustment tool, VOM/with high voltage probe, and mirror.

STANDARD: When adjusted, the video image will be sharp, clear, in focus with no distortion.

SOURCE FOR STANDARD: Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to video focus control.
3. Energize system.
4. Make adjustments.
5. Deenergize system.
6. Replace access panels, covers, etc.

ENABLING OBJECTIVE
Read a schematic.

LEARNING ACTIVITIES
1. Relate how you would sharpen a video image on a CRT.
2. Demonstrate what safety measures you must take before handling a television receiver.
3. Explain the theory of the scanning of lines on a CRT.
4. Locate on a schematic the focus control.
5. Identify the type of CRT that does not require a focus control.

RESOURCES
Grob. **Basic Television Principles and Servicing**, p. 188.

EVALUATION
Questions
1. Focus is sharpest in the center area. (True or False)
2. What method of focusing do CRT's use?
3. When adjusting the focusing control, what is on the screen that you seek fine detail?
4. How many scanning lines are there in a frame?
5. How many scanning lines are there in a field?

Answers
1. True
2. Electrostatic focus
3. Scanning lines
4. 525
5. 262 1/2

PERFORMANCE OBJECTIVE V-TECS 11

Practical Application
Gain access to circuit board for TV and locate potentiometer used for focus control. Adjust focus control to obtain clear picture and measure voltage across potentiometer.

Method of Evaluation
Use Checklist Performance Objective 11 to determine if the assignment has been met within 90 percent accuracy.

PERFORMANCE OBJECTIVE V-TECS 11 EVALUATION

PERFORMANCE OBJECTIVE F R ADJUSTING FOCUS CONTROL

Student's Name ______________________ Date ________

DIRECTIONS TO STUDENT: Check out TV monitor from storage room. Remove cover from unit. Locate potentiometer used for focus control. Use desolder tool and soldering iron to remove potentiometer. Use ohmmeter to determine resistance value of a potentiometer. Follow safety rules. Reinstall potentiometer. Clean work area and store tools properly.

DIRECTIONS TO EVALUATOR: Provide access to tools, equipment, and materials needed for the student to remove potentiometer from circuit. Observe the student. Accuracy of 90 percent is required.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Removed potentiometer from circuit.	______	______
2. Used soldering iron.	______	______
3. Used desoldering tool.	______	______
4. Did not overheat or damage other parts of the circuit.	______	______
5. Area was clean and orderly when completed.	______	______
6. Followed safety rules.	______	______
7. Completed activity in 30 minutes.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ Date ________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 12

TASK: Adjust Linearity (Vertical, Horizontal).

CONDITIONS: A video screen whose vertical and horizontal linearity are out of adjustment and the following equipment: screwdrivers (assorted blades and assorted phillips heads), adjustment tool, generator (color bar, cross hatch, DOT), NTSC test pattern generator, and a mirror.

STANDARD: When adjusted, the lines of resolution will be evenly spaced on the displayed cross hatch pattern.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
Lockhart and Rice. **AC Circuit Analysis.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to adjustment controls.
3. Locate/identify horizontal and vertical linearity controls.
4. Connect color bar generator or NTSC test, pattern to input lead of video circuit.
5. Energize system/equipment.
6. Make adjustments.
7. Deenergize system/equipment.
8. Disconnect test equipment.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE
Use of bar generator. Use of hand tools.

LEARNING ACTIVITIES
1. Describe the purpose of the horizontal linearity control.
2. Relate the purpose of the vertical linearity control.
3. Show where the controls are located.
4. Demonstrate using a bar generator, the proper adjustments of the vertical linearity.
5. Explain the safety precautions that must be taken prior to adjustments of controls.
6. Review the safety precautions necessary when working on electrical equipment.

RESOURCES
Johnson. **How to Troubleshoot a TV Receiver**, pp. 71-73.

EVALUATION
Questions
1. Does the vertical linearity affect the height or the width of the picture?
2. Does the horizontal linearity affect the height or the width of the picture?
3. When adjusting the linearity controls, it is necessary to adjust the height control too. (True or False)

PERFORMANCE OBJECTIVE 12 (Continued)

Answers

1. Height
2. Width
3. True

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 13

TASK: Adjust Impedance.

CONDITIONS: An electronic circuit requiring impedance adjustment and the following equipment: screwdrivers (assorted blades and assorted phillips heads), adjustment tool, signal generator, output measuring device.

STANDARD: When adjusted, the impedance will conform to design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
Department of the Navy. **Fundamentals of Electronics: Alternating Current, Vol. 1B.**
National Cash Register Company. **Data Communications Concepts.**
U.S. Army. **Digital Computers: Communications Electronics Fundamentals. FM 11-72.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to the circuit.
3. Locate impedance adjustment controls.
4. Connect signal generator to input lead.
5. Connect output measuring device.
6. Energize system/equipment.
7. Adjust as necessary.
8. Deenergize system/equipment.
9. Disconnect test equipment.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE
Read schematic diagrams, use multimeter.

LEARNING ACTIVITIES
1. Explain the procedures used to vary the impedance in an A.C. circuit.
2. Explain how changes in voltage, inductance, or capacitance will affect the impedance.
3. Show how to calculate impedance in an A.C. circuit.
4. Demonstrate impedance changes in an unloaded and loaded secondary winding of a transform.
5. Explain the procedure of matching the impedance of a source to the primary of a transform.

RESOURCES
Shrader, **Electrical Fundamentals for Technicians,** pp. 366-367.
Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, p. 130.

PERFORMANCE OBJECTIVE V-TECS 13 (Continued)

EVALUATION

Questions

1. Write the formula for determining impedance when indictive reactance and resistance values are known.
2. If it is desired to match the impedance of a source to the primary of a transformer, this can be accomplished by varying the load on the ______________.
3. When inductive reactance and resistance are both present in a circuit, this total opposition to current is called ______________, the letter symbol for which is ____________.
4. Impedance is measured in ______________.
5. In a series RL circuit, L = 2H, R = 500 ohms, E_s = 100V60HzA.C. Find X_4, I, and Z.

Answers

1. $Z = \sqrt{X_L^2 + R^2}$
2. Secondary winding
3. Impedance,
4. Ohms
5. $X_L = 2\pi fL = 2(3.14)(60)(Z) = 753.6\ \Omega$
   $Z = \sqrt{X_L^2 + R^2} = \sqrt{(753.6)^2 + (500)^2} = \Omega$
   $I = \frac{E_s}{Z} =$

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 14

TASK: Adjust Modulation Percentage.

CONDITIONS: A transmitter with a modulation percentage not meeting or exceeding tolerances and the following equipment: screwdrivers (assorted blades and assorted phillips heads), wrenches (socket set with nut drivers and hex), adjustment tools, signal input generator, and output measuring device.

STANDARD: When adjusted, the modulation percentage will meet the design specification of the transmitter and FCC regulations.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to transmitter circuit.
3. Locate modulation controls.
4. Connect input generator to input to transmitter.
5. Connect output measuring device.
6. Energize system/equipment.
7. Make adjustments.
8. Deenergize system/equipment.
9. Disconnect test equipment.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE
Describe methods of obtaining modulation.

LEARNING ACTIVITIES
1. Demonstrate methods of setting circuit up for this adjustment.
2. Explain why the different settings for the generators.
3. Compare the in and out at 100% modulation.
4. Calculate the output voltage increase at 50% modulation.
5. Demonstrate the use of trapezoidal oscilloscope patterns to measure percentage of modulation.

RESOURCES
Gerrish, et al., **Transistor Electronics**, Chapter 17, pp. 269-274.

PERFORMANCE OBJECTIVE V-TECS 14 (Continued)

EVALUATION

Questions

1. In a radio broadcasting studio, the process of molding, or regulating, the electric stream for speech or music is called ____________.
2. A ______________ is an electrical device which causes speech, music, or picture information to combine with the carrier wave.
3. The process of modulation allows the carrier wave to convey, or pass, information from one location to another by ______________ energy.
4. The process of ______________ results in the separation of an audio signal from the carrier signal used in radio or TV.
5. The semiconductor used to demodulate the audio signals is a ______________.

Answers

1. Modulation
2. Modulator
3. Electromagnetic
4. Demodulation
5. Detector diode

Practical Application

1. Set up trainer and make necessary connections.
2. Show correct procedures for connecting signal generators and oscilloscope.
3. Apply correct signals and adjust for proper pattern on the oscilloscope.
4. Calculate percentage of modulation.

Method of Evaluation

Use Checklist Performance Objective 14 to determine if the assignment has been met with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 14 EVALUATION

PERFORMANCE TEST FOR ADJUSTING MODULATION PERCENTAGE

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set up amplitude Modulation Circuit. Use proper test equipment for this project. AF and RF generators, oscilloscope, electronics digital multimeter and appropriate tools. Make proper jumper connections, and tune for 100% modulation signal on the oscilloscope. Make proper measurements and calculate average power contained in the wave form at 50% and at 100% modulation.

DIRECTIONS TO EVALUATOR: Observe the student while setting up the circuit and making adjustments. See that measurements and calculations are within tolerance.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The circuit was connected.	______	______
2. The test instruments were calibrated.	______	______
3. The student is able to determine the proper calibrations and measurements.	______	______
4. The student made calculations.	______	______
5. The student explained the steps taken in the exercise.	______	______
6. The training area is left clean and neat.	______	______
7. The student followed all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ **Date** __________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 15

TASK: Adjust Oscillator.

CONDITIONS: Insulated adjustment tool, screwdrivers (assorted blades and assorted phillips heads), frequency measuring device with leads, amplitude measuring device with leads, and oscilloscope with compensated probe.

STANDARD: When adjusted, the oscillator's frequency, amplitude, distortion and phase characteristics will conform to the design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
Kubala. **Circuit Concepts: Direct and Alternating Current.**
________________. **Soldiers Manual: 34F Skill Level Two/Three DSTE Repairman.**

PERFORMANCE GUIDE

1. Determine oscillator frequency, amplitude and wave shape characteristics from design specifications.
2. Deenergize system.
3. Gain access to oscillator.
4. Locate adjustment controls.
5. Connect calibrated frequency measuring device to the oscillator output.
6. Connect output amplitude measuring device to the oscillator output.
7. Connect an oscilloscope to the oscillator output.
8. Energize system and equipment.
9. Make adjustments.
10. Deenergize system/equipment.
11. Disconnect test equipment.
12. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)

1. Describe the different types of oscillators.
2. Identify the different schematic diagrams of the oscillators.

LEARNING ACTIVITIES

1. Explain the principles of the oscillator.
2. Show how different oscillators are adjusted.
3. Explain the LC tank circuit.
4. Demonstrate the phase change when resistance is changed in the RC oscillator.
5. Explain as capacitance is adjusted how the frequency and amplitude is affected.
6. Explain why there should be no distortion when properly adjusted.

RESOURCES

Gerrish, et al., **Electricity and Electronics**, Chapter 14, pp. 209-213.

PERFORMANCE OBJECTIVE V-TECS 15 (Continued)

EVALUATION

Questions

1. What function does the transistor of the Hartley oscillator serve?
2. What components determine the frequency of the Hartley oscillator?
3. What does feedback actually achieve in the operation of the oscillator?
4. What is the major difference between the Hartley and Colpitts oscillators?
5. Why are crystals used in oscillators?

Answers

1. A switch
2. Coil, capacitors and transistor
3. Oscillations
4. Colpitts is a tapped coil.
5. To produce VHF and stable frequencies.

Practical Application

Set up and adjust an oscillator for maximum performance without distortion.

Method of Evaluation

Use Checklist Performance Objective 15 to determine if the assignment has been met within 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 15 EVALUATION

PERFORMANCE TEST FOR ADJUSTING THE RC OSCILLATOR

Student's Name ______________________ **Date** ______________

DIRECTIONS TO STUDENT: Set up the RC Oscillator circuit using proper test equipment and tools. Adjust for proper phase relationships.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure all items being evaluated are in place. Notice the phase relations are being presented on the oscilloscope.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The student has prepared the trainer.	______	______
2. The student makes connections.	______	______
3. The student makes proper voltage and current measurements while adjusting the rheostat.	______	______
4. The student can calculate phase shift in each stage.	______	______
5. The student identifies the proper signals on the oscilloscope.	______	______
6. The student cleans and puts away all equipment.	______	______
7. The student follows all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ **Date** ______________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 16

TASK: Adjust Output of High Frequency Amplifiers (Grounded Grid, Cascade).

CONDITIONS: An electronic circuit containing a high frequency amplifier requiring adjustment and the following equipment: screwdrivers (assorted blades and assorted phillips heads), socket set of wrenches with nutdrivers, insulated adjustment tools, input indicator, input signal generator, and output measuring device.

STANDARD: When adjusted, the output of the high frequency amplifier will conform to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
______________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to the high frequency amplifier.
3. Locate adjustment controls.
4. Identify amplifier specifications.
5. Connect input signal generator.
6. Connect output measuring device.
7. Energize system/equipment.
8. Make adjustments.
9. Deenergize equipment.
10. Disconnect test equipment.
11. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
Identify the transistor circuit and determine the proper biasing polarity.

LEARNING ACTIVITIES
1. Measure base and collector current of an NPN transistor.
2. Measure base, emitter and collector voltages of an NPN transistor.
3. Measure base and collector currents of a PNP transistor.
4. Measure base, emitter and collector voltages of a PNP transistor.
5. Demonstrate by adjusting the bias, the affect on a lamp control circuit.

RESOURCES
Gerrish, et al., **Transistor Electronics**, p. 136.

EVALUATION
Questions
1. The NPN transistor is forward biased when ____________.
2. In a switching circuit, the lamp current is controlled by ____________.
3. In a controlled circuit, the lamp is brightest when the collector to emitter resistance is ____________.

PERFORMANCE OBJECTIVE V-TECS 16 (Continued)

Answers

1. The base is positive with respect to the emitter.
2. The base to emitter current
3. Minimum

Practical Application

Set up a variable lamp controlled circuit and demonstrate by measuring base and collector currents.
Show affects of varying the potentiometer, on lamp brightness.
Calibrate for proper bias. Circuit should be operating within specifications.

Method of Evaluation

Use Checklist Performance Objective 16 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 16 EVALUATION

PERFORMANCE TEST FOR ADJUSTING BIAS NETWORK

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the appropriate equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed below.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to the items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Correct components were selected.	______	______
2. Circuit is connected as per schematic diagram.	______	______
3. Was able to explain circuit operation as adjustment was made.	______	______
4. Checked voltage for bias polarity and amplitude.	______	______
5. Replaced all components and equipment when completed.	______	______
6. Followed all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 17

TASK: Adjust Power Converter Output.

CONDITIONS: Screwdrivers (assorted blades and assorted phillips heads), insulated adjustment tool, wrenches (adjustable and socket set with nutdrivers), and output measuring device.

STANDARD: When adjusted, the output of the power converter will conform to the design specifications for the converter.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to power converter.
3. Locate adjustment controls.
4. Connect output measuring device.
5. Energize system/equipment.
6. Make adjustments.
7. Deenergize system/equipment.
8. Disconnect test equipment.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
1. Identify and describe the principles of the DC to DC converter.
2. Read and understand schematic diagrams.

LEARNING ACTIVITIES
1. Explain the purpose of the adjustment.
2. Show how an unbalanced condition can exist.
3. Demonstrate the operation, by showing the signal on the oscilloscope.
4. Measure the period of oscillation and calculate the time constant.
5. Show the effect of frequency changes by the adjustment.

RESOURCES
Gerrish, et al., **Electricity & Electronics**, Chapter 14, page 214.
Gerrish, et al., **Transistor Electronics**, Chapter 16, pp. 258-259.

EVALUATION
Questions
1. DC — DC converters are basically known as _______________.
2. The complete conversion cycle of a DC — DC converter is from:
3. DC — DC converters usually operate at frequencies:

Answers
1. Oscillators
2. DC to AC to DC
3. Between 60Hz and 3KHz.

PERFORMANCE OBJECTIVE V-TECS 17 (Continued)

Practical Application
Set up the trainer and connect a converter circuit.
Demonstrate by adjusting the output rheostat to several positions. Show the results on the oscilloscope and EVOM.

Method of Evaluation
Use Checklist Performance Objective 17 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 17 EVALUATION

PERFORMANCE TEST FOR ADJUSTING A POWER CONVERTER OUTPUT

Student's Name **Date**

DIRECTIONS TO STUDENTS: Set up the trainer with a DC — DC converter, 100K potentiometer, EVOM and oscilloscope. Make several adjustments to the output rheostat and demonstrate the results with the test equipment as identified in the list below.

DIRECTIONS TO EVALUATOR: Observe the student, making sure all items to be evaluated are on hand. Make sure the student follows the recommended sequence in making these adjustments. The voltage, current and frequency should agree with the decal.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. All items are in place and properly prepared.	______	______
2. The student diagnosed the problem.	______	______
3. All protective cover has been removed.	______	______
4. The student connected test equipment.	______	______
5. All necessary power has been energized.	______	______
6. Adjustments have been completed.	______	______
7. Power has been deenergized.	______	______
8. The student made necessary calculations.	______	______
9. The student replaced all protective covers.	______	______
10. The student leaves the work area neat.	______	______
11. The student followed all safety precautions.	______	______

APPROVED: Yes _____ NO _____

Evaluator's Signature **Date**

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 18

TASK: Adjust Probe Calibrator Signal.

CONDITIONS: Alignment tool, screwdrivers (assorted blades and assorted phillips heads), adjustable and hex wrenches, output measuring device.

STANDARD: When adjusted, the calibrator signal will meet design specifications.

SOURCE FOR STANDARD: Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Determine probe calibrator signal design specifications.
2. Deenergize system.
3. Gain access to adjustment controls.
4. Connect output measuring device to calibrator output.
5. Energize system/equipment.
6. Make adjustments.
7. Deenergize system/equipment.
8. Disconnect test equipment.

ENABLING OBJECTIVE
Use of an oscilloscope.

LEARNING ACTIVITIES
1. Discuss why it is necessary to adjust the probe.
2. Explain the purpose of a probe.
3. Describe two types of probes.
4. Identify the adjustment control or controls.
5. Demonstrate using an oscilloscope the proper sequence in setting up the scope and probe to measure a small DC voltage.
6. Show how to set up the oscilloscope and probe to measure a frequency.

RESOURCES
Lemons. **Learning Electronics Through Troubleshooting**, pp. 382-384.

EVALUATION
Questions
1. To prevent frequency discrimination when pulses, square waves, and other complex waveforms are being measured, what type of probe should be used?
2. A shielded probe, without compensation, that is connected directly to the test point is what kind of probe?
3. Some probes have a switch located on it indicating the ratios of 1:1 and 10:1. What do they mean?
4. What is the purpose of the intensity control on an oscilloscope?

Answers
1. Low-capacitance
2. Direct
3. Indicates the multiplying factor.
4. To increase the brightness of the trace.

PERFORMANCE OBJECTIVE V-TECS 18 (Continued)

Practical Application
Utilize probe calibrator, prepare equipment and make necessary adjustments to probe calibrator signal.

Method of Evaluation
Use Checklist Performance Objective 18 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 18 EVALUATION

PERFORMANCE TEST FOR ADJUSTING PROBE CALIBRATOR SIGNAL

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set up trainer with a probe calibrator. Make appropriate connections for adjusting output stages.

DIRECTIONS TO EVALUATOR: Observe the student. See that all items to be evaluated are on hand. Be sure the student makes proper connections. Check the oscilloscope signal that the amplifier is not being overdriven.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The trainer was prepared.	______	______
2. The proper test instruments were used.	______	______
3. The probe calibrator was calibrated.	______	______
4. The student used appropriate steps when making adjustments.	______	______
5. The student made voltage checks.	______	______
6. The student calculated power output.	______	______
7. The student was able to determine if the calibrator signal is correct.	______	______
8. The work area is left in neat order.	______	______
9. The student followed safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ **Date** __________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 19.

TASK: Adjust Resonant Frequency.

CONDITIONS: An electronic circuit requiring a resonant frequency adjustment and the following equipment: screwdrivers (assorted blades and assorted phillips heads), wrenches (assorted open end and socket set with nutdrivers), adjustment tool, output indicator, input signal generator, and frequency counter.

STANDARD: When adjusted, the resonant frequency of the circuit will conform to its design specifications.

SOURCE FOR STANDARD:

Writing Team. State of Georgia.

Department of the Navy. **Fundamentals of Electronics: Alternating Current, Vol. 1B.**

Kubla. **Circuit Concepts: Direct and Alternating Current.**

U.S. Army. **Digital Computers: Communications Electronics Fundamentals. FM 11-72.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to circuit.
3. Locate frequency adjustment controls.
4. Connect input signal generator.
5. Connect output indicator.
6. Energize system/equipment.
7. Make adjustments.
8. Deenergize system/equipment.
9. Disconnect test equipment.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)

Use oscilloscope and multimeter.
Read schematic diagrams.

LEARNING ACTIVITIES

1. Explain the procedure used to adjust the frequency change of a tank circuit.
2. Demonstrate how to vary the resonant frequency of the tank.
3. Show how to use tools and testing equipment for testing circuit.
4. Draw a tuning selector section of a radio receiver.
5. Explain types of frequency uses in home radios and short wave.

RESOURCES

Gerrish, et al., **Electricity and Electronics**, pp. 235-240.

PERFORMANCE OBJECTIVE V-TECS 19 (Continued)

EVALUATION

Questions

1. The ability of a radio receiver to select a single frequency and only one frequency is called ______________.
2. The ability of a receiver to respond to weak incoming signals is called ___________.
3. What purpose does a variable capacitor serve?
4. Name the synonymous circuit for tuning section.
5. The combination coils L_1 and L_2 are usually called the _______________.

Answers

1. Selectivity
2. Sensitivity
3. A variable capacitor is used to vary the resonant frequency of the tank.
4. Tuning or station selector section of the radio receiver
5. Antenna coil

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 20

TASK: Adjust Tape Reader.

CONDITIONS: A tape reader requiring adjustment, screwdrivers (assorted blades and assorted phillips heads), wrenches (Allen and socket set with assorted nutdrivers) cleaning solution, rags, applicator, cotton swabs, test tape, voltmeter, oscilloscope, demagnetized probe.

STANDARD: When adjusted, the tape reader will be free of all foreign material, the output from each channel will be within specified values and the tape will not bind or tear when passing through the reader.

SOURCE FOR STANDARD:

Writing Team. State of Georgia.

U.S. Army. **Digital Computers: Communications Electronics Fundamentals. FM. 11-72.**

________________. **Soldiers Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to tape head.
3. Locate adjustment controls.
4. Demagnetize heads.
5. Clean head and drive components.
6. Adjust mechanical tension arm.
7. Place test tape on reader.
8. Connect output reading service.
9. Energize system/equipment.
10. Adjust spooler and reel for ease of operation.
11. Make adjustments for each channel.
12. Deenergize system/equipment.
13. Disconnect test equipment.
14. Remove test tape.
15. Replace access panels, covers, etc.

ENABLING OBJECTIVE

None

LEARNING ACTIVITIES

1. Describe a tape reader.
2. Tell why it is important to demagnetize the head.
3. Explain how you will clean the head and drive components.
4. a. The spooler
   b. Mechanical tension arm
   c. The reading head
5. Review what safety measures must be taken.

RESOURCES

Shrader. **Electronic Communications**, pp. 595-596.

PERFORMANCE OBJECTIVE V-TECS 20 (Continued)

EVALUATION

Questions

1. What type of material causes information to be recorded on a magnetic tape?
2. What tool is used on the head to "neutralize" any magnetic field that it may contain?
3. The drive wheel is not engaged during a playback. (True or False)

Answers

1. Iron oxide
2. Demagnetizing probe
3. False

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 21

TASK: Adjust Voltage.

CONDITIONS: An electronic circuit whose voltage requires adjustment and adjustment tool, voltmeter, screwdrivers (assorted blades and assorted phillips heads), adjustable wrench.

STANDARD: When adjusted, the voltage level will conform to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to the circuit.
3. Locate voltage adjustment controls.
4. Connect voltmeter to voltage test point.
5. Energize system/equipment.
6. Make voltage adjustments.
7. Deenergize system/equipment.
8. Disconnect test equipment.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)

1. Read multimeter.
2. Read schematic diagrams.

LEARNING ACTIVITIES

1. Explain procedures used to adjust voltage level in an electronic circuit.
2. Explain different methods of voltage regulators used.
3. Demonstrate adjustment procedures on an electronic circuit.
4. Show how load resistors, fener diodes, and voltage doubles can be used to regulate voltage.
5. Draw schematic diagrams illustrating voltage regulators in various circuits.

RESOURCES

Gerrish, et al., **Electricity and Electronics**, pp. 171-175.

EVALUATION

Questions

1. The voltage decrease under load, to the power supply voltage with no load, when expressed as a percentage, is called the ______________.
2. A load resistor serves a threefold purpose. List them.
3. Name an electronic device used as a voltage regulator.
4. How can voltage be raised without the use of a transformer?
5. What type of resistor may be used if intermittent adjustments of voltage are required?

PERFORMANCE OBJECTIVE V-TECS 21 (Continued)

Answers

1. Percentage of voltage regulation
2. a. Bleeder
   b. To improve regulation
   c. As a voltage divider
3. Fener diode
4. Through the use of voltage doubles.
5. A sliding tap resistor.

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 22

TASK: Align Tuned Radio Frequency.

CONDITIONS: Alignment tool, screwdrivers (assorted blades and assorted phillips heads), adjustable wrench, output device indicator, RF signal generator.

STANDARD: When aligned, the voltage and frequency of the circuit will conform to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to TRF circuit.
3. Locate adjustment controls.
4. Connect RF signal generator to input line.
5. Connect output indicating device to output line.
6. Energize system/equipment.
7. Make adjustments.
8. Deenergize system/equipment.
9. Disconnect test equipment.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
Identify and describe the principles of the superheterodyne receiver.
Read the schematic diagrams.

LEARNING ACTIVITIES
1. Explain procedures for aligning radio frequency.
2. Demonstrate connections necessary for alignment.
3. Explain the use of the 8 ohm resistor across the speaker terminals.
4. Explain the reason for applying 445KHz signal.
5. Demonstrate peaking the IF's for maximum signal on the EVOM.

RESOURCES
Garrish, et al., **Electricity and Electronics**, Chapter 16, pp. 247-248.

EVALUATION
Questions
1. What purpose does the pre-amp stage serve?
2. What causes amplifier distortion?
3. When is IF voltage gain high?
4. How many IF transformers does the two stage amplifier have?
5. What procedure should be followed when aligning the receiver?

PERFORMANCE OBJECTIVE V-TECS 22 (Continued)

Answers

1. To amplify the audic signal.
2. Input signal is too large.
3. At the IF frequency.
4. Three
5. A logical step-by-step.

Practical Application

Use a superheterodyne receiver, proper test equipment and demonstrate the alignment procedure.

Method of Evaluation

Use Checklist Performance Objective 22 to determine if the assignment has been met within 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 22 EVALUATION

PERFORMANCE TEST FOR ALIGNING TRF

Student's Name ______________________ Date ______________________

DIRECTIONS TO STUDENT: Using the Superheterodyne receiver circuit board make necessary connections for alignment. Obtain proper test equipment and tools. Tune the receiver for proper output.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student observes proper steps in the alignment procedures.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The student demonstrates connections.	______	______
2. The student tunes the IF transformers for maximum gain at the fixed IF frequency.	______	______
3. The student makes sure the converter output transformer is tuned to the fixed IF of the receiver.	______	______
4. The student rechecks the local oscillator and receiving station for the different frequencies (IF).	______	______
5. The student determines that the IF remains the same across the broadcast band.	______	______
6. The student leaves area clean and all items put away.	______	______
7. The student follows all safety precautions.	______	______

APPROVED: Yes _____ NO _____

Evaluator's Signature ______________________ Date ______________________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 23

TASK: Calibrate Multi-Vibrator Circuit.

CONDITIONS: Screwdrivers (assorted blades and assorted phillips heads), adjustable wrench, oscilloscope with calibrated time base, pulse generator.

STANDARD: When calibrated, the output wave will conform to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to circuit.
3. Locate adjustment controls.
4. Connect pulse generator to input point.
5. Connect oscilloscope to output point.
6. Energize system/equipment
7. Make adjustments.
8. Deenergize system/equipment.
9. Disconnect equipment.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
1. Identify the different types of multivibrators.
2. Identify the schematic diagram.

LEARNING ACTIVITIES
1. Explain the operation and measurements of DC operating voltage of the monostable multivibrator.
2. Demonstrate the relationship between the timing circuits and the output pulse, by measuring output pulse width.
3. Identify a bistable multivibrator and measure the output voltage.
4. Demonstrate by using different inputs, the operation of the bistable multivibrator.
5. Show the effect of coupling capacitors on the frequency of the astable multivibrator.

RESOURCES
Gerrish, et al., **Transistor Electronics**, Chapter 16, pp. 259-263.
Dungan. **Linear Intergrated Circuits for Technicians**, Chapter 6, pp. 140-145.

EVALUATION
Questions
1. What is the free running multivibrator called?
2. What is the one thing the bistable multivibrator may be triggered by?
3. What is another name for the astable multivibrator?
4. What would describe the stage the monostable multivibrator is in before an input trigger?
5. R = 10K, C = 0.05 micro farad, what is the width of the output pulse?

PERFORMANCE OBJECTIVE V-TECS 23 (Continued)

Answers

1. Astable
2. An external signal
3. One-shot
4. State or law
5. 0.5 micro second

Practical Application

Set-up the astable multivibrator circuit and proper test equipment. Calibrate the circuit for proper time base and pulse width.

Method of Evaluation

Use Performance Objective 23 to determine if the assignment has been accomplished within 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 23 EVALUATION

PERFORMANCE TEST FOR CALIBRATING THE ASTABLE MULTIVIBRATOR

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set up ammeter coupled astable multivibrator circuit. Using the electronic digital multimeter and oscilloscope adjust for proper waveform at the output.

DIRECTIONS TO EVALUATOR: Observe the student setting up the circuit and test equipment. Make sure the student makes proper calibrations for proper output.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The circuit was connected.	______	______
2. The student made test equipment connections.	______	______
3. The student made voltage measurements to determine if the circuit is operating.	______	______
4. The student determined time period on the oscilloscope.	______	______
5. The student calculated the frequency of the multivibrator.	______	______
6. The student demonstrated calibration procedures.	______	______
7. The work station was left in order.	______	______
8. The student followed all safety precautions.	______	______

APPROVED: Yes ____ NO ____

Evaluator's Signature ______________________ **Date** __________

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 24

TASK: Calibrate P-P Voltage.

CONDITIONS: Screwdrivers (assorted blades and assorted phillips heads), adjustment tool, calibrated oscilloscope.

STANDARD: When calibrated the P-P voltage will conform to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to the circuit.
3. Locate the P-P voltage controls.
4. Connect oscilloscope to output point.
5. Energize system/equipment.
6. Make adjustments.
7. Deenergize system/equipment.
8. Disconnect equipment.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE
Use oscilloscope properly, read schematic diagrams.

LEARNING ACTIVITIES
1. Explain the procedure used to adjust peak to peak voltage on an oscilloscope.
2. Demonstrate the peak to peak voltages on an oscilloscope.
3. Show how to vary voltage levels in a circuit.
4. Explain amplitude and frequency waveforms.
5. Draw waveforms illustrating peak to peak values.

RESOURCES
Gerrish, et al., **Electricity and Electronics**, pp. 72-74.

EVALUATION
Questions
1. The maximum rise of a waveform represents the ____________ of the wave and the __________ voltage or current.
2. The ____________ of cycles of events increases with the speed increase of rotation.
3. ______________ are used to represent magnitude and direction of a force.
4. What type of waveform is produced by a generator?
5. The period of one cycle consists of how many degrees?

PERFORMANCE OBJECTIVE V-TECS 24 (Continued)

Answers

1. Amplitude, peak
2. Frequency
3. Vectors
4. A sine wave
5. 360°

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 25

TASK: Calibrate Timing/Clock Pulse.

CONDITIONS: Screwdrivers (assorted blades and assorted phillips heads). adjustable wrench, calibrated (horizontal and vertical) oscilloscope.

STANDARD: When calibrated the timing/clock pulse frequency and amplitude will meet the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
Tedeschi and Taber. **Solid State Electronics.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to digital timing circuit.
3. Locate adjustment controls.
4. Connect oscilloscope to output point.
5. Energize system/equipment.
6. Make adjustments.
7. Deenergize system/equipment.
8. Disconnect equipment.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
Read schematic diagrams.
Interpret measuring instruments.

LEARNING ACTIVITIES
1. Explain the use of timing/clock pulses in a digital timing circuit.
2. Demonstrate oscilloscope use in interpreting timing pulses.
3. Show how to adjust frequency of timing pulses.
4. Record frequency readings on oscilloscope.
5. Show how to obtain desired frequency signals.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 431-434.

EVALUATION
Questions
1. A signal generator is a test instrument used to supply output voltages of various ______________.
2. The heart of a typical signal generator is an ____________ circuit.
3. The timing clock pulses generate ______________ waveforms.
4. Varying the frequency of the signal generator will vary the ___________ produced on the oscilloscope.
5. The binary numbers representing clock pulses are binary __________ and binary __________.

PERFORMANCE OBJECTIVE V-TECS 25 (Continued)

Answers

1. Frequencies
2. Oscillator
3. Square
4. Waveforms
5. 1,0

DUTY OR UNIT: ADJUSTING/ALIGNING/CALIBRATING ELECTRONIC CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 26

TASK: Calibrate Vertical Amplitude.

CONDITIONS: An electronic circuit with an uncalibrated vertical amplitude, screwdrivers (assorted blades and assorted phillips heads), calibrated square wave generator, calibrated oscilloscope.

STANDARD: The vertical amplitude will be calibrated when the voltage on the volt/cm scale is identical to the design voltage of a calibrated signal.

SOURCE FOR STANDARD:
__________ __________. **Soldiers Manual: 34F Skill Level Two/Three DSTE Repairman.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to circuit.
3. Locate adjustment controls.
4. Energize system (allow at least 10 minute warm-up).
5. Set scope, vertical gain to lv/cm. Adjust scope centerline; zero voltage is centered on gradicule.
6. Connect equipment to input point (lv P-P to vertical input of scope).
7. Make adjustments.
8. Deenergize system/equipment.
9. Disconnect equipment.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
Identify the schematic diagram and understand vertical circuits.

LEARNING ACTIVITIES
1. Explain the operation of the vertical circuit.
2. Demonstrate changes in waveforms at different stages of the circuit.
3. Show amplitude control by adjusting the calibration rheostat.
4. Adjust the vertical hold for proper height.
5. Adjust the vertical size for proper voltages and images.

RESOURCES
Prentiss. **Servicing Zenith Television**, p. 97.

EVALUATION
Questions
1. What type signal does the vertical module receive?
2. What voltages on a Zenith television are present in the vertical module?
3. Where is the vertical module output used?
4. What type signal is received by the deflection yoke?

PERFORMANCE OBJECTIVE V-TECS 26 (Continued)

Answers

1. Positive sync pulse.
2. +24V, +35V, -35V and +135V.
3. Vertical section of the deflection yoke.
4. Sawtooth

Practical Application

Use trainer and calibrate the vertical circuit, using proper test equipment and monitors.

Method of Evaluation

Use Checklist Performance Objective 26 to determine if proper alignment was accomplished within 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 26 EVALUATION

PERFORMANCE TEST FOR CALIBRATING VERTICAL AMPLIFIERS

Student's Name ____________________ Date ________

DIRECTIONS TO STUDENT: Using a vertical circuit board and test equipment, adjust output stages for output amplitude.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure that proper connections and adjustments are made. Determine that the student follows proper sequence. Make sure the circuit isn't overdriven.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The student prepared the circuit for calibration.	______	______
2. The student made necessary test equipment connections.	______	______
3. The student adjusted the vertical hold for proper voltage and signal at the base of the vertical multivibrator.	______	______
4. The student adjusted the vertical linearity and height for proper time delay and signal at the base of the vertical amplifier.	______	______
5. The student was able to calculate the time constant of the RC network.	______	______
6. The student adjusted the pincushion amplitude control and displayed the sawtooth wave form on the oscilloscope.	______	______
7. The student was able to explain the purpose of these adjustments.	______	______
8. The student left the area clean.	______	______
9. The student followed all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ____________________ Date ________

REPLACING COMPONENTS

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 75

TASK: Replace Amplifier Circuit.

CONDITIONS: A system with a defective amplifier circuit, wrenches (socket set, adjustable), screwdrivers (assorted blades, phillips head), soldering gun, resin core solder, pliers (needle nose, diagonal), safety glasses.

STANDARD: When replaced the amplifier circuit will function according to circuit design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
Department of the Navy. **Fundamentals of Electronics: Alternating Current, Vol. 1B.**
____________________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**

PERFORMANCE GUIDE
1. Deenergize equipment.
2. Gain access to amplifier circuit.
3. Disconnect all connections to amplifier circuit.
4. Unsolder any connectors, cut wire connectors.
5. Unfasten mechanical fasteners holding circuit.
6. Remove amplifier circuit.
7. Install and mechanically secure replacement circuit.
8. Reconnect cables.
9. Solder connectors where necessary.
10. Replace access covers, panels, etc.
11. Energize equipment.
12. Check operation.

ENABLING OBJECTIVE(S)
1. Use soldering equipment and determine correct wattage for the task.
2. Determine the safety procedures used in performing the task.

LEARNING ACTIVITIES
1. Explain the procedures for removing and replacing.
2. Explain why the heat sink must be used.
3. Demonstrate and state the methods of soldering.
4. Demonstrate the method of lifting the inoperative component.
5. Show the methods of connecting heat sinks and replacing the component.

RESOURCES
Gerrish, et al. **Transistor Electronics,** Chapter 12, pp. 177, 224-225.
Dungan. **Linear Integrated Circuits for Technicians,** Chapter 13, pp. 361-378.

PERFORMANCE OBJECTIVE V-TECS 75 (Continued)

EVALUATION

Questions

1. The heat sink is a mass of metal used to carry heat ______________.
2. What size soldering gun is used to replace the transistor?
3. What effect does heat have upon the transistor?
4. It is possible to replace the amplifier in an IC. (True or False)
5. It is necessary to check the entire circuit when replacing an amplifier. (True or False)

Answers

1. Away from the component
2. 25-30 watts
3. Increase current flow
4. False
5. True

Practical Application

Using a damaged circuit board remove, replace the amplifier circuit utilizing proper safety precautions.

Method of Evaluation

All solder joints must be bright, clean with no bridges. The circuit should operate in accordance with the Checklist Performance Objective 75 with 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 75 EVALUATION

PERFORMANCE TEST FOR REPLACING AMPLIFIER CIRCUIT

Student's Name ______________________ Date ________

DIRECTIONS TO STUDENT: Set up the soldering station. Use the proper wattage soldering iron and heat sinks. Remove and replace defective components.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure the student is able to diagnose effective components. See that all defective components are removed. See that correct iron and heat sinks are used to replace components.

Determine if any damage has been done. Check that finished project is complete and neat.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The soldering station was prepared.	____	____
2. All necessary equipment was available for the exercise.	____	____
3. Circuit checked with the ohmmeter to determine defective components.	____	____
4. The student used correct procedures when lifting defective components.	____	____
5. The student cleaned all for replacement of new components.	____	____
6. The student left all solder joints bright and shining with no bridges.	____	____
7. The student checked the finished product for proper measurements.	____	____
8. The student left the soldering station in a clean state.	____	____
9. The student followed all safety procedures.	____	____

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ Date ________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 76

TASK: Replace cathode ray tube.

CONDITIONS: An electronic circuit containing a defective cathode ray tube, screwdrivers (assorted blade, assorted phillips head) socket set of wrenches with nutdrivers, safety glasses, flashlight, assorted hex wrenches.

STANDARD: When the tube is replaced there will be no space between the rubber shock housing and the tube will be geometrically aligned.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
________________________. **Soldiers Manual: 34F Skill Level Two/Three DSTE Repairman.**

PERFORMANCE GUIDE
1. Deenergize circuit.
2. Gain access to cathode ray tube.
3. Discharge tube.
4. Disconnect socket and anode connections.
5. Remove accessories from CRT.
6. Remove supporting hardware.
7. Remove defective CRT.
8. Install replacement CRT.
9. Install supporting hardware.
10. Connect accessories to CRT.
11. Connect wiring.
12. Replace access panels, covers, etc.
13. Energize circuit.
14. Check operation.

ENABLING OBJECTIVE(S)
None

LEARNING ACTIVITIES
1. Discuss what precautions and safety measures must be practiced before handling a cathode ray tube.
2. Tell where CRTs are found and how used.
3. Explain what is used to coat the viewing screen.
4. Define how the electrons are emitted from the cathode and how they are shaped before striking the screen.
5. Express what precautions must be practiced before disconnecting the anode lead from the CRT.
6. Describe what precautions must be practiced when removing the socket connection from the CRT.
7. Relate what supporting hardware might be associated with the CRT.

RESOURCES
Lemons. **Learning Electronics Through Troubleshooting.** pp. 373-380.

PERFORMANCE OBJECTIVE V-TECS 76 (Continued)

EVALUATION

Questions

1. The most dangerous element of a CRT is ________________. (Explosion or Implosion)
2. Name at least one accessory that you might have to remove from the CRT?
3. In a black and white CRT, how many "guns" are there?
4. Due to the possibility of what could happen as per question 1, what major safety rule should be followed?

Answers

1. Implosion
2. Yoke -- Focus coil -- Magnet
3. One
4. Wearing of safety glasses

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 77

TASK: Replace capacitor.

CONDITIONS: An electronic circuit containing a defective capacitor, screwdrivers (assorted blade, assorted phillips head), soldering iron, solder, resin solvent, heat sink, pliers (needle nose, diagonal), wire brush, extension light, wiping cloth, safety glasses.

STANDARD: When the capacitor is replaced there will be no heat damage to the capacitor or circuit and the circuit will function according to design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize equipment.
2. Gain access to capacitor.
3. Unsolder capacitor using heat sink as necessary.
4. Clean circuit using solvent and brush.
5. Clip and form leads of capacitor to fit.
6. Install capacitor in circuit observing polarity or outside foil markings as applicable.
7. Solder capacitor using heat sink as required.
8. Remove heat sink.
9. Clean excess solder.
10. Install equipment covers.
11. Energize circuit.

ENABLING OBJECTIVE(S)

Use test equipment. Use soldering equipment.

LEARNING ACTIVITIES

1. Relate the theory of a capacitor.
2. Identify the types of capacitors.
3. Draw the schematic symbol for capacitors.
4. Explain the safety precautions necessary when handling capacitors.
5. Discuss the voltage ratings and safety precautions before replacing a capacitor.
6. Locate the polarity of a capacitor.

RESOURCES

Lemons. **Learning Electronics Through Troubleshooting.** pp. 300-332.

PERFORMANCE OBJECTIVE V-TECS 77 (Continued)

EVALUATION

Questions

1. It is necessary to observe the connections of a capacitor if it is non-polarized. (True or False)
2. What is another name for a polarized capacitor?
3. It is dangerous to connect a 16 volt capacitor in a 20 volt circuit. (True or False)
4. What does the term "dielectric material" mean?
5. What is the unit of measurement for capacitance?
6. If capacitors are connected in parallel, do they add or divide?

Answers

1. False
2. Electrolytic capacitor
3. True
4. It is the insulating material between the plates.
5. Farads
6. Add

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 78

TASK: Replace digital display segment.

CONDITIONS: An electronic circuit containing a defective digital display segment, screwdrivers (assorted blade, assorted phillips head), I.C. puller, soldering gun, solder, resin solvent, soldering braid, wrenches (assorted Allen, socket set), solder remover.

STANDARD: When replaced, the segment's pin placement will be aligned and there will be no sign of heat or physical damage to the display segment and associated circuitry.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
Tedeschi and Taber. **Solid State Electronics.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to digital display segment.
3. Locate defective segment.
4. Remove connectors on solder from segment.
5. Install replacement digital display segment.
6. Connect digital display segment to circuit. (Caution: If segment is to be soldered, use a small wattage soldering iron, do not make any soldering bridges).
7. Energize system.
8. Test for operation.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
None

LEARNING ACTIVITIES
1. Explain the basic theory of a seven-segment LED.
2. Tell what segments must be lit to display the numbers 3, 6, and 8.
3. Describe what safety precautions that must be used when unsoldering a solid-state device?
4. Identify what safety precautions must be exercised when soldering?
5. Relate the purpose of an IC puller.
6. Explain the use of soldering braid.

RESOURCES
Tokheim. **Digital Electronics**, pp. 67-77.

EVALUATION

Questions

1. If segments a, c, d, f, and g are lit, the decimal number is ______.
2. The letters "LED" stand for ____________________.
3. The letters "LCD" stand for ____________________.
4. The seven-segment displays that give off a red glow are of what type?
5. Which type of display is used where bright light will be a factor?

Answers

1. The number 5
2. Light emitting diode
3. Liquid-crystal display
4. LED
5. LED

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 79

TASK: Replace defective yoke.

CONDITIONS: Screwdrivers (assorted blade, assorted phillips head), socket set of wrenches with nutdrivers, pliers, needle nose pliers, flashlight, degaussing coil, wiping cloth, glass cleaner.

STANDARD: When replaced, the yoke will be mechanically secure around the cathode ray tube and be adjusted so as to respond to the full range of adjustment controls.

SOURCE FOR STANDARD:
Tedeschi and Taber. **Solid State Electronics.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to deflection yoke.
3. Disconnect CRT socket.
4. Remove accessories (blue lateral magnet, convergence yoke, etc.)
5. Remove deflection yoke.
6. Install replacement yoke.
7. Connect yoke plug.
8. Replace accessories.
9. Connect CRT socket.
10. Energize system.
11. Degauss CRT.
12. Test for performance.
13. Deenergize system.
14. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
Use of hand tools. Use of soldering equipment.

LEARNING ACTIVITIES

1. Discuss the basic operation of a yoke.
2. Show where the yoke is located inside of a receiver.
3. Relate the safety precautions that must be practiced when replacing the yoke.
4. Demonstrate the proper procedure in disassembly of set in order to replace the yoke.
5. Show the proper procedure of re-assembly of set and what adjustments might have to be made after yoke is replaced.
6. Indicate what soldering iron (if needed) is used for unsoldering the old yoke.
7. Explain what other hand tools will be needed to unsolder and remove the yoke.
8. Review the safety precautions that must be practiced when handling soldering equipment.

RESOURCES
Lemons. **Learning Electronics Through Troubleshooting.** p. 567.

PERFORMANCE OBJECTIVE V-TECS 79 (Continued)

EVALUATION

Questions

1. What is the purpose of the degaussing coil?
2. What does CRT mean?

Answers

1. Demagnetizes
2. Cathrode Ray Tube

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 80

TASK: Replace dynamotor.

CONDITIONS: A defective dynamotor, assorted blade screwdrivers, wrenches (socket set with nutdrivers, assorted open end), lifting device, voltmeter, extension light, wiping cloth.

STANDARD: When replaced, the dynamotor will be firmly secured to the mountings, there will be a minimum of vibration while running, the electrical terminals must be secure and polarity observed.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize equipment.
2. Gain access to dynamotor.
3. Disconnect electrical connections. (Caution: To ensure proper polarity when reconnecting terminals, mark the electrical connections).
4. Disconnect dynamotor from mounting.
5. Remove dynamotor.
6. Install replacement dynamotor.
7. Mechanically secure dynamotor to mounting.
8. Reconnect electrical terminals. (Caution: Observe polarity when connecting electrical leads).
9. Energize system.
10. Test for performance.
11. Deenergize system.
12. Replace access covers, panels, etc.

ENABLING OBJECTIVE(S)

1. Use tools properly.
2. Interpret meter readings.

LEARNING ACTIVITIES

1. Explain operation of a dynamotor.
2. Show construction of equipment.
3. Demonstrate the procedure for removal and replacement of dynamotor.
4. Show how to test dynamotor for defective part.
5. Explain different uses of dynamotor.

RESOURCES

Shrader, **Electrical Fundamentals for Technicians**, pp. 225-226.

PERFORMANCE OBJECTIVE V-TECS 80 (Continued)

EVALUATION

Questions

1. What device could be used to convert low voltage D-C to high-voltage D-C?
2. In an A.C. motor — D.C. generator set, would it be better to start the motor with the generator load on or off?
3. What adjustment should be used to change the voltage output?

Answers

1. Dynamotor
2. Off
3. Generator — shunt field, excitation

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 81

TASK: Replace energy storage cells.

CONDITIONS: An electronic circuit containing defective energy storage cells, screwdrivers (assorted blade, assorted phillips head), adjustable wrenches, wire brush, wiping cloth, flashlight.

STANDARD: When replaced, the energy storage cells will be secure in their mountings, terminals will be free of corrosion and the voltage polarity of the cells will be observed.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system. (Caution: When replacing energy storage cells, be able to observe all safety regulations).
2. Gain access to energy storage cells.
3. Identify defective cells.
4. Remove electrical connections (positive lead first).
5. Remove energy storage cell.
6. Remove any corrosion on terminals.
7. Install replacement cell.
8. Connect electrical connections (negative lead first).
9. Replace access panels, covers, etc.
10. Test for performance.

ENABLING OBJECTIVE(S)

1. Use tools properly.
2. Read meter.

LEARNING ACTIVITIES

1. Explain how to replace the battery in a transister radio.
2. Show how to test battery under load for determining if it is good or bad.
3. Demonstrate how to clean terminals and check continuity at terminals of circuit.
4. Show how to install new battery and check out operation of equipment.
5. Explain the purpose of keeping charged energy storage cells in the circuit.

RESOURCES

Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 140-146.

PERFORMANCE OBJECTIVE V-TECS 81 (Continued)

EVALUATION

Questions

1. If the value of the voltage is less than ________% of the open circuit voltage, the cell or battery should be replaced.
2. The voltage test must be made with the __________ connected.
3. If a dry cell or battery is not in good condition, its internal resistance is high due to the drying out of the __________.
4. The shelf life of a cell is that period of time during which the cell can be stored without losing more than approximately ______% of its original capacity.
5. List three types of energy storage cells.

Answers

1. 80
2. Load
3. Electrolyte
4. 10
5. a. Nickel cadmium cell
   b. Mercury cells
   c. Alkaline cells

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 82

TASK: Replace air filter.

CONDITIONS: An electronic circuit containing a defective air filter, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted Allen, socket set), flashlight, vacuum cleaner, wiping cloth.

STANDARD: When replaced, the filter will be mechanically secure and will be positioned to face the prescribed air flow directions.

SOURCE FOR STANDARD:
Lockhart and Rice. **AC Circuit Analysis.**
____________________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to filter.
3. Remove filter.
4. Clean lint, dirt, dust or any other foreign material from around filter mounting.
5. Install replacement filter.
6. Replace access panels, covers, etc.
7. Test for performance.

ENABLING OBJECTIVE(S)
Identify the different types of filters.

LEARNING ACTIVITIES
1. Demonstrate how to check pressure drop across the filter.
2. Show how to visually check the filter for clogging.
3. How would you determine that the filter is properly seated with no visual holes torn in the medium?
4. Explain how to check housing for deterioration and repair if necessary.
5. List the steps in replacing the filter if any of the above is evident.

RESOURCES
Althouse. **Modern Refrigeration and Air Conditioning**, Chapter 22.

EVALUATION
Questions
1. All filters can be thrown away. (True or False)
2. How should the filter be installed into the air handler?
3. How are the electrostatic air filters cleaned?

PERFORMANCE OBJECTIVE V-TECS 82 (Continued)

Answers

1. False
2. Arrows on the filters edge mark the direction of installation.
3. Water and a good cleaning detergent

Practical Application

Given a forced air system, the student will clean or replace the filter.

Method of Evaluation

Use Checklist Performance Objective 82 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 82 EVALUATION

PERFORMANCE TEST FOR REPLACING AN AIR FILTER

Student's Name ______________________________ **Date** __________

DIRECTIONS TO STUDENT: Set-up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The inspection area was prepared.	______	______
2. The filter was given a static check for any air blockage.	______	______
3. Visual inspection was performed.	______	______
4. Air handler checked for damage.	______	______
5. Filter cleaned or replaced.	______	______
6. Inspection panels replaced.	______	______
7. Performance check accomplished.	______	______
8. Followed all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ **Date** __________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 83

TASK: Replace frequency converter (motor generator).

CONDITIONS: Screwdrivers (assorted blade, assorted phillips head), wrenches (socket set with nutdrivers, assorted open end, assorted Allen), lifting device, voltmeter, frequency counter.

STANDARD: When replaced, the converter will have secure mechanical and electrical connections and conform to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize equipment.
2. Gain access to converter.
3. Mark and disconnect electrical connections.
4. Remove converter from mountings.
5. Install replacement converter.
(Note: Observe motor generator shaft alignment).
6. Make electrical connections conforming to markings made in Step 3.
7. Energize equipment.
8. Check rotation and frequency of frequency converter.
9. Deenergize equipment.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
1. Interpret meter readings.
2. Use oscilloscope properly.

LEARNING ACTIVITIES
1. Explain the procedures used in the removal and replacement of the frequency converter.
2. Explain the principles of operation of a D.C. and an A.C. generator.
3. Explain how the frequency is determined for generators.
4. Demonstrate the different voltage outputs by varying the RPMS of the generator.
5. Show how to adjust slip rings or brushes for proper voltage readings.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 150-157.

PERFORMANCE OBJECTIVE V-TECS 83 (Continued)

EVALUATION

Questions

1. A generator may be operated by rotating coils of wire through a ____________ or by rotating a ____________ past coils of wire.
2. The operation of a generator is based on the principles of ______________.
3. A generator may be defined as a machine which converts ____________ energy into ____________ energy.
4. A commutator is used in a ______________ generator.
5. The frequency of the alternating current produced by the generator depends upon the speed of the ____________ and the number of magnetic ____________ formed by the field windings.

Answers

1. Magnetic field, magnet
2. Magnetism
3. Mechanical, electrical
4. D.C.
5. Rotor, magnetic poles

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 84

TASK: Replace fuse.

CONDITIONS: An electronic circuit with a defective fuse, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted Allen, adjustable), fuse pullers, soldering gun, resin core solder, assorted fuses.

STANDARD: When replaced the fuse will fit securely in the fuse holder, be of same physical size and specifications and allow the current path to be complete.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to fuse.
3. Locate defective fuse.
4. Remove fuse.
5. Install replacement fuse.
6. Replace access panels, covers, etc.
7. Energize system.

ENABLING OBJECTIVE(S)
1. Use meter.
2. Interpret schematic diagram.

LEARNING ACTIVITIES
1. Explain how to check fuse with voltage on and off.
2. Demonstrate procedures used to remove fuse from the circuit.
3. Show how to solder and desolder a fuse in a printed circuit board.
4. Identify faulty fuses and good fuses.
5. Explain the operation of a fuse and how to rate them.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, pp. 28-30.

EVALUATION
Questions
1. A ____________ is a safety device which operates as a switch to turn a circuit off when the current exceeds a specified value.
2. _______________ fuses are most often used in motor circuits.
3. _______________ fuses are mounted in clip holders.
4. Never replace a fuse of the proper size with one that is __________ in size.
5. The ______________ fuse is designed to prevent a fuse from being replaced with one of a different electrical size.

PERFORMANCE OBJECTIVE V-TECS 84 (Continued)

Answers

1. Fuse
2. Dual element
3. Cartridge
4. Larger
5. Tamperproof

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 85

TASK: Replace Integrated Circuit chips.

CONDITIONS: An electronic circuit with a defective IC chip, screwdrivers (assorted blade, assorted phillips head), soldering iron, soldering pot, pliers (needle nose, diagonal), resin solvent, solder, heat sink, grounding straps, wire brush, solder remover.

STANDARD: When replaced, there will be no damage to chip or the circuit and the chip will function according to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize equipment.
2. Gain access to chip.
3. Install heat sink and grounding straps as applicable.
4. Unsolder chip. (Caution: Do not apply excessive heat).
5. Remove excess solder and resin from circuit board.
6. Remove new chip from protective packing material if applicable (CMOS devices).
7. Install chip in circuit. (Caution: Observe proper pin alignment to prevent improper installation).
8. Connect heat sink and ground straps as necessary.
9. Solder chip.
10. Check for solder bridges.
11. Remove heat sink and ground straps.
12. Clean circuit of excess solder and resin.

ENABLING OBJECTIVE(S)
Recognize static electricity and chips.
Use soldering iron properly.

LEARNING ACTIVITIES
1. Explain the method of removing and replacing an IC chip.
2. Demonstrate the removal of an IC chip using proper tool.
3. Show how to examine IC for cracks or damaged pins.
4. Show how to solder and unsolder IC in circuit, using a softer solder or solder wick.
5. Explain advantages of using IC chips in circuit.

RESOURCES
Fowler. **Electronic Principles and Applications**, pp. 228-230.

EVALUATION
Questions
1. Two precautions to take when replacing an IC are:
2. How are IC chips identified to determine proper installation?
3. What test equipment is mostly used to check IC chips?
4. What tools are required to remove an IC from a circuit?

PERFORMANCE OBJECTIVE V-TECS 85 (Continued)

Answers

1. a. Disconnect power, (never plug or unplug).
   b. Insure faults do not exist in the external parts. You run a risk of destroying a new IC if faults exist.
2. One end of an IC will be notched or have a painted dot to indicate the number sequence of the pins.
3. An oscilloscope is widely used to troubleshoot IC chips.
4. If an IC is plugged into a socket, an IC chip removed tool or small blade screw driver should be used for removal of chip. If IC is soldered, a desolving tool or grounding store along with a heat sink should be used.

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 86

TASK: Replace indicator lamps.

CONDITIONS: An electronic circuit containing a defective indicator lamp, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted Allen, socket set), assorted nutdrivers, assorted lamps.

STANDARD: When the lamp is replaced, it will illuminate when the circuit is activated and will not illuminate when the circuit is deenergized.

SOURCE FOR STANDARD:
Lockhart and Rice. **AC Circuit Analysis.**
____________________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE
1. Deenergize circuit.
2. Gain access to the indicator lamp.
3. Remove defective lamp.
4. Install replacement lamp.
5. Replace access panels, covers, etc.
6. Energize system.

ENABLING OBJECTIVE(S)
None

LEARNING ACTIVITIES
1. Tell the purpose of indicator lamps.
2. Identify the type of bases.
3. Draw the schematic symbol of an indicator lamp.
4. Explain what safety precautions must be taken.
5. Demonstrate how to test a lamp.

RESOURCES
Practical Electricity & Electronics, Vol 1., Bock Engineering (Lab Volt) pp. 8-1 - 8-4.

EVALUATION
Questions
1. In what direction do you turn a lamp to tighten? (Clock-wise or counter clock-wise)
2. What instrument is used to test a lamp?
3. A lamp operates if the filament is opened. (True or False)

Answers
1. Clockwise
2. VOM/VTVM
3. False

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 87

TASK: Replace klystron.

CONDITIONS: An electronic circuit with a defective klystron, screwdrivers (assorted blade, assorted phillips head), assorted hex wrenches, soldering iron, resin core solder, wiping cloth, flashlight, assorted nutdrivers.

STANDARD: When replaced, the klystron will have secure mechanical and electrical connections and function according to the design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to klystron.
3. Discharge klystron capacitor.
4. Remove electrical connections.
5. Remove mechanical connections.
6. Remove defective klystron.
7. Install replacement klystron.
8. Connect mechanical connections.
9. Connect electrical connections.
10. Replace access panels, covers, etc.
11. Test for performance.

ENABLING OBJECTIVE(S)

Use the knowledge of microwave systems.

LEARNING ACTIVITIES

1. Explain the reason why one never looks directly into the output of the klystron or the wave guide.
2. Explain how to determire if voltage is present before connecting the klystron to the power supp'y.
3. Demonstrate the methods of supporting the klystron while installing.
4. Show how to protect the wave guide flanges from nicks and scratches.
5. Demonstrate proper methods of applying power to the klystron.

RESOURCES

O'Kelley, G.L. **Electronic Phase C (Radio, Television and Microwave)**, Job Sheet 33.

PERFORMANCE OBJECTIVE V-TECS 87 (Continued)

EVALUATION

Questions

1. What type device is required to carry energy at frequencies higher than 3GHz?
2. Why is it necessary to protect the wave guide or klystron flange from scratches?
3. Which voltage should be applied to the klystron first?
   a. Reflector voltage
   b. Beam voltage
   c. Filament voltage
   d. Collector voltage

Answers

1. Wave guide
2. Prevent radiation leaks
3. a

Practical Application

Refer to Checklist Performance Objective 87. Use a microwave oven, have student replace the klystron observing all safety precautions.

Method of Evaluation

Use Checklist Performance Objective 87 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 87 EVALUATION

PERFORMANCE TEST FOR REPLACING A KLYSTRON

Student's Name ______________________________ **Date** ____________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfaction	Unsatisfactory
1. Safety was observed.	______	______
2. The wave guide and klystron was protected.	______	______
3. Checks were made for the absence of voltages before installation was started.	______	______
4. The reflector voltage was applied before beam voltage.	______	______
5. Area was left in a neat condition.	______	______
6. All safety precautions were followed.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ **Date** ____________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 88

TASK: Replace magnetron.

CONDITIONS: System with a magnetron (microwave oven, etc.). Screwdrivers (assorted blade, assorted phillips head), wrenches (assorted Allen, socket set with nutdrivers), soldering iron, resin core solder, flashlight, pliers (needle nose, diagonal).

STANDARD: When replaced, the magnetron will be mechanically secure, the electrical connections will be made and the magnetron will function according to the design specifications of the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to magnetron.
3. Discharge magnetron capacitor.
4. Remove electrical connections from magnetron.
5. Remove mechanical connectors.
6. Remove defective magnetron.
7. Install replacement magnetron.
8. Connect mechanical connections.
9. Connect electrical connections.
10. Replace access covers, plates, etc.
11. Test for performance.

ENABLING OBJECTIVE(S)
Use the operating principles of a radar transmitter.
Identify the microwave principle.

LEARNING ACTIVITIES
1. Explain safety precautions required in changing a magnetron.
2. Demonstrate care not to bend or jar the filament leads.
3. Explain the use of nonmagnetic tools during the installation.
4. Explain how a blow to the magnet could severely damage it.
5. Demonstrate the operation of the transmitter after the change has been completed.

RESOURCES
United States Air Force Manual 52-8 Electronic Circuit Analysis.

EVALUATION
Questions
1. It is not neccessarily essential to discharge the magnetron connector when replacing the magnetron. (True or False)
2. How do you check the magnetron for proper operation?

Answers

1. False
2. The magnetron must function according to the design specifications of the circuit.

Practical Application

Using a microwave oven replace the magnetron, and check the operation of the system. Use proper test equipment.

Method of Evaluation

Use Checklist Performance Objective 88 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 88 EVALUATION

PERFORMANCE TEST FOR REPLACING A MAGNETRON

Student's Name ______________________________ **Date** __________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Gain access to the transmitter section.	______	______
2. Checked that all voltage has been cut off.	______	______
3. Protected the wave guide and magnet from foreign objects.	______	______
4. Correct non-magnetic tools utilized.	______	______
5. Magnetron replaced using the safety procedures.	______	______
6. Care used when connecting the filament leads and coaxial cables.	______	______
7. Warm-up time allowed when the power was applied.	______	______
8. Power out and frequency checked in accordance to specifications.	______	______
9. All safety precautions were followed.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ **Date** __________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 89

TASK: Replace microphone.

CONDITIONS: An electronic circuit containing a defective microphone, screwdrivers (assorted blade, assorted phillips head), assorted Allen wrenches, pliers (needle nose, diagonal), soldering iron, resin core solder.

STANDARD: When replaced, mechanical connections will be tight, the electrical connections will be void of any movement and the microphone will be static free.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to pick up element.
3. Disconnect electrical connections.
4. Disconnect mechanical connections.
5. Remove defective microphone.
6. Install replacement microphone.
7. Connect mechanical connections.
8. Connect electrical connections.
9. Energize system.
10. Test performance.
11. Deenergize system.
12. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)

1. Read schematic diagram.
2. Use meter.

LEARNING ACTIVITIES

1. Explain the operation of a microphone.
2. Identify two types of microphones.
3. Demonstate operation of dynamic and crystal microphones.
4. Illustrate waveform of the amplitude.
5. Explain how to replace and maintain a microphone.

RESOURCES

Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 353-355.

PERFORMANCE OBJECTIVE V-TECS 89 (Continued)

EVALUATION

Questions

1. A microphone changes the energy of sound waves into __________ energy.
2. The microphone is called a ______________.
3. List two types of microphones.
   a. ____________
   b. ____________
4. When the crystal is vibrated mechanically, an alternating voltage is developed. This is known as the _____________ effect.
5. Good quality dynamic microphones can respond to frequencies ranging from approximately _____________ to ______________ Hz.

Answers

1. Electric
2. Transducer
3. Dynamic, crystal
4. Piezoelectric
5. [illegible]-15000

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 90

TASK: Replace oscillator.

CONDITIONS: An electronic circuit with a defective oscillator, screwdrivers (assorted blade, assorted phillips head), socket set of wrenches with nutdrivers, soldering iron, resin core solder, pliers (needle nose, diagonal), wiping cloth, flashlight, wire stripoers.

STANDARD: When replaced, the oscillator will be mechanically secure, the terminals electrically bonded and the oscillator will function according to circuit design specifications.

SOURCE FOR STANDARD:

________________. **Soldier's Manual: 34F Skill Level Two/Three DSTE Repairman.**

PERFORMANCE GUIDE

1. Deenergize equipment.
2. Gain access to oscillator.
3. Disconnect all connections to oscillator (unsolder or cut electrical connections).
4. Remove oscillator.
5. Install replacement oscillator.
6. Connect mechanical fasteners.
7. Solder electrical connectors.
8. Replace access panels, covers, etc.
9. Energize equipment.
10. Test for performance.

ENABLING OBJECTIVE(S)

1. Determine the operation and correct schematic diagram for the oscillator.
2. Use of safety procedures in lifting the component.

LEARNING ACTIVITIES

1. Explain the purpose of the oscillator.
2. Explain the importance of a good electrical bond.
3. Explain the difference between the different oscillators.
4. Demonstrate the proper method of soldering the transistor into the circuit.
5. Show methods of determining proper operation of the oscillator.

RESOURCES

Gerrish, et al., **Transistor Electronics,** Chapter 16, pp. 250-259.

Dungan. **Linear Integrated Circuits for Technicians,** Chapter 5, pp. 119-138 and Chapter 13, p. 9.

PERFORMANCE OBJECTIVE V-TECS 90 (Continued)

EVALUATION

Questions

1. What determines the oscillations in the LC oscillator?
2. What determines the phase shift of the oscillator?
3. How many RC sections must be used to provide an inphase feedback to the input of the oscillator?
4. What is the frequency of the oscillator, if T = 10 micro seconds?
5. Why was a heat sink used during replacement of the oscillator?

Answers

1. LC tank circuit.
2. Resistors and capacitors.
3. Three or more
4. 1KHz
5. Dissipate heat

Practical Application

Utilize the circuit board, make necessary checks, remove and replace affected components.

Method of Evaluation

Use Checklist Performance Objective 90 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 90 EVALUATION

PERFORMANCE TEST FOR REPLACING THE OSCILLATOR

Student's Name ______________________ **Date** ________

DIRECTIONS TO STUDENT: Set up the soldering station. Using the proper equipment check the circuit to be replaced. Determine what components should be removed and remove the components. Replace and check new circuit.

DIRECTIONS TO EVALUATOR: Observe the student and make sure the proper equipment is being used. Check to see that the finished product is complete and checks.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	The soldering station is prepared.	______	______
2.	All necessary equipment is available for the exercise.	______	______
3.	The student used correct procedures checking and lifting effective components.	______	______
4.	The student checked circuit for proper measurements and solid neat connections.	______	______
5.	The student cleaned the area when finished.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ **Date** ________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 91

TASK: Replace Printed Circuit boards.

CONDITIONS: An electronic circuit having a defective P.C. board, screwdrivers (assorted blade, assorted phillips head), adjustable wrenches, soldering iron, resin core solder, pliers (needle nose, diagonal), flashlight.

STANDARD: When replaced, the P.C. board must not wobble or vibrate, all connections must be electrically bonded and there must be no damage to the P.C. board or surrounding boards or circuits.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize equipment.
2. Gain access to board.
3. Observe physical position of board.
4. Remove solder or plug connections from board.
5. Remove defective board.
6. Compare part numbers and revision levels of replacement board and defective board.
7. Insure that replacement board is interchangeable with defective board.
8. Install replacement board being careful not to damage plug or board.
9. Make plug or solder connections as necessary.
10. Replace access covers.
11. Energize equipment.
12. Test for performance.

ENABLING OBJECTIVE(S)

Use of soldering equipment.
Recognize static electricity.

LEARNING ACTIVITIES

1. Relate why manufacturers are more apt to use the Micro Processors, I.C. over any other type circuit.
2. Explain how a cracked PC board may be repaired.
3. Demonstrate the proper soldering and unsoldering techniques when working on PC boards.
4. Review the safety measures that must be used when soldering.
5. Discuss the special service techniques that must be used while working on and with PC boards.
6. Tell what safety measures you have to take prior to the removal of any circuit board.

RESOURCES

Lemons. **Learning Electronics Through Troubleshooting.** pp. 574-584.

PERFORMANCE OBJECTIVE V-TECS 91 (Continued)

EVALUATION

Questions (True or False)

1. When replacing parts on a PC board, it is not acceptable practice to crush the defective part with pliers.
2. Excessive heat can cause the foil on the PC board to separate from the board.
3. The most common type of PC board is the "etched" circuit.
4. An acceptable method for locating a suspected open conductor is to attach a jumper wire while the circuit is turned on.

Answers

1. False
2. True
3. True
4. True

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 92

TASK: Replace photo-electric relays.

CONDITIONS: An electronic circuit with defective photo-electric relays, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted Allen, socket set with assorted nutdrivers), pliers (needle nose, diagonal), flashlight.

STANDARD: When replaced, the photo-electric relays must not be loose, the electrical contacts must be continuous and the relays must function according to design specifications.

SOURCE FOR STANDARD:
Lockhart and Rice. **AC Circuit Analysis.**
________________. **Soldier's Manual 34E Sill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to photo-electric relays.
3. Remove all connections from relays.
4. Remove defective relay.
5. Install replacement relay.
6. Connect all mechanical and electrical connections.
7. Replace access covers, panels, etc.
8. Energize equipment.
9. Test for performance.

ENABLING OBJECTIVE(S)
1. Use tools properly.
2. Interpret meter readings.

LEARNING ACTIVITIES
1. Explain the procedures for removing and replacing a photo-electric relay.
2. Show how to mark and remove conductors from relay.
3. Demonstrate the method of testing the removed and replacement relay.
4. Explain the operation of the photo-electric relay.
5. Show how to install relay into circuit.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, pp. 194-195.

EVALUATION
Questions
1. Photocells belong to a group of devices which are called ____________.
2. Describe the operation of a photoconductive cell.
3. What happens in a system when the path between the light source and the photocell is interrupted?
4. The relay acts as an ____________ to activate counters, alarm systems, inspection or supervision equipment and other devices.

PERFORMANCE OBJECTIVE V-TECS 92 (Continued)

Answers

1. Transducers
2. As light strikes the photocell, its resistance decreases, allowing more current to flow in the circuit.
3. The current in the relay circuit decreases.
4. On-off switch

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 93

TASK: Replace power supplies.

CONDITIONS: An electronic circuit with a defective power supply, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted hex, adjustable), soldering iron, resin core solder, pliers (needle nose, diagonal), flashlight, wiping cloth, VOM.

STANDARD: When replaced, electrical polarity of the connections will be observed, the power supply connections will not be loose and they will generate the specified voltage.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to power supplies.
3. Remove electrical connections. (Caution: Note the polarity of the electrical connectors. Mark if necessary).
4. Remove defective power supplies.
5. Install replacement power supplies.
6. Connect power supplies to system. (Caution: Observe polarity of connections).
7. Replace access panels, covers, etc.
8. Energize system.
9. Test for performance.

ENABLING OBJECTIVE(S)
1. Read a schematic.
2. Recognize a circuit.

LEARNING ACTIVITIES
1. Relate the purpose of a power supply.
2. Indicate on a schematic a power supply.
3. Discuss the theory of operation of a full-wave rectifier.
4. Name another kind of rectifier.
5. Explain the theory of the filtering system on a power supply.
6. Review the safety practices that must be used prior to and during the replacement of a power supply.
7. Point out the power supply on a circuit board.

RESOURCES
Lemons. **Learning Electronics Through Troubleshooting.** pp. 478-490.

PERFORMANCE OBJECTIVE V-TECS 93 (Continued)

EVALUATION

Questions

1. What instrument would be best to test the rectifier diode?
2. It is necessary for a power supply to have a transformer. (True or False)
3. What is the minimum amount of diodes necessary for a full-wave rectifier?
4. How many diodes does a bridge rectifier use?
5. Looking at the schematic symbol for a diode, does current flow through a diode against the arrow or with the arrow?

Answers

1. VOM or Ohmmeter
2. False
3. Two
4. Four
5. Against the arrow.

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 94

TASK: Replace pulley belt.

CONDITIONS: An electronic circuit with a defective pulley belt, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted hex, assorted open end), pliers, flashlight.

STANDARD: When replaced, the belt must have no deterioration, frays or unevenness, must be aligned with the pulley wheels and the tension of the belt must conform to design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to pulley belts.
3. Remove defective belt.
4. Install replacement belt.
5. Make adjustments to pulley wheels.
6. Energize system.
7. Test for performance.
8. Deenergize system.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
1. Use tools properly.
2. Use meter.

LEARNING ACTIVITIES
1. Explain operation of tape recorder using pulley belt.
2. Demonstrate how to remove belt and replace.
3. Show how to determine if belt is defective.
4. Show how to adjust tension on belt.
5. Explain advantages of maintaining belt operation.

RESOURCES

Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 364-365.

EVALUATION

Questions
1. The belt is connected to the ______________ and the drive mechanism in a tape recorder.
2. The belt should be replaced when it becomes __________ or __________.
3. List the advantage of a belt system on a recorder.

Answers
1. Drive motor
2. Worn, torn
3. Ease of adjustment and protection of motor overload.

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 95

TASK: Replace relays.

CONDITIONS: An electronic circuit with a defective relay, VOM, screwdrivers (assorted blade, assorted phillips head), socket set of wrenches with nutdrivers, needle nose pliers, assorted connectors, crimp tool, flashlight, soldering iron, resin core solder.

STANDARD: When replaced, the relay must open and close the circuit in accordance with the design specifications of the circuit.

SOURCE FOR STANDARD:
__________________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to defective relay.
3. Disconnect relay.
4. Remove relay from circuit.
5. Insert replacement relay.
6. Reconnect electrical and mechanical connections.
7. Energize system.
8. Test for performance.
9. Replace access covers, panels, etc.

ENABLING OBJECTIVE(S)
Use a VOM.

LEARNING ACTIVITIES
1. Discuss the type of relays available.
2. Explain the basic operation of a relay.
   a. The contacts
   b. The coil
   c. Electromagnetism
3. Indicate the parts of a relay.
4. Draw the schematic symbol of a relay SPST.
5. Show the method and instrument used to test relays.
6. Identify the terms NO contacts and NC contacts.
7. Demonstrate how to test a relay.
8. Review the type of soldering iron that will be used.
9. Tell what type of solder will be used.
10. Describe what safety precautions must be taken when handling soldering equipment

RESOURCES
Lemons. **Learning Electronics Through Troubleshooting.** pp. 201-204.

PERFORMANCE OBJECTIVE V-TECS 95 (Continued)

EVALUATION

Questions

1. On a relay the part that is attracted to the coil when current is flowing is called ______________.
2. When replacing a relay, what type of solder should be used?
3. The relay is what type of switching device?
4. What does NC mean?
5. What is the purpose of a relay?

Answers

1. Armature
2. Resin core
3. Electromechanical
4. Normally closed
5. To control voltage and current.

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS

TASK: Replace guide roller.

CONDITIONS: An electronic circuit containing a defective guide roller, screwdrivers (assorted blade, assorted phillips head), assorted open end wrenches, pliers, needle nose pliers, light duty grease, wiping cloth.

STANDARD: When replaced, the roller must conform to the mechanical tolerances and tensions, and function without vibration or binding.

SOURCE FOR STANDARD:
Lockhart and Rice. **AC Circuit Analysis.**
________________. **Soldier's manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to roller guide.
3. Disconnect mechanical fasteners.
4. Remove defective guide roller.
5. Insert replacement guide roller. (Caution: Insure gears from roller guide and drive gear mesh properly).
6. Lubricate gears.
7. Lock guide roller in place.
8. Energize system.
9. Test for performance.
10. Replace access panels.

ENABLING OBJECTIVE(S)
Uses of guide rollers

LEARNING ACTIVITIES
1. Show how to remove all covers and panels necessary to gain access to the roller.
2. Explain how to determine which guide roller is bad.
3. Demonstrate how to remove defective roller.
4. Show how to replace with new roller making sure of alignment.
5. Demonstrate how to clean and lubricate the entire roller track.
6. Discuss how to replace all paneling and check operation of the system.

RESOURCES
Ruel, **Servicing Electrical Appliances. Motor Theory and Motor Driven Appliances.**

EVALUATION
Questions
1. Why are roller guides used in the electric dryer?
2. What indication would a broken or binding roller give?
3. It is necessary to remove the dryer tub to replace a roller. (True or False)

PERFORMANCE OBJECTIVE V-TECS 96 (Continued)

Answers
1. To support the tub.
2. The tub would bind or not turn and the drying process would not complete.
3. False

Practical Application
Replace a set of rollers in a dryer.

Method of Evaluation
Use Checklist Performance Objective 96 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 96 EVALUATION

PERFORMANCE TEST FOR REPLACING A GUIDE ROLLER

Student's Name ______________________________ Date ______________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Determined that there is a bad roller.	____	____
2. Removed the real panel of the dryer.	____	____
3. Located the damaged roller.	____	____
4. Used some means of supporting the drum.	____	____
5. Removed retainers and pulled the roller.	____	____
6. Reversed the above procedure and replaced the roller guide.	____	____
7. Pulled a performance check.	____	____
8. Replaced rear panel and cleaned area.	____	____
9. Followed all safety rules.	____	____

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ Date ______________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 97

TASK: Replace servomechanism.

CONDITIONS: An electronic circuit with a defective servomechanism, screwdrivers (assorted blade, assorted phillips head), assorted hex wrenches, pliers (needle nose, diagnoal), soldering iron, resin core solder, flashlight.

STANDARD: When replaced, the servomechanism must be mechanically secure and the armature and stator connections must allow the servomechanism to function according to circuit specifications.

SOURCE FOR STANDARD:
________________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to servomechanism.
3. Disconnect electrical and mechanical connections.
4. Remove defective servomechanism.
5. Insert replacement servomechanism.
6. Reconnect electrical and mechanical connectors.
7. Energize system.
8. Test for performance.
9. Deenergize system.
10. Replace panels, covers, etc.

ENABLING OBJECTIVE(S)
Use electrical and mechanical operations of a servomechanism.

LEARNING ACTIVITIES
1. Explain how to determine and mark the rotor position of the servo.
2. Explain why the alignment is important.
3. Demonstrate the aligning of the shaft of the servo.
4. Explain the phase relationship of the electrical connections.
5. Demonstrate the operation of the replaced servo.

RESOURCES
United States Air Force Manual 52-8 Electronic Circuit Analysis 1964.

EVALUATION
Questions
1. How much AC should be applied to the transmitter?
2. The __________ and ____________ connections must allow the servomechanism to function according to circuit specifications.

Answers
1. 120
2. Armature, stator

PERFORMANCE OBJECTIVE V-TECS 97 (Continued)

Practical Application

Assemble a servo system, apply 120 AC to the transmitter. Set the new transmitter dial to zero degrees and record the displacement angle of the output dial. Make necessary adjustments. Repeat until the receiver follows the transmitter.

Method of Evaluation

Use Checklist Performance Objective 97 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 97 EVALUATION

PERFORMANCE TEST FOR REPLACING A SERVOMECHANISM

Student's Name ____________________ Date ____________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Gain access to the servomechanism.	____	____
2. Check alignment and mark.	____	____
3. Remove indicator before set screws.	____	____
4. Loosen clamps before removing the servomechanism.	____	____
5. Align housing of new servo and tighten clamps.	____	____
6. Check proper phase of electrical connectors before applying power.	____	____
7. Check operation and secure system.	____	____
8. Followed all safety precautions.	____	____

APPROVED: Yes _____ No _____

Evaluator's Signature ____________________ Date ____________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 98

TASK: Replace solid state diodes (rectifier).

CONDITIONS: An electronic circuit with a defective solid state diode (rectifier), screwdrivers (assorted blade, assorted phillips head), assorted open end wrenches, resin core solder, low wattage soldering iron, pliers (needle nose, diagonal), flashlight, wiping cloth, heat sink.

STANDARD: When replaced, the lead placement must observe the polarity requirements and solid state diode must function according to the design specifications of the circuit.

SOURCE FOR STANDARD:

________________. **Fundamentals of Electronics: Vol. 3, Transmitter and Circuit Applications.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to the solid state diode.
3. Remove electrical and mechanical connectors.
4. Remove faulty diode.
5. Insert replacement diode.
6. Connect electrical connectors. (Caution: Insure polarity is observed. Also note, if soldering is necessary, use heat sink; excessive heat is deleterious to the diode).
7. Connect mechanical connectors.
8. Energize system.
9. Test for performance.
10. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)

1. Determine the correct wattage soldering form.
2. Use the heat sinks.
3. Determine the type solder to use.

LEARNING ACTIVITIES

1. Explain the purpose of the diode.
2. Identify the proper diodes.
3. Determine the anode and cathode.
4. Demonstrate the methods of soldering the diode in place.
5. Determine the circuit is operating properly.

RESOURCES

Gerrish, et al., **Transistor Electronics,** Chapter 12, pp. 178-193.

Dungan. **Linear Integrated Circuits for Technicians,** Chapter 2, p. 43, Chapter 10, p. 257.

PERFORMANCE OBJECTIVE V-TECS 98 (Continued)

EVALUATION

Questions

1. What identifies the cathode of most diodes?
2. What does the arrow in a diode symbol represent?
3. What is a characteristic of a good semiconductor?
4. What is the voltage drop across a silicon diode?
5. What is the voltage drop across a germanium diode?

Answers

1. Circular band
2. Direction of current flow
3. Low forward and high reverse resistance
4. 0.5 volts to 0.7 volts
5. 0.2 volts to 0.5 volts

Practical Application

Utilizing a circuit board, make necessary checks, remove the defective diode and replace with a functioning diode.

Make all necessary operational checks.

Method of Evaluation

Use Checklist Performance Objective 98 to determine if the assignment has been completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 98 EVALUATION

PERFORMANCE TEST FOR REPLACING THE SOLID STATE DIODES

Student's Name ____________________ Date ____________

DIRECTIONS TO STUDENT: Set up soldering station. Determine the diode to be replaced in the rectifier circuit. Make sure no other components are damaged. Use the identifiers or the ohmmeter to determine the annode and the cathode of the diode. Use iron and heat sinks to replace the diode.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure all precautions are observed.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The soldering station is prepared.	______	______
2. All equipment is available for the exercise.	______	______
3. Correct procedures used when checking the defective circuit.	______	______
4. The student used correct method when checking the diode.	______	______
5. The student used precautions when soldering the diode into the circuit.	______	______
6. The student checked the circuit for proper connections and measurements.	______	______
7. The student left the area in order.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ____________________ Date ____________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 99

TASK: Replace switches (lead, contact, mercurial).

CONDITIONS: An electronic circuit with a defective switch, screwdrivers (assorted blade, assorted phillips head), assorted hex wrenches, VOM, pliers (needle nose, diagonal), soldering iron, resin core solder, flashlight, wiping cloth.

STANDARD: When replaced, the switch must interrupt current when deactivated and restore circuit continuity when activated.

SOURCE FOR STANDARD: Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to the switch.
3. Disconnect switch.
4. Remove defective switch.
5. Insert replacement switch.
6. Connect wires to switch.
7. Mechanically secure switch.
8. Energize system.
9. Test for performance.
10. Deenergize system.
11. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)

Use test equipment.

LEARNING ACTIVITIES

1. Explain and demonstrate the various types of switches used in electronic and electrical circuits.
2. Show the schematic symbols for the following switches:
   a. SPST
   b. SPDT
   c. DPST
   d. DPDT
   e. NO push button
   f. NC push button
3. Demonstrate how to remove a switch from a circuit.
4. Discuss the purposes of switches.
5. Demonstrate how to test a switch for continuity.
6. Describe the safety precautions that must be taken when handling soldering equipment.
7. Describe the safety precautions used when handling mercury switches.
8. Show the type of solder necessary for electrical connections.
9. Review the various types of soldering irons available and what type is used in this exercise.

PERFORMANCE OBJECTIVVE V-TECS 99 (Continued)

RESOURCES

Lemons. **Learn Electronics Through Troubleshooting.** pp. 143-151.

EVALUATION

Questions

1. What instrument would you use to test a switch for continuity?
2. How many connections does a SPDT switch have?
3. What is the purpose of a SPST switch?

Answers

1. VOM
2. Three
3. To open or close a circuit

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 100

TASK: Replace tape head.

CONDITIONS: An electronic circuit containing a defective tape head, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted hex, adjustable), soldering iron, resin core solder, flashlight, hair brush, cotton swab.

STANDARD: When replaced, the tape head must be aligned, the electrical and mechanical connections secure and the tape must be read with a minimum amount of distortion.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to tape head.
3. Mechanically unfasten tape head.
4. Remove defective tape head.
5. Insert replacement tape head. (Caution: When working with video tape heads do not touch heads with bare hands; tape heads are very brittle).
6. Reattach all fasteners and connectors.
7. Replace access panels, covers, etc.
8. Test for performance.

ENABLING OBJECTIVE(S)
Recognize tape head functions.

LEARNING ACTIVITIES
1. Relate the different types of tape heads.
2. Point out a recording head.
3. Illustrate the operation and theory of a recording head.
4. Describe the special precautions that must be taken when handling a tape head.
5. Review the safety practices and precautions when working and using soldering equipment.

RESOURCES
Lemons. **Learning Electronics Through Troubleshooting.** p. 502.

EVALUATION
Questions
1. A misaligned tape head will cause what problem?
2. What type of coating is used on a "magnetic tape?"
3. Tape heads are quite tough and can withstand rough handling. (True or False)

Answers
1. Distortion
2. Iron oxide
3. False

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 101

TASK: Replace thermal breakers.

CONDITIONS: An electronic circuit with a defective thermal breaker, screwdrivers (assorted blade, assorted phillips head) wrenches (assorted hex, assorted open end), pliers (needle nose, diagonal), soldering iron, resin core solder, flashlight, wiping cloth.

STANDARD: When replaced, the breaker must not be loose, must have solid electrical connections and when heated to circuit specifications the thermal breaker will interrupt the circuit.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to thermal breakers.
3. Disconnect electrical connections.
4. Remove defective breaker.
5. Insert replacement breaker.
6. Attach electrical and mechanical connectors.
7. Replace access covers, panels, etc.
8. Energize system.

ENABLING OBJECTIVE(S)
1. Read meter.
2. Use tools properly.

LEARNING ACTIVITIES
1. Explain the operation of a thermal breaker.
2. Identify the type of breaker to be replaced.
3. Show how to remove and replace a thermal breaker.
4. Demonstrate how to reset and wire correctly.
5. Explain the safety procedures to be followed when working with circuit breakers.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics**, 3rd edition.

EVALUATION
Questions
1. Circuit breakers are rated in terms of the amount of current in __________ which can pass through them before they are tripped.
2. A circuit breaker can be ____________ or __________ after being tripped.
3. A ________________ is a mechanical device which performs the same protective function as a fuse.
4. A circuit breaker can serve as an ____________ switch.
5. Thermal control of switching action uses a ___________ element.

PERFORMANCE OBJECTIVE V-TECS 101 (Continued)

Answers

1. Amperes
2. Reset, closed
3. Circuit breaker
4. On/off
5. Bimetallic

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 102

TASK: Replace transducer.

CONDITIONS: An electronic circuit with a defective transducer, screwdrivers (assorted blade, assorted phillips head), wrenches (hex, assorted open end), soldering iron, resin core solder, flashlight, wiping cloth.

STANDARD: When replaced, the transducer must be mechanically secure, electrical connections must be continuous and the transducer must operate according to the design specifications of the circuit.

SOURCE FOR STANDARD: Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to the transducer.
3. Disconnect electrical connections.
4. Remove defective transducer.
5. Insert replacement transducer.
6. Attach electrical connections.
7. Replace access covers, panels, etc.
8. Energize system.
9. Test for performance.

ENABLING OBJECTIVE(S)

Recognize and use the theory of transducers.
Identify the uses of transducers.

LEARNING ACTIVITIES

1. Determine the type of transducer to be replaced.
2. Explain the purpose of the transducer.
3. Explain the different types of transducers.
4. Calculate and explain the importances of impedance matching.
5. Demonstrate the operation of the replaced transducer.

RESOURCES

Course 252 Basic Electronic Circuitry Applications. DeVry Institute of Technology.

EVALUATION

Questions

1. When used as an input device, the crystal transducer acts as a ___________.
2. The magnetrostrictive transducer is widely used in the field of ___________.
3. Maximum power exist when load impedance is equal to ___________.

Answers

1. Voltage generator
2. Communications
3. Source impedance

PERFORMANCE OBJECTIVE V-TECS 102 (Continued)

Practical Application
Using a circuit with an unknown output impedance. Calculate the impedance and match the output transducer.

Method of Evaluation
Use Checklist Performance Objective 102 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 102 EVALUATION

PERFORMANCE TEST FOR REPLACING A TRANSDUCER

Student's Name ______________________________ **Date** __________

DIRECTIONS TO STUDENT: Set up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Impedance properly determined.	______	______
2. Proper transducer selected.	______	______
3. Operational check performed without distortion.	______	______
4. All tools and equipment replaced to storage.	______	______
5. Followed all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ **Date** __________

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 103

TASK: Replace transformer.

CONDITIONS: An electronic circuit with a defective transformer, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted hex, socket set with nutdrivers), soldering iron, resin core solder, pliers (needle nose, diagonal), flashlight, wiping cloth, VOM.

STANDARD: When replaced, the transformer must be mechanically secured and must convert input voltage to required output voltage.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to transformer.
3. Disconnect electrical and mechanical connectors. (Caution: Mark leads to ensure proper polarity when reinstalling).
4. Remove defective transformer.
5. Insert replacement transformer.
6. Reconnect electrical and mechanical connectors. (Caution: Insure proper polarity when connecting electrical leads).
7. Replace access panels, covers, etc.
8. Energize system.
9. Test for performance.

ENABLING OBJECTIVE(S)

Use soldering equipment, test equipment, and small hand tools.

LEARNING ACTIVITIES

1. Describe the purpose and types of transformers.
2. Draw transformer schematic symbols.
3. Discuss the basic theory and operation of a transformer.
4. Explain and demonstrate how to test a transformer.
5. Identify the color codes of transformer leads.
6. Demonstrate the proper method in removing and replacing a transformer using the tools necessary.

RESOURCES

Lemons. **Learn Electronics Through Troubleshooting.** pp. 338-355.

PERFORMANCE OBJECTIVE V-TECS 103 (Continued)

EVALUATION

Questions

1. In testing a transformer, a check of the secondary voltage indicates 0 volts. Are the transformer windings opened or shorted?
2. It is necessary to observe plarity when connecting the leads. (True or False)
3. What instrument is best suitable to test a transformer?
4. A transformer primary winding has 1000 turns and the secondary winding has 200 turns. Assuming that the input voltage is 120 VAC, what would the output voltage be?
5. In question 4, what would the turns ratio be?

Answers

1. Opened
2. True
3. VOM — VTVM
4. 24 Volts
5. 5 : 1

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 104

TASK: Replace transistors (SCR, TRIAC).

CONDITIONS: An electronic circuit with a defective transistor, screwdrivers (assorted blade, assorted phillips head), wrenches (Allen, adjustable), soldering iron, resin core solder, pliers (needle nose, diagonal), flashlight, wiping cloth, heat sink, soldering braid.

STANDARD: When replaced, there must be no heat or physical damage to the transistor and the circuit must function according to design specifications.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to the transistor.
3. Disconnect transistor.
4. Remove defective transistor.
5. Insert replacement transistor.
6. Attach electrical leads. (Caution: Do not form solder bridges, avoid excess heat).
7. Replace access panels, covers, etc.
8. Energize system.
9. Test for performance.

ENABLING OBJECTIVE(S)
Use test equipment (VOM and transistor tester).

LEARNING ACTIVITIES
1. Illustrate the basic operation and theory of a transistor.
2. Explain and show transistor biasing.
3. Indicate transistor current path.
4. Show transistor schematic symbols.
5. Review the advantages of transistors.
6. Show the various types of soldering equipment available.
7. Identify which soldering iron is best for this task.
8. Give the precautions that must be practiced when working on PC boards.
9. Explain the types of solder and what type is best for electrical connections.
10. Demonstate the use of a heat sink.
11. Tell the safety precautions that must be taken when using soldering equipment.
12. Discuss the usage of the soldering braid or desoldering gun.
13. Demonstrate the proper desoldering techniques.
14. Show the proper soldering techniques.
15. Demonstrate the proper method in testing transistors.
    a. Using a transistor tester.
    b. Using a VOM.

RESOURCES
Lemons. **Learn Electronics Through Troubleshooting.** pp. 431-467.

PERFORMANCE OBJECTIVE V-TECS 104 (Continued)

EVALUATION

Questions

1. What is the purpose of soldering braid?
2. What is the purpose of a heat sink?
3. What type of solder should be used on electrical connections?
4. Name the three elements of a transistor?
5. Name the type of crystals that may be used in transistors.
6. What is the phase relationship in a common emitter amplifier?

Answers

1. To absorb the solder from the connection
2. To absorb the heat away from the transistor
3. Resin core solder
4. Emitter — Base — Collector
5. Germanium — Silicon
6. 180 degrees out of phase

DUTY OR UNIT: REPLACING COMPONENTS

PERFORMANCE OBJECTIVE V-TECS 105

TASK: Replace tubes.

CONDITIONS: An electronic circuit with a defective tube, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted Allen, adjustable) tube puller, tube pin straightener.

STANDARD: When replaced, the tube must be aligned with the tube holder, pins must be straight and all pins must make contact.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to the tube.
3. Remove defective tube. (Caution: If tube is broken be careful of broken glass).
4. Position replacement tube. (Caution: Insure proper pin alignment).
5. Insert tube into holder.
6. Replace tube shields if necessary.
7. Replace access panels, covers, etc.
8. Energize system.
9. Test for performance.

ENABLING OBJECTIVE(S)

Use test equipment. Recognize vacuum tube sockets.

LEARNING ACTIVITIES

1. Explain the basic theory of the vacuum tube.
   a. The diode
   b. The triode
   c. Multi-grid type tubes (tetrode, pentode)
2. Show the schematic symbols for the following vacuum tubes:
   a. Diode
   b. Triode
   c. Tetrode
   d. Pentode
3. Explain the safety measures that must be taken when handling vacuum tubes.
4. Demonstrate how to use vacuum tube testers and how to test vacuum tubes.
5. Discuss the types of vacuum tube bases and sockets.
6. Demonstrate the proper method for discharging beam power type tubes.
7. Explain the usage of tube shields.
8. Define the wiring connections of tubes that are wired in series or parallel.

RESOURCES

Lemons. **Learn Electronics Through Troubleshooting**, pp. 388-427.

PERFORMANCE OBJECTIVE V-TECS 105 (Continued)

EVALUATION

Questions

1. What is the purpose of the grid in the triode vacuum tube?
2. What safety measure must be made before handling a beam power tube?
3. A four element tube is better known as ____________________.
4. If a filament is opened in one tube, the remaining tubes that were connected in a series circuit would remain lit. (True or False)
5. What is the emitter called in a vacuum tube?

Answers

1. Controls the flow of electrons from cathode to plate.
2. Discharge the tubes anode against the chassis.
3. Tetrode
4. False
5. Cathode

MAINTAINING ELECTRONIC DEVICES

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 59

TASK: Assemble Structural Members According to Assembly Drawing.

CONDITIONS: Wrenches (assorted open end and adjustable), hammer, pliers, needle nose pliers, wire cutters, wire strippers, assorted terminal connectors, safety glasses.

STANDARD: When completed, the structure will be assembled with structural members in place according to the assembly drawing.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review assembly drawing.
2. Inventory parts.
3. Layout parts according to assembly sequence.
4. Assemble small members.
5. Assemble large members.
6. Combine large and small members according to suggested sequence.
7. Tighten assembly.
8. Replace tools and equipment.

ENABLING OBJECTIVES
1. Read blueprints.
2. Use tools correctly.

LEARNING ACTIVITIES
1. Explain how to assemble a two-pole universal motor from a working drawing.
2. Show the working drawings for interpretation.
3. Demonstrate how to assemble the parts, wind the coil, attach the armature, and tape and drill the core.
4. Demonstrate the wiring procedures and soldering techniques.
5. Explain the operation of the simple motor after assembly is completed.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, p. 300.

EVALUATION
Questions
Use working drawing to answer the following:
1. How is the field core constructed?
2. What is the assembly attached to in the drawing?
3. How is armature connected to assembly?
4. The brushes are made of ____________________.
5. The commutator is constructed of ______________________.

PERFORMANCE OBJECTIVE V-TECS 59 (Continued)

Answers

1. Using band iron and bending in the shape of a horseshoe, wrap with tape and wrap three layers of magnet wire.
2. Wood base (3/4" x 4½" x 6")
3. Soldered to shaft
4. Sheet brass
5. Tin plate

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 60

TASK: Clean Air Filters.

CONDITIONS: Flashlight, assorted blade screwdriver, wiping cloth, vacuum cleaner, whisk broom, cleaning solution, forced air (restricted pressure), extension cord.

STANDARD: Cleaning is complete when filter airflow is unimpeded and there are no visible signs of dirt or lint.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Remove access panels.
3. Remove filter.
4. Perform cleaning activities.
5. Replace filter.
6. Replace access panels.
7. Energize system.
8. Test for performance.

ENABLING OBJECTIVE(S)
Identify the systems requirement for air flow.

LEARNING ACTIVITIES
1. Using proper test instruments, determine air flow in the compartments of excessive temperature.
2. Explain why it is necessary to bring in ambient air for the system.
3. Show how to remove necessary panels to gain access to air chambers.
4. Demonstrate how to use the manometer check for proper static pressure.
5. Explain how to check filter for restrictions.
6. Explain how to clean or replace the filter.
7. List reasons in replacing all panels or openings.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air Conditioning.** Chapter 22.

EVALUATION
Questions
1. Why would a solid state system have a need for forced air?
2. A dirty filter affects the operation of an electronic system. (True or False)
3. How often should a filter be checked?

Answers
1. To cool down the excessive heat that builds up in enclosed areas.
2. True
3. At least twice per year, more often in high lint or dust areas.

PERFORMANCE OBJECTIVE V-TECS 60 (Continued)

Practical Application
Given a unit with a dirty filter, make static pressure measurements, and change the filter.

Method of Evaluation
Use Checklist Performance Objective 60 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 60 EVALUATION

PERFORMANCE TEST FOR CLEANING AIR FILTERS

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Does the student understand the manometer readings?	______	______
2. Was a second reading taken after a clean filter was installed?	______	______
3. Did the student retape the air plenum when the measurement was completed?	______	______
4. Were all panels and openings replaced?	______	______
5. All equipment and area were left in good order.	______	______
6. Were all safety precautions followed?	______	______

APPROVED: Yes ____ No _____

Evaluator's Signature ______________________ **Date** __________

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 61

TASK: Clean Chassis.

CONDITIONS: A dirty chassis, assorted open end wrenches, screwdrivers (assorted blade, assorted phillips head), cleaning solution, vacuum cleaner with attachment, forced air (restricted pressure), flashlight, extension cord, whisk broom, wiping cloth, safety glasses.

STANDARD: When completed, there will be no visible signs of dirt or lint.

SOURCE FOR STANDARD:

Lockhart and Rice. **AC Circuit Analysis.**

Tedeschi and Taber. **Solid State Electronics.**

____________________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to chassis.
3. Remove loose dirt/lint.
4. Apply cleansing solution (allow time to soak).
5. Wipe out excess dirt.
6. Remove all dirt and lint.
7. Blow dry, if necessary.
8. Replace panels, covers.
9. Check operation.

ENABLING OBJECTIVE(S)

Use of small hand tools.

LEARNING ACTIVITIES

1. Tell what safety measures must be taken when using and applying a cleaning solution.
2. Demonstrate how a chassis is removed and what safety precautions must be taken.
3. Besides the cleaning agent, explain what other equipment is required to clean a chassis.
4. Justify the cleaning of a chassis.
5. Review the safety rules for handling a chassis.

RESOURCES

Johnson. **How to Troubleshoot a TV Receiver**, pp. 138-141.

EVALUATION (True or False)

Questions

1. A dirty chassis will cause a circuit to be faulty.
2. It is okay to use any cleaning agent.
3. As long as the set is disconnected, the receiver is safe to work on.

PERFORMANCE OBJECTIVE V-TECS 61 (Continued)

Answers
1. True
2. False
3. False

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 62

TASK: Clean Circulation Fans (Exhaust and Intake).

CONDITIONS: An electronic circuit whose circulation fans need cleaning, wrenches (assorted socket and assorted Allen), screwdrivers (assorted blade and assorted phillips head), flashlight, vacuum cleaner with attachments, extension cord, wiping cloth, cleaning solution, forced air (restricted pressure), safety glasses.

STANDARD: When completed, the fans will be free of any dirt, grease or lint.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
Lockhart and Rice. **AC Circuit Analysis.**
Tedeschi and Taber. **Solid State Electronics.**
__________________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to fans.
3. Remove loose dirt, lint or grease from the fan.
4. Apply cleansing solution (allow time to soak).
5. Wipe off excess dirt, grease and lint.
6. Remove all visible dirt, grease and lint from fans and protective covers.
7. Blow dry if necessary.
8. Replace panels, covers, etc.
9. Check operation of fans.

ENABLING OBJECTIVE(S)
Recognize the purpose of air circulation fans.

LEARNING ACTIVITIES
1. Remove access panels.
2. Using a stiff brush remove dirt and grease from blades and housing.
3. Use calgunite or spray solution to loosen baked on grease and dirt.
4. Demonstrate removal by wiping off with a cloth.
5. Replace all panels and secure system.
6. Test the unit to assure proper operation of the fan.
7. Clean the area and replace all tools and equipment.

RESOURCES
Althouse, et al., **Modern Refrigeration and Air-Conditioning.**

EVALUATION
Answers
1. How often should the air system be checked?
2. What could be a problem if the fan and air chamber are always collecting lint and dirt?
3. Chemicals should be sprayed on the fan while in operation. (True or False)

PERFORMANCE OBJECTIVE V-TECS 62 (Continued)

Answers

1. Twice a year or more often in high lint or dust areas.
2. Dislodged or torn filter.
3. False

Practical Application

Refer to Checklist Performance Objective 62. Remove protective paneling and demonstrate the cleaning of the fan and oil chamber.

Method of Evaluation

Use Checklist Performance Objective 62 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 62 EVALUATION

PERFORMANCE TEST FOR CLEANING CIRCULATION FANS (EXHAUST AND INTAKE)

Student's Name **Date**

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Unit was prepared for inspection.	______	______
2. Filter was checked for proper position and in good order.	______	______
3. Used a clean soft cloth for the final wiping off of the fan and the components.	______	______
4. All access panels replaced.	______	______
5. An operational check was performed.	______	______
6. The system worked without hesitation with fresh air to the circuitry.	______	______
7. All safety steps were followed.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 63

TASK: Clean Contact Points.

CONDITIONS: Contact points requiring cleaning, screwdrivers (assorted blade, assorted phillips head), strips of bond paper, burnishing tool, forced air (restricted pressure), cleansing solution, wrenches (assorted open end, assorted Allen), flashlight, wiping cloth.

STANDARD: When completed, the contact points will be visually free of any dirt or corrosion and register minimum resistance between point surfaces.

SOURCE FOR STANDARD:

Writing Team. State of Georgia.

____________________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**

Tedeschi and Taber. **Solid State Electronics.**

U.S. Army. **Digital Computers; Communications Electronics Fundamentals. FM 11-72.**

____________________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE

1. Deenergize equipment.
2. Gain access to points.
3. Open contact points (mechanically).
4. Insert burnishing tool between contact points and burnish points.
5. Remove burnishing tool.
6. Dip bond paper in cleansing solution and insert between contact points. (Caution: Use cleansing solution approved for electronic circuits).
7. Mechanically close points and pull bond strip between points.
8. Open contact points and remove excess cleanser, blow dry if necessary.
9. Replace panels, covers, etc.
10. Energize system.
11. Check operation.

ENABLING OBJECTIVE(S)

1. Use tools properly.
2. Read metering devices.

LEARNING ACTIVITIES

1. Explain the purpose of contacts in a relay.
2. Disassemble the relay to gain access to the contacts.
3. Show how to use burnishing tool, bond paper with cleansing solution and tools for cleaning contacts.
4. Demonstrate the use of contacts when the relay is energized.
5. Explain the operation of the relay when the contacts are opened and closed.

RESOURCES

Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 118-119.

PERFORMANCE OBJECTIVE V-TECS 63 (Continued)

EVALUATION

Questions

1. The purpose of the contacts on a relay is to ______________ the circuit when the relay is energized.
2. The ______________ rating of its contacts indicates the maximum safe load current the relay can handle.
3. The contacts of a relay are often described as being ____________ or ____________.
4. The important advantage of a relay is that it allows the control of a large load current at a ____________ voltage, using only a small relay energizing current at a ______________ voltage.

Answers

1. Complete
2. Current
3. Normally open, normally closed
4. High, low

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 64

TASK: Clean Drive Mechanism.

CONDITIONS: Screwdrivers (assorted blade, assorted phillips head), wrenches (assorted hex, socket set), cleansing solution, wiping cloth, flashlight, safety glasses, forced air (restrict flow).

STANDARD: When clean, the drive mechanism will be free of any visible dirt, grease or lint.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
____________________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**
____________________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to drive mechanism.
3. Wipe dirt, grease, lint from drive gears.
4. Remove excess cleaning solution from gears -- blow dry if necessary.
5. Replace access covers, panels, etc.
6. Check operation.

ENABLING OBJECTIVE(S)
1. Interpret circuit drawings.
2. Use tools properly.

LEARNING ACTIVITIES
1. Explain how to clean the drive motor and replace belt drive on a cassette tape recorder.
2. Show how to gain access to drive motor on cassette recorder.
3. Demonstrate how to adjust belt tension and use cleaning solvent to clean drive.
4. Explain operation of recorder.
5. Explain advantages of performing maintenance on a recorder.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics,** 3rd Edition, pp. 363-365.

PERFORMANCE OBJECTIVE V-TECS 64 (Continued)

EVALUATION

Questions

1. The motor and mechanisms necessary to pull the tape from the feed reel past one or more tape heads to take-up reel are called the ____________ or ____________.
2. The tape can be set to run at any one of three standard speeds, ____________, ____________, or ____________ inches per second.
3. Tapes operated at ________ inches per second have superior sound reproduction.
4. ________________ are used to record sounds on the tape.

Answers

1. Tape transport, deck
2. 1 7/8, 3 3/4, 7 1/2
3. 7½
4. Tape heads

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 65

TASK: Clean Reflector Mirror.

CONDITIONS: A tape reader with a dirty reflector mirror, screwdrivers (assorted blade, assorted phillips head), photographer's lens cleaning tissue, cleaning solution (freon, alcohol, etc.), assorted open end wrenches, flashlight, wiping cloth.

STANDARD: When cleaned, the mirror surface will be free of dust and dirt and give a clear reflection of the light source.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
______________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**
______________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE
1. Deenergize equipment.
2. Gain access to mirror.
3. Apply cleaning solution (Caution: reflector mirror has sharp edges).
4. Wipe mirror dry.
5. Inspect for a clean dust-free surface.
6. Replace access panel covers.
7. Energize equipment.
8. Check operation.

ENABLING OBJECTIVF(S)
None

LEARNING ACTIVITIES
1. Review the safety measures that must be taken when using chemicals for cleaning purposes.
2. Tell what safety precautions are required when gaining excess to the deflector mirror.
3. Indicate where the deflector is located.
4. Point out the tools required to dismantle the equipment.
5. Explain the purpose of the deflector mirror.

RESOURCES
Manufacturer's Manual

EVALUATION
Questions
1. What type of solution is used to clean the mirror?
2. Why is it important to keep the mirror clean?
3. What is the most important safety measure you must take before dismantling the equipment.

PERFORMANCE OBJECTIVE V-TECS 65 (Continued)

Answers

1. Freon, alcohol, cleaning solution for camera lenses, etc.
2. It could cause the reflected beam to be misaligned, or in such a state that the beam will not reflect bright enough.
3. Deenergize the equipment. (Pull the plug).

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 66

TASK: Clean Tape Head.

CONDITIONS: A tape head that required cleaning, screwdrivers (assorted blade, assorted phillips head) wiping cloth, cotton or buckskin swab, cleaning solution, flashlight, demagnetizing probe.

STANDARD: When cleaned, the tape head will be free of all traces of tape material, dirt and lint.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
_______________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**
_______________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE

1. Deenergize system.
2. Gain access to tape head.
3. Demagnetize head.
4. Wipe cleaning solution on tape head. (Caution: use approved tape head cleanser; audio heads use cotton swab -- video head use buckskin swab and read manufacturer's cleaning specifications).
5. Energize system.
6. Check for peak performance.
7. Deenergize system.
8. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)

Use a demagnetizing probe. Use a cleaning agent.

LEARNING ACTIVITIES

1. Discuss the different types of tape heads.
2. Tell the purpose of the demagnetizing probe.
3. Demonstrate how the demagnetizing probe is used.
4. Relate what safety precautions must be practiced when handling a cleaning agent.
5. Describe the basic theory of how a tape head operates.
6. Explain the importance of following the manufacturers specifications in cleaning a tape head.

RESOURCES

Lemons. **Learning Electronics Through Troubleshooting.** pp. 501-502.

PERFORMANCE OBJECTIV· , V-TECS 66 (Continued)

EVALUATION

Questions

1. Why is it necessary to clean a tape head?
2. What type of swab is used to clean a video head?
3. What type of swab is used to clean an audio head?
4. Safety must be practiced at all times when working with any type of cleaning agent and on electrical circuits. What is the number one rule?

Answers

1. To remove any traces of tape material, dirt, lint, etc.
2. Buckskin swabs.
3. Cotton swabs.
4. Wear safety glasses.

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 67

TASK: Clean Tape Reader.

CONDITIONS: A tape reader, screwdrivers (assorted blade, assorted phillips head), assorted Allen wrenches, cleaning solution, lint-free wiping cloth, cotton swabs, adjustable wrenches, flashlight, demagnetizing probe.

STANDARD: When cleaned, the tape reader will be free of foreign materials.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.
____________________. **Fundamentals of Electronics: Vol. 7, Electromagnetic Circuits and Devices.**
____________________. **Soldier's Manual 34E Skill Level Two/Three NCR 500 Repairman.**

PERFORMANCE GUIDE
1. Deenergize equipment.
2. Gain access to tape reader.
3. Demagnetize head.
4. Clean tape reader with solvent (allow solvent to dissolve crusted materials).
5. Wipe tape reader.
6. Remove excess solvent.
7. Replace access covers, panels, etc.
8. Energize equipment.
9. Check operation.

ENABLING OBJECTIVE(S)
None

LEARNING ACTIVITIES
1. Explain what the tape reader is.
2. Indicate where the tape reader is.
3. Review what safety precautions must be taken before working on a piece of equipment.
4. Tell what precautions you would take when handling cleaning solutions.
5. Discuss the use of the demagnetizing probe.

RESOURCES
Manufacturer's Manual

EVALUATION
Questions
1. A degausser is the same as a demagnetizer. (True or False)
2. What type of cleaning solution is used on a tape reader?
3. Is a tape reader the same as a tape head? (True or False)

Answers
1. True
2. Alcohol or tape head cleaning agent
3. True

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 68

TASK: Clean Tuner.

CONDITIONS: A tuner requiring cleaning, screwdrivers (assorted blade, assorted phillips head), wiping cloth, tuner cleaner, eraser, small wiping brush.

STANDARD: Tuner must be cleaned so that the tuner provides a static-free, noise-free output.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to the tuner. Note: Do not bend or dislocate parts or shields.
3. Spray tuner contacts with tuner cleaner.
4. Straighten tuner contacts.
5. Use eraser to remove corrosion (turret contacts only).
6. Energize system.
7. Check operation.
8. Deenergize system.
9. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
None

LEARNING ACTIVITIES
1. Discuss the purpose of a tuner.
2. Identify the two main types of tuners used in television.
3. Relate the safety precautions that must be practiced when using a cleaning agent.
4. Tell how you would use an eraser to clean the contacts of a tuner.
5. Explain the safety measures that have to be practiced while disassembling the receiver.

RESOURCES
Johnson. **How to Troubleshoot a TV Receiver.** pp. 20-22.

EVALUATION
Questions
1. What type of contacts can you use an eraser to clean?
2. What are the main causes for contacts in tuners to get dirty?
3. Name the two types of tuners that might be found in a TV set?
4. What do the letters VHF stand for?

Answers
1. Turret
2. Dirt -- grease
3. VHF and UHF
4. Very High Frequency

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 69

TASK: Clean Potentiometer (Volume Control, Video, Chroma, etc.).

CONDITIONS: An electronic circuit containing a potentiometer in need of cleaning, screwdrivers (assorted blade, assorted phillips head), wrenches (socket set, assorted hex, adjustable), cleaning solution or degreaser, ohmmeter.

STANDARD: When cleaned, the potentiometer will register a smooth increase or decrease of resistance as shown on ohmmeter.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Gain access to potentiometer.
3. Spray potentiometer.
4. Rotate control clockwise and counter clockwise.
5. Wipe excess cleaner.
6. Energize system.
7. Check for noise free operation.
8. Replace access panels, covers, etc.

ENABLING OBJECTIVE(S)
None

LEARNING ACTIVITIES
1. Draw the schematic symbol for a potentiometer.
2. Discuss the theory of operation of a potentiometer.
3. Explain why there is a physical size difference in potentiometers.
4. Give the operation differences between a rheostat and a potentiometer.
5. Review the safety precautions that must be practiced when working with a cleaning solution.
6. Analyze why a potentiometer might have to be cleaned.

RESOURCES
Lemons. **Learn Electronics Through Troubleshooting**. pp. 168-176.

EVALUATION
Questions
1. A potentiometer controls which of the following in an electrical circuit?
   a. Voltage
   b. Current
   c. Resistance
   d. None of the above
2. What does a rheostat control in an electrical circuit?
3. It is true that a rheostat can replace a potentiometer. (True or False)
4. What instrument would be best to test a potentiometer?
5. In a radio receiver, what control is a potentiometer?

PERFORMANCE OBJECTIVE V-TECS 69 (Continued)

Answers

1. a
2. Current
3. True
4. VOM — Ohmmeter
5. Volume control

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 70

TASK: Locate Component Malfunctions Using Fault Location Guides.

CONDITIONS: System with component malfunctions, fault location guides, screwdrivers (assorted blade, assorted phillips head), assorted hex wrenches, flashlight, VOM, output measuring device.

STANDARD: When completed, the defective component(s) of the circuit will be located and identified.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Identify test requirements from manufacturer's specifications.
2. Energize system and observe operation and symptoms.
3. Initiate process prescribed in fault location guides.
4. Continue process until decision(s) is/are made regarding location and identity of defective component(s).
5. Isolate defective components.
6. Identify defective components.

ENABLING OBJECTIVE(S)
Use fault location guide.
Use test equipment.
Read and interpret schematics.

LEARNING ACTIVITIES
1. Relate the purpose of fault finding guides.
2. Tell where one will find fault guides.
3. Discuss the type of instruments you would use with fault guides.
4. Review the safety factors necessary when troubleshooting electrical equipment.
5. Identify the proper troubleshooting procedures.

RESOURCES
Johnson. **How to Troubleshoot a TV Receiver**, pp. 1-16.

EVALUATION
Questions
1. The main purpose of using fault guides is to speed up the troubleshooting process. (True or False)
2. Are TV block diagrams ace fault guides? (True or False)
3. Name two places where fault guides can be located.

Answers
1. True
2. True
3. Manufacturers and Schematics

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 71

TASK: Mount System In/Out Physical Support.

CONDITIONS: An electronic circuit/module, slings, lift hooks, clamps, hoist/lift device, screwdrivers (assorted blade, assorted phillips head), wrenches (assorted open end, assorted hex).

STANDARD: When mounted, the circuit/module will be physicaliy secure and there will be no damage to the equipment or personnel.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Secure system in preparation to hoist or lift.
2. Hoist system and position to mounting place.
3. Lower system in mounting place.
4. Install fasteners holding system to physical support.
5. Remove lifting device (straps, chains, clamps, etc.) from system.
6. Check for sturdiness and security.

ENABLING OBJECTIVE(S)
Understand the equipment necessary to mount a Receiver-Transmitter of the AN/CPS-9.

LEARNING ACTIVITIES
1. Prepare the tower hoist for operation.
2. Lower hoist cable for attaching the Transmitter-Receiver.
3. Secure lifting hooks and strapping for lifting.
4. Lift package to top of tower and rotate crane in place for lowering into RT mount.
5. Demonstrate safety in mounting the package to the RT mount, making sure all connectors and mounting brackets are aligned.

RESOURCES
Manufacturer's Manual

EVALUATION
Questions
1. What preparation must be made of the hoist?
2. Why would it not be permissible to leave the hoist up after completing the lift?
3. Why is it necessary to replace the RT package occasionally?

Answers
1. The hoist has to be raised above the tower platform to give clearance for movability of the RT package.
2. It would create frequency pulling when the antenna sweeps through it.
3. The package has to be pulled and returned for depot repair every 1000 hours of operation.

PERFORMANCE OBJECTIVE V-TECS 71 (Continued)

Practical Application
Replace and conduct a proper checkout procedure, making all power and sensitivity checks with proper test equipment.

Method of Evaluation
Use Checklist Performance Objective 71 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 71 EVALUATION

PERFORMANCE TEST FOR MOUNTING SYSTEM IN/OUT PHYSICAL SUPPORT

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Was hoist properly locked and secured before lowering the RT package?	______	______
2. Was safety procedures followed before positioning the package over the side of the tower?	______	______
3. Was hoist brake working properly?	______	______
4. Was replacement package properly prepared for mounting before hoisting up?	______	______
5. Was care taken when maneuvering the RT package into place?	______	______
6. Was care taken when aligning package to mount?	______	______
7. Did all power and sensitivity checks fall into specifications?	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ **Date** __________

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 72

TASK: Record Meter Readings.

CONDITIONS: An electronic system containing meters requiring continuous monitoring, pencil/pen, recording sheet, reading meter schedule, flashlight, watch, clipboard.

STANDARD: When recorded, the meter readings will reflect the actual indication of the meter at the time of the reading.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review meter reading sheet.
2. Review schedule.
3. Determine an efficient pattern to be used to record meter readings.
4. Observe meter readings.
5. Record time, date and reading on recording sheet.

ENABLING OBJECTIVE(S)
Read metering devices.

LEARNING ACTIVITIES
1. Explain how voltage, current, and power are measured with panel meters.
2. Demonstrate how panel meters are connected into an electrical circuit.
3. Show how to interpret and record voltage, amperes, and wattage when connected to energized circuit.
4. Demonstrate how a recording graph is used when monitoring an operation.
5. Explain how the accuracy of meters aids in conserving energy.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, pp. 81-82.

EVALUATION
Questions
1. In the typical meter, a mechanism called the ___________ reacts to the flow of current and rotates a shaft to which is connected a pointer.
2. The amount of current necessary to move the pointer to the maximum reading on the meter scale is called the full-scale ____________ current of the meter.
3. The ______________ can be used to measure voltage, current, and resistance.
4. __________________ are single-purpose instruments made to be mounted on test equipment or instrument panels.
5. A typical ammeter is connected in _______________ with the load.

PERFORMANCE OBJECTIVE V-TECS 72 (Continued)

Answers

1. Meter movement
2. Deflection
3. Multimeter
4. Panel meters
5. Series

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 73

TASK: Splice Wires.

CONDITIONS: Wire, VOM, assorted connectors, crimp pliers, screwdrivers (assorted blade, assorted phillips head), needle nose pliers, wire cutters, electrical tape, crimpers, splice sleeves, soldering iron, resin core solder, wire strippers.

STANDARD: When spliced the wires will be mechanically and electrically bonded, the insulation will not be frayed, the splice will not short cut and there will be no voltage drop across the splice.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Deenergize system.
2. Trim ends of wire.
3. Connect ends of wire, use twisting motion to intertwine wires and secure.
4. Tape for insulation.
5. Energize system.
6. Test performance.

ENABLING OBJECTIVE(S)
1. Use crimping tools.
2. Use soldering iron properly.

LEARNING ACTIVITIES
1. Explain procedures used in splicing conductors together.
2. Show methods of stripping insulation from conductors.
3. Demonstrate how to twist conductors together and cutting the proper length.
4. Show methods of soldering conductors and selecting proper size wire nuts.
5. Explain where splices are used.

RESOURCES

Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, p. 281.

EVALUATION

Questions
1. When must splices be used?
2. Explain procedures used for joining two conductors together.
3. List at least three tools that are used for splicing conductors.
4. Where are splices used?

PERFORMANCE OBJECTIVE V-TECS 73 (Continued)

Answers

1. Splices are used when two or more conductors need to be joined together to complete a circuit.
2. To join conductors together, strip insulation from each conductor approximately one inch, cross one conductor over the other holding ends of insulation together, then twist stripped ends together. Next, cut the twisted stripped ends back to approximately three quarter inch and twist wire nuts on tightly.
3. Three commonly used tools for splicing conductors are wire strippers, linesmen pliers and wire cutters.
4. Splices are joined together in junction boxes to prevent fire hazards.

DUTY OR UNIT: MAINTAINING ELECTRONIC DEVICES

PERFORMANCE OBJECTIVE V-TECS 74

TASK: Solder/Unsolder Components.

CONDITIONS: Wire cutters, wire stripper, VOM, soldering gun, flashlight, wire brush, soldering braid, resin solvent, solder, diagonal pliers, spray lacquer, safety glasses.

STANDARD: When completed, the component can be integrated or removed from the circuit with no functional deterioration of the circuit, and no excess solder visible.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Deenergize equipment.
2. Connect heat sink to device.
3. Connect needed ground straps to soldering equipment components, etc.
4. Unsolder component and remove excess solder until component is free from circuit.
5. Remove component.
6. Clean circuit using solvent and brush.
7. Insert new component.
8. Install heat sink and necessary ground straps.
9. Solder component.
10. Remove heat sink and grounding straps.
11. Clean excess resin from circuit using brush and solvent.
12. Spray clean board with lacquer solution.

ENABLING OBJECTIVE(S)

1. Use soldering iron properly.
2. Interpret meter readings.

LEARNING ACTIVITIES

1. Explain the procedures for removing and replacing an electrical component from a printed circuit board.
2. Demonstrate safe soldering practice.
3. Explain why the heat sink must be used to remove or replace the component.
4. Demonstrate and state the methods of soldering.
5. Demonstrate the method of lifting the inoperative component.
6. Show the methods of connecting heat sinks and replacing the component.

RESOURCES

Fowler. **Electronics Principles and Applications**, pp. 259-264.
Burban, et al., **Understanding Electricity and Electronics**, pp. 240-247.

PERFORMANCE OBJECTIVE V-TECS 74 (Continued)

EVALUATION

Questions

1. Why is it necessary to use a heat sink?
2. What is the purpose of a desoldering tool?
3. Describe the appearance of a properly soldered component.
4. Describe the appearance of an improper soldered component.
5. What size soldering gun is used to replace components on a printed circuit board?

Answers

1. A heat sink removes the heat to prevent damage to a component being soldered.
2. A desoldering tool is used to remove the solder when heated so the component can be removed more easily.
3. A properly soldered connection will have a shiny appearance with no cracks.
4. An improperly soldered connection will have a dull appearance or a crack at the edges.
5. A 25 to 30 watts soldering gun.

Practical Application

Prepare equipment and solder/unsolder components correctly.

Method of Evaluation

Use Checklist Performance Objective 74 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 74 EVALUATION

PERFORMANCE TEST FOR SOLDER/UNSOLDER COMPONENTS

Student's Name ______________________________ **Date** __________

DIRECTIONS TO STUDENT: Set up test bench with solder.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure all items to be evaluated are on hand. Be sure the student follows sequence for making the solders and unsolders.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The test bench is prepared.	____	____
2. The student has diagnosed the area needing soldering.	____	____
3. The student has removed the protective covers.	____	____
4. The student has prepared the materials for soldering/unsoldering.	____	____
5. The student makes solders/unsolders.	____	____
6. The student secures equipment.	____	____
7. The student replaces protective covers.	____	____
8. The student does the appropriate documentation.	____	____
9. The student leaves work area clean.	____	____
10. The student follows all safety precautions.	____	____

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ **Date** __________

DESIGNING EQUIPMENT AND CIRCUITRY

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 38

TASK: Conduct Physical Inventory.

CONDITIONS: The requirement to inventory an area for specified tools or equipment, tool list, equipment list, pen/pencil, clipboard, hand receipt file, inventory form.

STANDARD: When the physical inventory is complete, all tools and equipment will be accounted for and included in an up-to-date inventory list.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Obtain inventory lists for tools and equipment.
2. Become familiar with storage areas for tools and equipment.
3. Match each tool to tool inventory list. Note deviations.
4. Match each piece of equipment to the equipment inventory list. Note deviations.
5. Add tools and equipment not noted on the inventory list.
6. Identify tools and equipment on the equipment list which cannot be located physically or cannot be accounted for by receipt.
7. Update inventory list.

ENABLING OBJECTIVE(S)
Identify Components.

LEARNING ACTIVITIES
1. Explain why a physical inventory is important to an employer.
2. Tell why it is important to become familiar with the storage areas.
3. Relate why equipment, tools, and supplies should be grouped in separate areas.
4. Discuss why part identification is important.
5. Design a layout where equipment, supplies, and tools should be stored.
6. Indicate how you would label whether an area has been previously inventoried.

RESOURCES
Ammer. **Materials Management**, pp. 267-290.

EVALUATION
Questions
1. It is okay to use a pen when taking an inventory. (True or False)
2. It is necessary to note any defects in the equipment during an inventory. (True or False)
3. If a piece of equipment is not on the inventory it is not necessary to record it. (True or False)

PERFORMANCE OBJECTIVE V-TECS 38 (Continued)

Answers

1. False
2. True
3. False

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 39

TASK: Construct External Interface Adapters.

CONDITIONS: Tin snips, wire cutters, wire strippers, electronic cable, metals, wood, plastic, clamps, drill with assorted bits, assorted punches, drill guides, screwdrivers (assorted blades, assorted phillips heads), assorted screws, glue, soldering iron, resin core solder, coping saw, hammer, measuring tape, vise, assorted files, hacksaw, reamer, lock washers, wire ties.

STANDARD: When constructed, the external interface adapters must be mechanically compatible providing a tight fit with no looseness and the adapters must not compromise the electronic data between modules.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Identify adapter specifications from blueprint/designer modules.
2. Identify type of connectors, fixtures and/or materials needed.
3. Layout scribe lines for cutting, drilling and fabricating raw materials.
4. Fabricate ada, t · sections.
5. Mount har 'vare/modules.
6. Secure adapter mountings to chassis.
7. Connect wire or cabling to chassis.
8. Connect to adapters.

ENABLING OBJECTIVE(S)
Read wiring diagrams.

LEARNING ACTIVITIES
1. Determine area and position the adapter is to be mounted.
2. Demonstrate drilling and cutting space for the adapter.
3. Show proper procedures while mounting the adapter.
4. Use proper soldering equipment when soldering wires to the chassis and adapter.
5. Demonstrate proper safety techniques while performing this objective.

RESOURCES
Manufacturer's Training Manual

EVALUATION
Questions
1. It is necessary to have extensive varieties of wiring diagrams to properly use a specific diagram. (True or False.
2. Where would one obtain a wiring diagram for a specificator?

Answers
1. True
2. Manufacturers

PERFORMANCE OBJECTIVE V-TECS 39 (Continued)

Practical Application

1. Given a chassis and proper hardware, the student will determine and outline the position.
2. Using proper equipment the student will prepare the space for mounting the connector.
3. The student will mount the adapter and use proper soldering iron. He will follow safety procedures while soldering the iron.

Method of Evaluation

Use Checklist Performance Objective 39 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 39 EVALUATION

PERFORMANCE TEST FOR CONSTRUCTING EXTERNAL INTERFACE ADAPTOR

Student's Name ______________________ Date ______________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Correct hardware selected.	______	______
2. Mounting area clear of components and wiring.	______	______
3. Mounting space properly cut and cleaned of burs.	______	______
4. Make sure the adapter is secured.	______	______
5. Determine proper soldering iron.	______	______
6. Make sure safety procedures are observed.	______	______
7. Are all soldered joints clean and bright?	______	______
8. All connections checked with the ohmmeter.	______	______
9. Work station left in neat order.	______	______
10. All safety precautions were followed.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ Date ______________

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 40

TASK: Construct Tables Displaying Electronic Data (Variables, Parameters).

CONDITIONS: Data, measurements recorded from various electronic circuits, assorted colored pencils, graph paper, erasers, straight edge, clear adhesive tape.

STANDARD: When displayed, the data will be accurate, clear and uncluttered.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Obtain recorded data.
2. Review data to develop scheme for graph.
3. Identify time lines/vertical/horizontal components.
4. Sketch rough draft.
5. Delete or make additions to draft.
6. Include pertinent information in reference list.
7. Add title to graph.
8. Transfer draft to graph paper to complete table.

ENABLING OBJECTIVE(S)
1. Read measuring instruments.
2. Operate signal generator.

LEARNING ACTIVITIES
1. Explain how a table is constructed to record data for circuit being tested.
2. Construct a parallel resonant circuit.
3. Demonstrate how to measure points in circuit with oscilloscope, voltmeter and ammeter.
4. Show how to record information in table in the correct column.
5. Demonstrate how to use the information recorded.

RESOURCES
Buck Engineering Co., Inc., **Introduction to Electricity and Electronics**, (Lab Volt), pp. 35-4.

EVALUATION
Questions
1. Resonance Xa = YL are ______________ and ____________ in phase.
2. At frequencies other than resonance, line current will be either ____________ or ______________ depending on which current, I_L or I_C is greater in the tank circuit.
3. At the resonant frequency, f_r, the voltage across a tank circuit is at ____________.
4. The impedance at resonance is ____________ in a tank circuit.
5. How could you determine the impedance for the tank circuit?

PERFORMANCE OBJECTIVE V-TECS 40 (Continued)

Answers

1. Equal, opposite
2. Inductive, capacitive
3. Maximum
4. Maximum
5. Using the ohm's law equation
   $Z_t = E_t / I_{Line}$

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 41

TASK: Design Interfaces Between Sub-Assemblies (Electrical, Mechanical).

CONDITIONS: An electronic circuit that requires unique electrical terminations, drafting kit, drafting table, pen, pencils, erasers, straight edge, electronic equipment templates.

STANDARD: When completed, the design will provide for uncomplicated, easy-to-assemble interfaces which will not compromise circuit design.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review design specifications of circuit.
2. Review chassis or assembly where interfaces are to be attached.
3. Review connectors/interfaces in stock.
4. Design interfaces (modify and adapt to existing equipment when possible).
5. Compare interface design and design specifications of the circuit.

ENABLING OBJECTIVE(S)
Identify circuit involved in interfacing.
Read and interpret schematics.
Use in-depth theory of design interfaces between sub-assemblies.

LEARNING ACTIVITIES
1. Identify components to be interfaced.
2. Discuss the different methods of connecting the components.
3. Discuss how to determine the length of cable to be used.
4. Explain how to determine the number of pins required for the interface.
5. Demonstrate method of cutting the cable and mounting the hardware.

RESOURCES
Manufacturer's Manual

EVALUATION
Questions
1. It is not important for convertions to be properly aligned. (True or False)
2. Continuity is total when measured by an ohmmeter. (True or False)

Answers
1. False
2. True

Practical Application
Select proper connectors and cable, construct the interface cabling without damage to the cable or connectors. Using proper test instruments, check cable for continuity.

PERFORMANCE OBJECTIVE V-TECS 41 (Continued)

Method of Evaluation

Use Checklist Performance Objective 41 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 41 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING AND DESIGNING INTERFACE BETWEEN SUBASSEMBLIES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Explain the purpose of the adapter.	______	______
2. Correct steps followed in the process.	______	______
3. Safety was observed in the process.	______	______
4. Make sure the flat cable is not twisted.	______	______
5. Show that connectors are properly aligned.	______	______
6. Use proper tools when connecting hardware.	______	______
7. Demonstrate proper continuity by use of the ohmmeter.	______	______
8. Area was left clean and neat.	______	______
9. Followed all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 42

TASK: Design Physical Support Hardware for New Electronic Equipment.

CONDITIONS: Newly designed or prototype electronic equipment, drafting kit, drafting table, pen, pencils, erasers, straight edge.

STANDARD: When completed, the design will accommodate the unique characteristics of the prototype equipment.

SOURCE FOR STANDARD: Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review design specifications and intent of new hardware.
2. Review physical size and other physical peculiarities of equipment.
3. Compare stock items with design support required.
4. Design physical support hardware on rough draft. (Use stock items when and where practicable).
5. Compare design with hardware specifications.
6. Transfer to final draft.
7. Check final draft of design for accuracy and neatness.

ENABLING OBJECTIVE(S)
1. Interpret circuit diagrams.
2. Identify electronic components.
3. The theory of design for a physical support hardware.

LEARNING ACTIVITIES
1. Explain "specifications."
2. Define "prototype" equipment.
3. Show what type of drafting equipment you will need to use.
4. Discuss the importance of exact measurement when doing design work.
5. Locate examples of support hardware on electronic equipment.

RESOURCES

Brown. **Drafting for Industry**, pp. 164-170.

EVALUATION

Questions
1. Using the scale of "1/4 inch = 1 foot", what would an inch and a half represent in feet?
2. What is the name of the drafting tool that makes circles?
3. What instrument is used when making long horizontal lines?

Answers
1. 6 feet
2. Compass
3. T-Square

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 43

TASK: Draft Preliminary Specifications for an Electronic Device.

CONDITIONS: Schematic design, circuitry design, design specifications, circuit requirements.

STANDARD: When completed, the specifications will conform to the design of the electronic device and the circuit for which it will be used.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Review design specifications of the electronic device.
2. Determine tolerances for circuit.
3. Review design specifications of the circuit.
4. Determine circuit specifications.
5. Compare specifications of the circuit with those of the design.
6. Draft preliminary specifications for the circuit and the device.

ENABLING OBJECTIVE(S)

Use drawing instruments.

Use the theory for the drafting of preliminary specifications for an electronic device.

LEARNING ACTIVITIES

1. Tell what the word "specifications" would mean in electronics.
2. Explain what "quality control" means.
3. Discuss why extensive tests on each product made is important.
4. Show what electronic parts would have specifications.
5. Review the need of schematics.

RESOURCES

Crozier. **Introduction to Electronics**, pp. 141-142.

EVALUATION

Questions

1. It is necessary to have extensive tests on certain products. (True or False)
2. What is an electronic drawing indicating current paths and components called?
3. Where would one get specifications?

Answers

1. True
2. Schematic
3. From the manufacturer or data books.

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 44

TASK: Draw Schematic of Circuitry.

CONDITIONS: A rough drawing of an electronic circuit, drafting kit, drafting table, pen, pencil, erasers, straight edge, electronic equipment templates.

STANDARD: When completed the schematic will use standardized symbols, designations, conventions and accurately depict circuit functions.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review rough draft of schematic.
2. Layout schematic.
3. Make preliminary draft.
4. Review preliminary draft making additions and deletions.
5. Sketch final draft.
6. Check for accuracy and neatness.

ENABLING OBJECTIVE(S)
Read schematic diagram.

LEARNING ACTIVITIES
1. Identify electronic symbols to be used in circuit drawing.
2. Select correct electronic symbol to be used in a circuit drawing.
3. Demonstrate the procedures of drawing a circuit.
4. Differentiate between types of circuits.
5. Explain the operation of the circuit drawing.

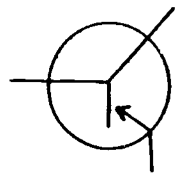
RESOURCES
Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, pp. 13-20.

EVALUATION
Questions
1. Draw the symbol for a PNP transistor.
2. Describe the current flow in a circuit containing an NPN transistor.
3. The use of a schematic diagram makes it possible to trace the ___________ of a circuit from beginning to end.
4. The dot symbol is used to show that wires are electrically ______________ at that point.
5. A schematic diagram does not show the actual _____________ of components or the _______________ of the wire runs used to connect the components.

PERFORMANCE OBJECTIVE V-TECS 44 (Continued)

Answers

1.



2. Current flows through the emitter, to the base, to the collector when the transister is conducting.
3. Operation
4. Connected
5. Location

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 45

TASK: Plan Quality Assessment Checks (Physical, Electrical).

CONDITIONS: An electronic assembly line with varying stages of assembly in process, stop watch, work roster, job descriptions, product specifications (assembly, subassembly, final product), time-motion study sheets, pencils, paper, erasers.

STANDARD: When completed, the plan will provide for quality control assessment at all critical points of the assembly line.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review production schematic from parts layout to assembly to subassembly to final product.
2. Review specifications, time and/or quality of subassemblies.
3. Review reports citing areas with most breakdowns.
4. Identify specific areas where quality control checks can be set up.
5. Develop plan using quality control checkpoints, break down statistics and assembly areas most suited for checks.

ENABLING OBJECTIVE(S)
Identify purpose of component being checked.
Define quality of assessment checks (physical, electrical).

LEARNING ACTIVITIES
1. Determine procedures used at the quality control station.
2. Determine production time to be used for the subassembly.
3. Determine failure areas and establish reports.
4. Determine quality checks using operational statistics.
5. Demonstrate proper operation of the subassembly.

RESOURCES
Driscoll. **Industrial Electronics, Devices, Circuits and Applications**, pp. 407-417.

EVALUATION
Questions
1. Why is it necessary to establish a quality control system?
2. How are time standards established?
3. All subassemblies should pass through the quality control station. (True or False)
4. How are performance checks established?
5. It is necessary to keep statistics on problem areas. (True or False)

Answers

1. Check for any faults or inferior components installed on the assembly line.
2. Under controlled environment.
3. True
4. Through an operational station, system is checked for established operations.
5. True

Practical Application

Set up a station with subassembly. Check for soldering defects and proper connections according to the wiring diagrams. Make a power on check for operation in accordance with established procedures.

Method of Evaluation

Use Checklist Performance Objective 45 to evaluate student's performance to determine if the task was completed with at least a 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 45 EVALUATION

PERFORMANCE TEST FOR PLANNING QUALITY CONTROL CHECKS

Student's Name _______________________________ **Date** __________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Explain procedures for making the checks.	______	______
2. Check all connections for proper connections.	______	______
3. Perform continuity checks.	______	______
4. Perform voltage tests.	______	______
5. Determine assembly is operating in accordance with established standards.	______	______
6. Follow all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature _______________________________ **Date** __________

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 46

TASK: Prepare Cost Factors Report.

CONDITIONS: Estimate of production time, time-motion study sheets, stopwatch, pencils, paper.

STANDARD: When completed, the report should accurately reflect the actual cost and cost centers.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review production time estimate.
2. Review materials needed.
3. Review manpower required.
4. Determine cost of new machinery, if necessary.
5. Determine overhead costs.
6. Determine quantities required/produced.
7. Apply monetary values to determinations made in steps 1-6.
8. Divide total costs by quantity produced per given period.
9. Recheck figures.

ENABLING OBJECTIVE(S)
1. Use math skills.
2. Use of records report.
3. Use the cost center concept.
4. Use the time motion concept.
5. Use of Management Training Techniques.

LEARNING ACTIVITIES
1. Explain purpose of preparing cost factor reports.
2. Demonstrate how to locate information from files on equipment cost, labor cost, and profit needed.
3. Show how to use math skills to determine cost factor.
4. Show how to determine a change in production rate or change in man power costs.
5. Explain usefulness of cost factor reports.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, pp. 424-427.

EVALUATION
Questions
1. Where do you obtain information for preparing cost reports?
2. What information is essential for determining cost factors?
3. If factors of demand are greater than supply, what change is necessary?
4. How can production time be determined?
5. What is the value of keeping cost factor reports?

PERFORMANCE OBJECTIVE V-TECS 46 (Continued)

Answers

1. Good filing systems.
2. Material cost, manpower required, new equipment cost, overhead cost, and production time estimate.
3. More manpower or new equipment to increase production.
4. Divide total cost by quantity produced per given period.
5. To keep from going backrupt or to increase profit margin.

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 47

TASK: Prepare an Estimate of Production Time.

CONDITIONS: Pencils, paper, stopwatch, time-motion study sheets, production records of similar jobs, calculator.

STANDARD: When completed, the production estimate will be supported by factual data and will identify time centers.

SOURCE FOR STANDARD: Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Determine by time study sheets, written specifications, and/or observations actual time necessary to perform all subassemblies.
2. Use sampling intervals to collect data.
3. Estimate operator efficiency, application and skill.
4. Compute estimated averages for production time.
5. Statistically analyze all data collected.
6. Crosscheck results with production records of similar jobs.

ENABLING OBJECTIVE(S)

Use drawing instruments.

LEARNING ACTIVITIES

1. Explain how to interpret information from a manufacturing process sheet.
2. Show how to determine time used for production of an electrical component.
3. Identify the component to be timed.
4. Explain the steps used for developing the product.
5. Explain importance of developing a production time schedule.

RESOURCES

Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 424-427.

EVALUATION

Questions

1. The ____________ time is the actual time it takes to do the operation.
2. Time estimates are checked against the ____________ and corrected when necessary.
3. ______________ is considered to be a concern of all persons in the company rather than of one person or department.
4. The three items listed under the standard time column on a manufacturing process sheet are ____________, ______________, and _______________.

Answers

1. Standard
2. Pilot run
3. Quality control
4. Standard unit, hours/unit, total

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 48

TASK: Prepare a Parts List for Prototype Equipment.

CONDITIONS: A schematic for the development of prototype equipment, parts inventory, parts reference catalog, pencils, paper, erasers.

STANDARD: When completed, the parts list will contain all of the parts which make up the equipment.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review prototype schematic.
2. List parts required to fabricate equipment.
3. Compare parts lists to parts catalog.
4. Determine parts needed.
5. List parts required identifying parts in stock and parts to be purchased or fabricated.
6. Include on special procurement information modifications of fabrication in notes.

ENABLING OBJECTIVE(S)
Interpret schematic drawings.

LEARNING ACTIVITIES
1. Explain what the word "Prototype" means.
2. Tell why it is necessary to have a parts list.
3. Show what part or parts might be "fabricated."
4. Collect at least two parts lists for equipment.
5. Estimate from a printed circuit board how many different components there might be.

RESOURCES
Crozier. **Introduction to Electronics.** p. 52.

EVALUATION
Questions
1. Why should parts be listed separate from the schematic?
2. Which would be more difficult to revise, schematics or a parts list?
3. The following is the description of a resistor sufficient for a parts list. (True or False)

"1000 ohms 1/2 watt carbon resistor"

Answers
1. It keeps the schematic from being cluttered.
2. Schematics
3. False

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 49

TASK: Prepare a Survey of Production Schedules.

CONDITIONS: Production schedules for all related and interrelated pieces of equipment, assorted colored pencils, paper, erasers, weekly and monthly time sheets, graph paper.

STANDARD: When completed, the survey will provide an accurate comprehensive representation of the actual production schedules.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review production schedules.
2. Translate each production schedule to the weekly time sheet.
3. Compare all schedules.
4. Combine schedules using differing colors or shadings.
5. Translate all weekly schedules to monthly schedules.
6. Compare all schedules.
7. Consolidate schedules into survey report.
8. Check for accuracy.

ENABLING OBJECTIVE(S)
Use drawing instruments.

LEARNING ACTIVITIES
1. Explain how to prepare a manufacturing process sheet.
2. Show how to draw charts to label columns.
3. Identify the location, time, and materials being used for production.
4. Explain the steps used for developing the product.
5. Explain the purpose and usefulness of a production process sheet.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 424-427.

EVALUATION
Questions
1. Two important documents that have been developed to control product manufacturing are the ________________ and ________________.
2. The information needed for production of a part are ______________, ____________, ______________, and ______________.
3. The purpose of ________________ is to achieve high-grade production of all manufactured products.

PERFORMANCE OBJECTIVE V-TECS 49 (Continued)

4. The product manufacturing process involves five steps:
   a. ____________
   b. ____________
   c. ____________
   d. ____________
   e. ____________

Answers

1. Manufacturing process sheets, manufacturing process specifications
2. Name, number, standard time of manufacture, routing
3. Quality control
4. Sales, engineering, prototype development, production, shipping

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 50

TASK: Translate Graphic Information into Written Specifications.

CONDITIONS: Graphic information from technical manuals, pencils, paper erasers.

STANDARD: When completed, the written specifications will be an exact translation of the graphic information.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review technical data instructions.
2. Determine specific technical data to be removed.
3. List technical data as depicted by graphs.
4. Combine information into written steps.
5. Check for accuracy and continuity.

ENABLING OBJECTIVE(S)
Identify electrical characteristics and family of curves.

LEARNING ACTIVITIES
1. Determine information given on the graphics.
2. Specify information being extracted from the graphs.
3. Demonstrate putting this information in written form.
4. Identify specific information being written.
5. Explain the advantages of written over graphic data.

RESOURCES
The Transistor Specification Sheet. (Lab Volt) Buck Engineering Co., pp. 29-1 -- 29.9.
Gerrish, et al., **Transistor Electronics**, pp. 217-218.

EVALUATION
Questions
1. What is the precautionary value given on the Transist or Specification Sheet?
2. Transistor parameter symbols are indicated ________________ on the graphs.
3. If the transistor is used as an electronic switch, what two characteristics would be important?
4. The transistor is a ______________ ____________ and a ______________ device.

Answers
1. Maximum rating value
2. Abbreviations
3. On-off, maximum rating
4. Semi-conductor, bi-polar and current controlling

PERFORMANCE OBJECTIVE V-TECS 50 (Continued)

Practical Application
Refer to Checklist Performance Objective 50 and translate graphic information into written specifications.

Method of Evaluation
Use Checklist Performance Objective 50 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 50 EVALUATION

PERFORMANCE TEST FOR TRANSLATING GRAPHIC INFORMATION INTO WRITTEN SPECIFICATIONS

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Explain the procedures when interpreting graphic information.	____	____
2. Construct a parameter table.	____	____
3. Determine that the 2N2219A is used for this project.	____	____
4. Identify correct family of curves.	____	____
5. Explain the use of the symbols.	____	____
6. Observe that the work station is in order.	____	____

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ **Date** __________

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 51

TASK: Write Operational Procedures.

CONDITIONS: A system of operating procedures, design specifications, pencils, paper, erasers, system support equipment.

STANDARD: When completed, the operating procedures will include all sequential steps necessary to operate the system.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Review design specifications requirements.
2. Review all supportive equipment necessary to operate system.
3. Observe procedures.
4. Perform procedures.
5. List all procedures required.
6. Sequence procedures.
7. Supplement sequenced procedures with additional procedures (when and where necessary).
8. Try out procedures.
9. Make necessary deletions, additions, etc.

ENABLING OBJECTIVE(S)

Use basic operation of electronic components.

LEARNING ACTIVITIES

1. Describe what "procedures" mean.
2. Tell why it is necessary to have the design specifications when writing operating procedures.
3. Review what safety measures must be taken when performing this task.
4. Point out the equipment you will need.
5. Explain why it is important to have available the schematic in writing operational procedures.

RESOURCES

Grozier. **Introduction to Electronics**

EVALUATION

Questions

1. Why is it important to write the procedures in sequence?
2. Once the procedures are written, why is it necessary to test them out?
3. What is a schematic?

Answers

1. So that when someone operates the device, it is done properly, and in order.
2. To be sure they are operational.
3. A diagram of an electrical circuit showing components.

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 52

TASK: Write Summary Report of Operational Tests.

CONDITIONS: Operational test reports, pencils/pens, paper, eraser, technical manual, dictionary.

STANDARD: When completed, the summary reports will be brief, accurate, and sequentially describe the operational tests.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Review all operational tests.
2. Determine sequence of tests.
3. Summarize each operational test.
4. Check data by use of technical manuals and/or experts.
5. Sequentially summarize summaries of each test.
6. Read for continuity, conciseness and clarity.
7. Make necessary corrections.
8. Prepare final draft of summary report of operational tests.

ENABLING OBJECTIVE(S)

Familiar with operation of electronic components.

LEARNING ACTIVITIES

1. Explain what an "operational test" is.
2. Discuss what test instruments you might use.
3. Indicate what type of circuits on which an operational test might be performed.
4. Review the safety measures that have to be taken.
5. Tell why concise wording is important when writing a report.
6. Identify the correct spelling of electronic terminology.

RESOURCES

Crozier. Introduction to Electronics, pp. 113-115.

EVALUATION

Questions

1. A summary should be writing as lengthy as possible. (True or False)
2. When writing a report on operational tests, it is necessary to sequence the report. (True or False)
3. Instruments are necessary for operational tests. (True or False)

Answers

1. False
2. True
3. False

DUTY OR UNIT: DESIGNING EQUIPMENT AND CIRCUITRY

PERFORMANCE OBJECTIVE V-TECS 53

TASK: Design Circuits From Engineering Specifications.

CONDITIONS: Engineering specifications for a circuit, pencil/pen, paper, eraser, straight edge, electronic symbols template.

STANDARD: When completed, the design circuit will be accurate, neat and not compromise the intent of the design.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review the specifications.
2. Review the design intent.
3. Sketch circuitry.
4. Compare circuitry with specifications.
5. Make adjustments.
6. Prepare final design.

ENABLING OBJECTIVE(S)
Read engineering specifications.

LEARNING ACTIVITIES
1. Identify the specification sheet for a push-pull power amplifier.
2. Select components and parts necessary to construct the circuit.
3. Construct a schematic diagram from these parts.
4. Calculate the input/output using the schematic.
5. Breadboard the circuit, using your schematic.

RESOURCES
Gerrish, et al., **Transistor Electronics**, pp. 247-248, 1979.

EVALUATION

Questions
1. How do you determine minimum and maximum operating points?
2. Name the point on the characteristic curve that the input and output signal swings about.
3. In a push-pull power amplifier the collector signals are _______________.

Answers
1. From the Engineering Specifications
2. Operating point
3. Out of phase with each other

Practical Application
Apply power to your circuit and display the signals on the oscilloscope.

Method of Evaluation
Use Checklist Performance Objective 53 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 53 EVALUATION

PERFORMANCE TEST FOR DESIGNING CIRCUITS FROM ENGINEERING SPECIFICATIONS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Specification sheet described for the purpose of the amplifier.	______	______
2. Explain the parameters of the components selected for the amplifier.	______	______
3. Was the schematic drawn as per the specifications of the components selected?	______	______
4. Was the circuit constructed in accordance with the schematic?	______	______
5. Do expected results appear on the oscilloscope?	______	______
6. Make sure the area is left in an acceptable condition.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

PERFORMING ENVIRONMENTAL TESTS

DUTY OR UNIT: PERFORMING ENVIRONMENTAL TESTS

PERFORMANCE OBJECTIVE V-TECS 54

TASK: Perform Corrosive Test.

CONDITIONS: Information sheets, climatically controlled chamber, voltage time recording graph, clock, corrosion specifications, test metals, input measuring device, output measuring device, signal generator, wire brush, needle nose pliers, pliers, assorted open end wrenches, soldering gun, acid core solder, rubber gloves, safety glasses.

STANDARD: When completed, the test will have exposed the circuit to all potential forms of corrosion and recorded the results of each test.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review corrosion specifications.
2. Determine type of corrosion test (inter-metallic or granular).
3. Set up test area (climatic chamber).
4. Connect input measuring device.
5. Connect output measuring device.
6. Connect time controlled graph recording.
7. Overlay two dissimilar pieces of metal to form an electric connection for current to pass through (intermetallic). For granular corrosion check use only one piece of test metal.
8. Connect input voltage.
9. Energize system and equipment.
10. Record results.

ENABLING OBJECTIVE(S)
Aware of safety precautions when working with batteries.

LEARNING ACTIVITIES
1. Explain the cause of corrosion on different metals.
2. Demonstrate the corrosion process on iron and steel objects and aluminum and copper.
3. Show how to test points where corrosion is formed.
4. Demonstrate the process of cleaning corroded areas of metal.
5. Demonstrate the use of a climatically controlled chamber.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 140-141.

PERFORMANCE OBJECTIVE V-TECS 54 (Continued)

EVALUATION

Questions

1. What is the primary cause of corrosion on iron?
2. What causes corrosion build up on copper and aluminum wiring connections?
3. What is the purpose of a climatically controlled chamber?

Answers

1. Moisture and air
2. Oxidation, because of bonding unlike metals
3. To prevent moisture and air from causing corrosion build up on metals.

DUTY OR UNIT: PERFORMING ENVIRONMENTAL TESTS

PERFORMANCE OBJECTIVE V-TECS 55

TASK: Perform Maximum Power (Input Signal) Test.

CONDITIONS: Variable input signal, graph paper, pencil/pen, clock, information sheets, isolation transformer, test area, power recording device, assorted open end wrenches, soldering gun, resin core solder.

STANDARD: When completed, the test will have identified the maximum power (input signal) the circuit will withstand and still function.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review specifications of the circuit.
2. Build test stand in test area.
3. Connect input signal to circuit.
4. Connect output signal to circuit.
5. Connect recording devices, time and power, to circuit.
6. Energize circuit and equipment.
7. Gradually increase input signal (power) until circuit overloads, ceases to function, or functions abnormally.
8. Record results.

ENABLING OBJECTIVE(S)
Use signal measuring test instruments.

LEARNING ACTIVITIES
1. Explain the purpose of this test.
2. Show how the family of curves are accomplished.
3. Demonstrate construction of a curve by plotting the voltage and current ratings.
4. Calculate power dissipation at a selected point of the curve.
5. Show by drawing the load line, the method of determining the load resistor.

RESOURCES
Gerrish, et al., **Transistor Electronics**, Chapter 14, p. 218.

EVALUATION
Questions
1. What temperatures are desirable for best transistor operation?
2. I_c is determined by what formula?
3. Using the curve, V_{ce}=8V, I_c=3.1mA, I_b= ?
4. With V_{ce}=24V, I_c=12.5mA. What is the value of R_L?
5. What type of circuit is used for this operation?

PERFORMANCE OBJECTIVE V-TECS 55 (Continued)

Answers

1. 25 degree celsius
2. $I_C = \frac{\text{rated mW}}{V_{ce}}$
3. 25 micro amps.
4. 1920 ohms
5. CE (common emitter)

Practical Application

Utilize the trainer and set up the circuit. Demonstrate the correct procedure for measuring and plotting the power curves.

Method of Evaluation

Use Checklist Performance Objective 55 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 55 EVALUATION

PERFORMANCE TEST FOR PERFORMING MAXIMUM POWER TEST

Student's Name ______________________________ **Date** __________

DIRECTIONS TO STUDENT: Set up a circuit for this exercise and use test equipment for measuring voltage and current. Use proper characteristic chart and plot voltages and current. From the chart determine the undistorted signal. Calculate the maximum power output.

DIRECTIONS TO EVALUATOR: Observe the student. Make sure the circuit is properly prepared. Make sure the student knows how the proper measurements are obtained. See that student can prepare proper characteristic chart and determine when maximum signals are reached. See that the student can calculate the power output.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The trainer is prepared.	______	______
2. The characteristic chart is correct for the transistor being used.	______	______
3. Voltage and current is within range of the transistor in use.	______	______
4. The student determines the change in collector current.	______	______
5. The student determines the range in collector voltage.	______	______
6. The student calculates the maximum power output.	______	______
7. The student leaves the trainer area neat.	______	______
8. The student follows all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ **Date** __________

DUTY OR UNIT: PERFORMING ENVIRONMENTAL TESTS

PERFORMANCE OBJECTIVE V-TECS 56

TASK: Perform Pressure Test.

CONDITIONS: Circuit specifications, climatically controlled test chamber, recording graph, input signal generator, measuring device output, assorted open end wrenches, soldering gun, resin core solder, needle nose pliers.

STANDARD: When completed, the test will have identified the range of pressures to which the circuit will be exposed.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Review circuit specifications.
2. Determine parameters of climatic chamber.
3. Install circuit in chamber.
4. Connect recording device to circuit.
5. Connect output measuring device.
6. Connect input signal.
7. Seal chamber.
8. Energize circuit and equipment.
9. Initiate tests, vary pressure from low pressure to high pressure to simulate extreme conditions to which the circuit will be subjected.
10. Record results.

EVALUATING OBJECTIVE(S)

1. Use oscilloscope properly.
2. Read schematic diagram.

LEARNING ACTIVITIES

1. Explain the operation of crystal oscillators.
2. Explain where and why crystals are used.
3. Show the procedure used in connecting an oscillator circuit.
4. Demonstrate the input and output signals.
5. Show the schematic symbols used for this circuit.

RESOURCES

Gerrish, et al., **Electricity and Electronics**, pp. 212-214.
Shrader, et al., **Electrical Fundamentals for Technicians**, pp. 429-430.
Burban, et al., **Understanding Electricity and Electronics**, pp. 353-356.

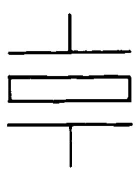
PERFORMANCE OBJECTIVE V-TECS 56 (Continued)

EVALUATION

Questions

1. A circuit which exhibits a very high frequency stability is the ________________.
2. A voltage applied to the surfaces of a crystal will produce ____________.
3. Crystals are made from ________________, ________________, or ________________.
4. Draw the symbol for a crystal used in an electrical circuit.
5. ________________ is the property of certain crystalline substances of changing shape when an emf is inpressed upon crystal.

-rs

1. Crystal -- controlled oscillator
2. Distortion
3. Quartz, tourmaline, rochelle salts
4. 
5. Piezoelectric effect

DUTY OR UNIT: PERFORMING ENVIRONMENTAL TESTS

PERFORMANCE OBJECTIVE V-TECS 57

TASK: Perform Shock (Impact) Test.

CONDITIONS: Circuit/module specifications, assorted open end wrenches, impact imparting (variable) device, needle nose pliers, soldering gun, resin core solder, timepiece, recording graph, pencils/paper, information sheets, eraser, graph paper, output measuring device, input signal generator, impact recording instrument, safety glasses.

STANDARD: When completed, the test will record the ability of the circuit or module to withstand various impacts.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review circuit/model specifications.
2. Determine impact parameters to be tested.
3. Install circuit/module in test area.
4. Connect impact measuring device to system.
5. Connect circuit/module output measuring device.
6. Connect input signal generator.
7. Turn on system.
8. Activate impact imparting device.
9. Record results.

ENABLING OBJECTIVE(S)
Read transistor specification sheet and understand the parameters.

LEARNING ACTIVITIES
1. Determine the maximum parameters of the 2N2219A transistor.
2. Demonstrate the effect of overdriving the voltage.
3. Explain the effect of the high currents.
4. Explain the effect on the output power.
5. Demonstrate the changing temperatures and its effect.

RESOURCES
The Transistor Specification Sheet (Lab Volt). Buck Engineering Co.

EVALUATION
Questions
1. The maximum ratings of a transistor are normally used as ______________.
2. Transistor Specification Sheets are useful in the ________________.
3. Maximum ratings are important when a transistor is used as an ____________.

PERFORMANCE OBJECTIVE V-TECS 57 (Continued)

Answers

1. Design limits
2. Design of a circuit
3. Electronic switch

Practical Application

Set up a circuit using the 2N2219A transistor and demonstrate the shock treatment by overdriving the circuit limits.

Method of Evaluation

Use Checklist Performance Objective 57 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 57 EVALUATION

PERFORMANCE TEST FOR PERFORMING SHOCK (IMPACT) TEST

Student's Name ______________________________ **Date** __________

DIRECTIONS TO STUDENT: Set up the equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completed the tasks within a reasonable time. A score of 90% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Explained the normal operations of the circuit.	______	______
2. Followed the specification sheet.	______	______
3. Demonstrated signal patterns of the circuit in normal operation.	______	______
4. Showed the distorted patterns of the over-driven circuit.	______	______
5. Explained why it is necessary to observe proper temperature and voltage when operating transistor circuits.	______	______
6. Followed all safety precautions.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ **Date** __________

DUTY OR UNIT: PERFORMING ENVIRONMENTAL TESTS

PERFORMANCE OBJECTIVE V-TECS 58

TASK: Perform Temperature Test.

CONDITIONS: Circuit/module specifications, climatically controlled test chamber, temperature recording graph, timing device, input measuring device, input signal generator, output measuring device, needle nose pliers, assorted open end wrenches, soldering gun, resin core solder, pencils/pens, information sheets, graph paper, erasers.

STANDARD: When completed, the circuit/module performance under temperature extremes will be recorded.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review circuit/module specifications.
2. Determine temperature parameters of climatic test chamber.
3. Install circuit/module in test chamber.
4. Connect output measuring device.
5. Connect input signal generator.
6. Connect temperature monitoring device to circuit module.
7. Energize system.
8. Adjust temperatures as desired.
9. Record results.

ENABLING OBJECTIVE(S)
1. Read schematic diagram.
2. Interpret meter readings.

LEARNING ACTIVITIES
1. Explain the operation of a thermocouple meter.
2. Demonstrate the method of using the thermocouple meter.
3. Show the D'Arsonval meter movement.
4. Explain uses of the thermocouple meter.
5. Explain advantages and disadvantages of this type meter.

RESOURCES
Fowler, **Electricity Principles and Applications**, p. 287.

PERFORMANCE OBJECTIVE V-TECS 58 (Continued)

EVALUATION

Ques.ions

1. At RF (Radio Frequency) currents the ________________ reactance of the meter coil is high and the ______________ reactance of the capacitance between the turns of the coil is low.
2. The thermocouple meter avoids the reactance problem by ______________ the basic movement from the RF currents.
3. The the mocouple meter uses a ________________ meter movement connected to a thermocouple.
4. A thermocouple is a device that converts ___________ energy into __________ energy.
5. The _______________ meter can accurately respond to very high-frequency curves.

Answers

1. Inductive, capacitive
2. Isolating
3. D'Arsonal
4. Heat, electrical
5. Thermocouple

ADMINISTERING PERSONNEL

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 27

TASK: Administer Diagnostic Tests to Prospective Employees.

CONDITIONS: Prospective employees and employee diagnostic tests, pencils, paper, erasers, name tags, timing device, roster form, test materials.

STANDARD: The test will be administered in a comfortable, undisturbed environment and conform to time limits specified.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Obtain list of prospective employees.
2. Determine date and place test will be administered.
3. Reserve the testing room.
4. Notify prospective employees when and where test will be administered.
5. Fill out attendance roster on test day.
6. Pass out test and test equipment.
7. Explain test instructions.
8. Administer test for specified time limits.
9. Collect tests.

ENABLING OBJECTIVE(S)
Identify basic knowledge of normal operation of power and power supply.

LEARNING ACTIVITIES
1. Explain the purpose of the test.
2. Explain the importance of completing the test.
3. Demonstrate correct troubleshooting techniques.
4. Show how to select proper test equipment.
5. Demonstrate correct procedures when calculating output results.

RESOURCES
Gerrish, et al., **Transistor Electronics**, Chapter 12, pp. 180-186.

EVALUATION
Questions
1. The first step in taking a test is to ______________.
2. Any vacant room is suitable for administering a test. (True or False)
3. What is the last step in administering a test?

Answers
1. Read the instructions.
2. False
3. Collect the tests.

PERFORMANCE OBJECTIVE V-TECS 27 (Continued)

Practical Application

Refer to Checklist Performance Objective 27. Administer diagnostics tests to prospective employees.

Method of Evaluation

Use Checklist Performance Objective 27 to evaluate student's performance to determine if the task was completed with at least a 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 27 EVALUATION

PERFORMANCE TEST FOR PROSPECTIVE EMPLOYEES

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: With pencil and paper list possible causes for the problem identified in the power supply. Make diagnostic checks, using correct troubleshooting techniques and identify defective components. Using safe methods remove and replace the affected components. Check power supply for proper operation.

DIRECTIONS TO EVALUATOR: Observe the student, making sure items to be evaluated are on hand. Be sure the student completes the assignment within the alloted time. A score of 90% should be accomplished.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The students being tested are properly seated.	______	______
2. The test date was announced.	______	______
3. The testing room was reserved and properly prepared.	______	______
4. The attendance roster was completed.	______	______
5. The test equipment was in place.	______	______
6. The tester explained the instructions.	______	______
7. The time limits were stated.	______	______
8. The tests were collected at the end of the time limit.	______	______
9. Safety precautions were followed.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________ **Date** __________

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 28

TASK: Conduct Instruction by Demonstration/Performance.

CONDITIONS: A lesson plan, training aids, chalkboard, chalk, overhead projector, projection screen, evaluation device.

STANDARD: When the instruction is terminated the lesson objectives will be met.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review lesson plan.
2. Review training aids.
3. Set up screen.
4. Position chalkboard.
5. Arrange teaching room or laboratory.
6. Present lesson.
7. Administer evaluation device.
8. Review results of evaluation.

ENABLING OBJECTIVE(S)
1. Use overhead projector.
2. Use multimeter.
3. Use chalkboard.

LEARNING ACTIVITIES
1. Explain use of resistors in electronic circuits (using lesson plans).
2. Show color bands used on resistors (using overhead).
3. Demonstrate how to interpret color code chart and color bands on resistors. (Using overhead and chalkboard)
4. Demonstrate how to read resistance with multimeter and compare with color band value. (Using multimeter and overhead)
5. Demonstrate resistor symbol used in electronic circuits. (Using chalkboard)

RESOURCES
Burban and Schmitt, **Understanding Electricity and Electronics,** 3rd edition, pp. 54-62.

EVALUATION
Questions
1. Resistors can be used to control either ______________ or ______________.
2. The first two color bands on a resistor represent the actual ______________ for that color band.
3. The third color band on a resistor represents the ______________ used for determining the ohmic value of a resistor.
4. The silver or gold band represents the ______________ value when located as the fourth band on a resistor.
5. Resistors using color bands are called ______________ resistor.

PERFORMANCE OBJECTIVE V-TECS 28 (Continued)

Answers

1. Voltage, current
2. Number
3. Multiplier
4. Tolerance
5. Carbon-composition

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 29

TASK: Evaluate Employee Performance.

CONDITIONS: A performance rating device and the job description(s) of employee(s), pencil, clock, eraser.

STANDARD: The job performance(s) must be evaluated according to the criteria reflected on the rating device. The rating must coincide with ratings performed by other evaluators.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review incumbent's job description.
2. Review criteria listed on the rating device.
3. Determine observation period.
4. Observe employee performance.
5. Fill out rating device.
6. Discuss rating with ratee.

ENABLING OBJECTIVE(S)
Use test equipment, follow instructions and compute results.

LEARNING ACTIVITIES
1. Explain the procedures of the evaluation.
2. Evaluate the methods used by the employee.
3. Demonstrate the correct methods when necessary.
4. Explain when steps become necessary in troubleshooting techniques.
5. Show why calculations are important.

RESOURCES
Gerrish, et al., **Transistor Electronics**, Chapter 12, pp. 180-186.

EVALUATION
Questions
1. Evaluating an employee requires a knowledge of ________________.
2. ______________ ______________ are good evaluating trouble techniques.
3. The rating should coincide with ____________________________.

Answers
1. The employee's performance
2. Observation and rating devices
3. Ra.ings of other evaluations

PERFORMANCE OBJECTIVE V-TECS 29 (Continued)

Practical Application
Use laboratory exercise for the full wave power supply to set-up trainer. Diagnose and repair the defective circuitry.

Methods of Evaluation
Use Checklist Performance Objective 29 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 29 EVALUATION

PERFORMANCE TEST FOR EVALUATING EMPLOYEE PERFORMANCE

Employee's Signature ____________________ Date ____________

DIRECTIONS TO EMPLOYEE: This evaluation is to be conducted while doing your routine duties and will be conducted in accordance with the job description.

DIRECTIONS TO EVALUATOR: Observe the employee, making sure all items to be evaluated are on hand. Be sure the employee follows procedures as outlined in the job description and is within time allotted with at least 90% accuracy.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The job description is up to date and followed.	______	______
2. The employee completes all assignments on the rating device.	______	______
3. The evaluation was performed in the time limit.	______	______
4. The employee performed all task.	______	______
5. The rating device was checked for all areas.	______	______
6. The rating w : critiqued with the employee.	______	______
7. All safety precautions were followed.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature ____________________ Date ____________

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 30

TASK: Evaluate Training Programs.

CONDITIONS: Operational training programs, the goals and objectives of the training programs, purpose of the evaluation, evaluation instrument(s), pencil(s), program schedules, roster of trainees and of trainers, training budget figure, supervisor/trainee reports, training aid list.

STANDARD: The training program will be evaluated when it can be determined if the training program is meeting its goals and objectives.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review stated purpose of the evaluation.
2. Review stated goals of the evaluation.
3. Ensure program manager is aware of evaluation.
4. Provide program manager with evaluation agenda.
5. Conduct evaluation.
6. Compile results.
7. Review results with program manager.
8. Prepare final evaluation report.

ENABLING OBJECTIVE(S)
1. Read schematic diagrams.
2. Interpret meter readings.

LEARNING ACTIVITIES
1. Explain curriculum objectives to be covered in electronics course.
2. Show experiments to be performed for each objective.
3. Demonstrate equipment to be used in performing experiments.
4. Show cost figures for equipment and tools needed for training equipment.
5. Demonstrate evaluation process of each training experience.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics**, 3rd edition, pp. ix-xi.
Electricity and Electronics, Buck Engineering Co., Inc., (Lab Volt), pp. viii-ix.

EVALUATION
Questions
1. How do you know the objectives to be covered in the electronics course?
2. What types of equipment are used in the electronics course?
3. How do you determine the cost of equipment used in the electronics course?
4. How do you determine the budget needed for each year?

PERFORMANCE OBJECTIVE V-TECS 30

Answers

1. The text book contents, curriculum guide and the trainee manual.
2. Oscilloscope, meters for current, voltage, resistance, and power and electronic components.
3. Checking inventory sheet for course and updated price sheet for replacement parts.
4. Cost of repairs for equipment, prices for needed new equipment, advisory council recommendations, cost of replacing text books, and instructional supplies.

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 31

TASK: Evaluate Personnel Safety Violations.

CONDITIONS: Safety evaluator's reports, violations report, accident report, safety procedures, equipment procedures.

STANDARD: The evaluation will be complete when the reasons for the violations are determined.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review safety violation report.
2. Review safety evaluator's report.
3. Review accident report (if applicable).
4. Review normal procedures for performing job in which violation occurred.
5. Review safety procedures for job for which violation occurred.
6. Interview supervisor in area where violation occurred.
7. Interview witnesses (if any).
8. Interview violator (if applicable).
9. Compare testimony, evidence and observation with safety procedures and equipment operating procedures.
10. Make recommendations.

ENABLING OBJECTIVE(S)
Describe the necessary forms and regulations.

LEARNING ACTIVITIES
1. Explain the purpose of the report.
2. Describe the possible harm that could occur to personnel and equipment.
3. Determine the reports needed for the violation.
4. Explain how proper precautions prevent violations.
5. Explain how the buddy system should be used when working hazardous areas.

RESOURCES
National Safety Council
National Electrical Manufacturers Association
Occupational Safety and Health Administration
Kaiser, **Electrical Power Motors, Controls, Generators and Transformers**, Chapter 1, pp. 8-9.

EVALUATION
Questions
1. Why are safety glasses worn when soldering?
2. What is the purpose of posting safety regulations?
3. Every safety violation needs to be supported by a ____________________.

PERFORMANCE OBJECTIVE V-TECS 31 (Continued)

Answers

1. Protect the eyes.
2. Legal protection and employee answers
3. Written report

Practical Aplication

Given a printed circuit board, applicable tools and equipment, remove a component by desoldering, without damaging the circuit. Replace the component using correct procedures and check circuit with the ohmmeter to see if there was any heat damage.

Method of Evaluation

Use Checklist Performance Objective 31 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 31 EVALUATION

PERFORMANCE TEST FOR PERSONNEL SAFETY VIOLATION

Student's Name **Date**

DIRECTIONS TO STUDENT: Complete the safety report on the circuit board that was damaged while soldering. Complete the accident report on your hand that was burned with the soldering iron.

DIRECTIONS TO EVALUATOR: Observe that the student completes the parts of the forms applicable. All entries should be in accordance with check list.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The student completes violation report.	_____	_____
2. The student completes the accident report.	_____	_____
3. The student used the correct procedures when soldering.	_____	_____
4. The student reviewed the procedures for safe use of the hot soldering iron.	_____	_____

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 32

TASK: Interview Prospective Employees.

CONDITIONS: Completed job application forms and resumes, interview room, chairs, small table, desk, paper, pencil, job description.

STANDARD: Interviews should determine if a prospective employee has the qualifications to perform the job. Interview will be completed when it is determined if a prospective employee is or is not qualified to perform the job.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Ensure a room or space within a room is available to conduct interviews.
2. Determine interviewing agenda for the day.
3. Contact interviewee and finalize appointment, place, and time.
4. Review job description for position.
5. Review job application forms and resumes.
6. Determine questions to be asked of each prospective employee.
7. Conduct interviews.
8. Compare observations, interview results with job requirements.
9. Make recommendations.

ENABLING OBJECTIVE(S)
Read and fill out an application.

LEARNING ACTIVITIES

1. Explain why interviews are important.
2. Tell why you think hand writing is an important part of the application.
3. List at least four items that you will look for when interviewing a potential employee.
4. Show from four different applications what you think is the best application and indicate why.
5. Relate whether appearance is important or not.
6. Discuss how you would judge an applicant by the manner in which he speaks.
7. Prepare what you believe is a good application.
8. Write out a job description for the position that is open.
9. Record the questions that you will ask the potential employee.

RESOURCES
Livingstone. **Janus Job Interview Guide**, pp. 5-16.

PERFORMANCE OBJECTIVE V-TECS 32 (Continued)

EVALUATION

Questions

1. It is all right for the applicant to smoke during ar iew. (True or False)
2. It is all right for the interviewer to smoke. (Truc alse)
3. Should an application be written or printed?
4. Should a pen or pencil be used in completing an application?
5. How should the interviewer be dressed?
6. You should consider a quiet place important for an interview. (True or False)

Answers

1. False
2. False
3. Printed
4. Pen
5. Neat. Clean. (Should be dressed in the manner of the position and company they represent).
6. True

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 33

TASK: Maintain Work Records of Employees.

CONDITIONS: Work records of employees, file folders, filing cabinet, typewriter, file folder labels.

STANDARD: The records of any employee must be correct, properly filed, and up-to-date.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE

1. Determine information to be included in work records.
2. Obtain file folders.
3. Put individual work records in individual file folders.
4. Label each file folder with name and other identifiers as determined by filing system used.
5. Transfer information to work record.
6. File work records, (alphabetically, numerically by division, by group, by shift, etc.).

ENABLING OBJECTIVE(S)
Use drawing instruments.

LEARNING ACTIVITIES

1. Explain purpose for maintaining good work records for employees.
2. Demonstrate type chart to be drawn for keeping records.
3. Show how to file records in filing cabinet.
4. Demonstrate how to keep time, keep progress reports, and other necessary data.
5. Explain importance of good record keeping.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics,** 3rd edition, pp. 424-425.

EVALUATION
Questions

1. How should records for employees be filed in a file cabinet?
2. How should records be marked?
3. What information is necessary to record on employee's records?
4. How often should records be updated?

Answers

1. In alphabetical order and by shift, group, division, etc.
2. By name and number
3. Type work performed, time worked, pay schedule, and insurance information.
4. Daily or whenever progress is reported.

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 34

TASK: Monitor Programmed Instructions.

CONDITIONS: A group of trainees who have been administered the programmed instructions materials, programmed instruction guide, master answer guide, trainee roster, program instruction schedule.

STANDARD: The progress of each trainee should be current, and programmed instructions should be terminated as scheduled.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review program instruction schedules.
2. Determine where trainees should be in program.
3. Compare trainees programmed instruction completion sheet with proposed progress chart.
4. Note deviations.
5. Advise trainees and supervisor of progress.

ENABLING OBJECTIVE(S)
Identify and describe the principles of the learning exercise.

LEARNING ACTIVITIES
1. Explain the procedures to be followed.
2. Show proper sequence to be followed.
3. Demonstrate by accomplishing one of the objectives.
4. Show correct procedures of using the trainers.
5. Explain the safety precautions when working with electronic components.

RESOURCES
Practical Electricity and Electronics Fundamentals for Career Preparation, (Lab Volt -- Vol. 1), Buck Engineering Co.

EVALUATION
Questions
1. What is the advantage of program instruction over the conventional method?
2. What, if any, advantage does program instruction give the slower student?
3. What role does the classroom instructor play in the program instructions?

Answers
1. They give every student a chance to progress at their own rate.
2. They do not have to progress at the same rate as the faster student, as in the conventional methods.
3. Monitor and advisor. He also revises programs to suit the particular situation.

PERFORMANCE OBJECTIVE V-TECS 34 (Continued)

Practical Application
Given a program of instruction, a trainer and test equipment, set-up a circuit following the proper instructions. Complete the objectives in order.

Method of Evaluation
Use Checklist Performance Objective 34 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 34 EVALUATION

PERFORMANCE TEST FOR MONITORING PROGRAMMED INSTRUCTIONS

Student's Name ______________________ Date ______

DIRECTIONS TO STUDENT: Use the LAP and Trainer and complete the assignment with given instructions.

DIRECTIONS TO EVALUATOR: Observe the student making sure all items are completed in sequence. All items are to be completed with 90% accuracy.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The trainer is prepared.	____	____
2. The student read the instructions.	____	____
3. The student followed the objectives in order.	____	____
4. The student identified the test equipment to be used.	____	____
5. All checks completed.	____	____
6. The student utilized their time to the fullest without waste.	____	____
7. The student demonstrated the self-paced method.	____	____
8. The student expressed his opinion of the concept.	____	____
9. The student followed all safety precautions.	____	____

APPROVED: Yes _____ No _____

Evaluator's Name ______________________ Date ______

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 35

TASK: Orient Personnel to Procedures.

CONDITIONS: Policies or procedures, training aids, chalkboard, chalk, overhead projector, chalkboard eraser.

STANDARD: All procedures must be explained in proper sequence and the acceptable performance indicated.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review procedures to be included in the orientation.
2. Study procedures.
3. List personnel that will be orientated.
4. Notify personnel time and place of orientation.
5. Pass out attendance roster.
6. Present procedures.
7. Answer questions.

ENABLING OBJECTIVE(S)
None

LEARNING ACTIVITIES
1. Describe what procedures are.
2. Explain what policies are.
3. Tell why it is important that personnel be familiar with and understand the policies and procedures an employer might have.
4. Prepare three (3) procedures that an employer might have.
5. Compose three (3) policies an employer might have.

RESOURCES
Ammer. **Materials Management**, pp. 78-81.

EVALUATION
Questions
1. How would you dress to present policies and procedures to employees?
2. How important is your manner of speech?
3. Would it be a good idea to pass out copies of the policies and procedures (prior to) (after) the meeting?
4. In reference to question 3, explain why.

Answers
1. Clean, neat and in a manner that is acceptable to the occupation.
2. Very important. You should insure that you are understood and your points are getting across.
3. Prior to.
4. Because they can go through the list as you explain. This will make the presentation more readily understood.

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 36

TASK: Plan Work Schedule.

CONDITIONS: Work assignments and time blocks to accomplish the assignments, section work requirements, calendar, list of workers, work schedule forms, pencils, writing paper, erasers.

STANDARD: When completed the work assignments will be covered within the time frame allocated by personnel qualified to do the assignment.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review work allocation requirements.
2. Review worker list.
3. Match skills and competencies of worker(s) to compatible areas.
4. Draft preliminary work schedule.
5. Notify shift foreman, supervisor, etc. of scheduling meeting.
6. Submit copies of tentative schedules to shift supervisors.
7. Record suggestions.
8. Modify schedule as necessary.
9. Print final work schedule.
10. Distribute work schedule to personnel.

ENABLING OBJECTIVE(S)
Interpret table charts.

LEARNING ACTIVITIES
1. Explain purpose of a work schedule.
2. Identify areas where work is to be performed.
3. Select personnel to be assigned to perform a certain task.
4. Construct a chart showing names of persons, time for task, location, and task to be performed.
5. Cite advantages of a good work schedule.

RESOURCES
Student Information Sheet

EVALUATION
Questions
1. List the types of work to be performed in class.
2. What is the purpose of posting a work schedule?
3. How do you determine the number of people needed for the assigned tasks?

PERFORMANCE OBJECTIVE V-TECS 36 (Continued)

Answers

1. a. Lab area to be swept and put in order.
   b. Equipment to be turned off and put away.
   c. Furniture arranged in instructed order.
2. Planned work schedules aid in keeping down confusion. Everyone knows what to do and when to do it.
3. Evaluate the task involved and assign the number of workers to a particular task to accomplish it.

PERFORMANCE OBJECTIVE V-TECS 36 (Continued)

STUDENT INFORMATION SHEET
PLANNING A WORK SCHEDULE
ELECTRONICS LAB

Students taking an electronics course will be able to work together in cleaning up their work areas and other assigned areas designated by the instructor.

Each student will be responsible for planning a work schedule each week during the course of study. Plans for assigning students to certain work stations are as follows:

Task	Area	Number Of Students	Student
Straighten Desks	Classroom	2	X X
Sweep	Classroom	2	X X
Check Equipment	Laboratory	2	X X
Sweep	Laboratory	2	X X
Empty Trash	Classroom & Lab	1	X
Straighten Tool Boxes	Laboratory	1	X
Straighten Book Shelf	Classroom	1	X
Clean Work Area	Laboratory	All Students	All Students

DUTY OR UNIT: ADMINISTERING PERSONNEL

PERFORMANCE OBJECTIVE V-TECS 37

TASK: Report Equipment Related Safety Violations.

CONDITIONS: A list of equipment related safety violations, safety violations report form, pen/pencil, safety violations list, clipboard, supervisor's list.

STANDARD: Reports must be concisely written, and accidents categorized by equipment and type of safety violation.

SOURCE FOR STANDARD:
Writing Team. State of Georgia.

PERFORMANCE GUIDE
1. Review all safety violations recorded.
2. Identify equipment related violations.
3. Group specific equipment violations.
4. Group violations by potential severity (potential persorral or property loss) under each category.
5. Summarize violation patterns.
6. Finalize report.

ENABLING OBJECTIVE(S)
Identify and describe the proper use of tools and equipment.

LEARNING ACTIVITIES
1. Explain the purpose of the report.
2. Identify the proper reports to be used.
3. Demonstrate the proper method for filing the report.
4. Determine if there is a violation.
5. Explain that an unsafe tool or piece of equipment should never be used.

RESOURCES
Burban, et al., **Understanding Electricity and Electronics,** Unit 6, pp. 33-34.
Kaiser. **Electrical Power Motors, Controls, Generators, Transformers,** Chapter 6, pp. 92-93.

EVALUATION
Questions
1. When is it permissable to use a tool with a damaged extention cord?
2. When connecting any electrical wire into the circuit the power should be ______________.
3. A report can be written in general terms. (True or False)
4. A log out should be written if an ohmmeter is connected into the circuit with the power on. (True or False)

Answers
1. Never
2. Off
3. False
4. True

PERFORMANCE OBJECTIVE V-TECS 37 (Continued)

Practical Application
The student will complete the violation report, utilizing the proper forms.

Method of Evaluation
Use Checklist Performance Objective 37 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 37 EVALUATION

PERFORMANCE TEST FOR REPORTING EQUIPMENT SAFETY VIOLATIONS

Student's Name ______________________________ Date __________

DIRECTIONS TO STUDENT: Using an unsafe tool and proper form complete the violation report.

DIRECTIONS TO EVALUATOR: Observe the student making sure all items are reported. The form should be completed in accordance with the checklist.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The correct forms are used.	______	______
2. The equipment was inventoried.	______	______
3. All safety violations were reported.	______	______
4. The report was completed.	______	______

APPROVED: Yes _____ No _____

Evaluator's Name ______________________________ Date __________

APPENDIX A

CROSS-REFERENCE TABLE OF DUTIES, TASKS AND PERFORMANCE OBJECTIVES

APPENDIX A

CROSS-REFERENCE TABLE OF DUTIES, TASKS AND PERFORMANCE OBJECTIVES

	Duty and Task	Performance Objective/ Page Number
A.	Adjusting/Aligning/Calibrating Electronic Circuitry	
	Adjust AC Generator Output	V-TECS-01/5
	Adjust Amplifier Gain	V-TECS-02/8
	Adjust Armature or Field Connection Voltage	V-TECS-03/11
	Adjust Audio Intensities	V-TECS-04/14
	Adjust Automatic Gain Control	V-TECS-05/17
	Adjust Bias Network	V-TECS-06/20
	Adjust Capacitance	V-TECS-07/23
	Adjust Core for Slug Tuned Circuits	V-TECS-08/25
	Adjust DC Generator Output	V-TECS-09/27
	Adjust Drive Gear	V-TECS-10/29
	Adjust Focus Control	V-TECS-11/32
	Adjust Horizontal Linearity	V-TECS-12/35
	Adjust Impedance	V-TECS-13/37
	Adjust Modulation Percentage	V-TECS-14/39
	Adjust Oscillator	V-TECS-15/42
	Adjust Output of High Frequency Amplifiers (Grounded Grid; Cascade)	V-TECS-16/45
	Adjust Power Converter Output	V-TECS-17/48
	Adjust Probe Calibrator Signal	V-TECS-18/51
	Adjust Resonant Frequency	V-TECS-19/54
	Adjust Tape Reader	V-TECS-20/56
	Adjust Voltage	V-TECS-21/58
	Align TRF	V-TECS-22/60
	Calibrate Multi-Vibrator Circuit (Stable, Monostable, Bistable, Flip Flop)	V-TECS-23/63
	Calibrate P-P Voltage	V-TECS-24/66
	Calibrate Timing/Clock Pulse	V-TECS-25/68
	Calibrate Vertical Amplitude	V-TECS-26/70
B.	Replacing Components	
	Replace Amplifier	V-TECS-75/74
	Replace Cathode Ray Tube	V-TECS-76/77
	Replace Capacitor	V-TECS-77/79
	Replace Digital Display Segment	V-TECS-78/81
	Replace Deflection Yoke	V-TECS-79/83
	Replace Dynamotor	V-TECS-80/85
	Replace Energy Storage Cells	V-TECS-81/87

Replacing Components continued:

Replace Air Filter	V-TECS-82/89
Replace Frequency Converter	V-TECS-83/92
Replace Fuse	V-TECS-84/94
Replace IC Chips	V-TECS-85/96
Replace Indicator Lamps	V-TECS-86/98
Replace Klystron	V-TECS-87/99
Replace Magnetron	V-TECS-88/102
Replace Microphone	V-TECS-89/105
Replace Occillator	V-TECS-90/107
Replace PC Boards	V-TECS-91/110
Replace Photo Electric Relays	V-TECS-92/112
Replace Power Supplies	V-TECS-93/114
Replace Pulley Bolt	V-TECS-94/116
Replace Relays	V-TECS-95/117
Replace Guide Roller	V-TECS-96/119
Replace Servomechanism	V-TECS-97/122
Replace Solid State Diodes	V-TECS-98/125
Replace Switches (Leaft, Contact, Mercurial)	V-TECS-99/128
Replace Tape Head	V-TECS-100/130
Replace Thermal Breakers	V-TECS-101/131
Replace Transducer	V-TECS-102/133
Replace Transformer	V-TECS-103/136
Replace Transistors	V-TECS-104/138
Replace Tubes	V-TECS-105/140

C. Maintaining Electronics Devices

Assemble Structural Members According to Assembly Drawing	V-TECS-59/143
Clean Air Filters	V-TECS-60/145
Clean Chassis	V-TECS-61/148
Clean Circulation Fans (Exhaust and Intake)	V-TECS-62/150
Clean Contact Points	V-TECS-63/153
Clean Drive Mechanism	V-TECS-64/155
Clean Reflective Mirror	V-TECS-65/157
Clean Tape Head	V-TECS-66/159
Clean Tape Reader	V-TECS-67/161
Clean Tuner	V-TECS-68/162
Clean Potentiometer (Volume Control, Video, Chroma, etc.)	V-TECS-69/163
Locate Component Malfunctions Using Fault Location Guides	V-TECS-70/165
Mount System in/out Physical Support	V-TECS-71/166
Record Meter Readings	V-TECS-72/169
Splice Wires	V-TECS-73/171
Solder/Unsolder Components	V-TECS-74/173

D. Designing Equipment and Circuitry

Conduct Physical Inventory	V-TECS-38/177
Construct External Interface Adapters	V-TECS-39/179
Construct Tables Displaying Electronic Data (Variables, Parameters)	V-TECS-40/182
Design Interfaces Between Sub-Assemblies (Electrical, Mechanical)	V-TECS-41/184
Design Physical Support Hardware for New Electronic Equipment	V-TECS-42/187
Draft Preliminary Specifications for an Electronic Device	V-TECS-43/188
Draw Schematic of Circuitry	V-TECS-44/189
Plan Quality Assessment Checks (Physical, Electrical)	V-TECS-45/191
Prepare Cost Factors Report	V-TECS-46/194
Prepare an Estimate of Production Time	V-TECS-47/196
Prepare a Parts List for Prototype Equipment	V-TECS-48/197
Prepare a Survey of Production Schedules	V-TECS-49/198
Translate Graphic Information into Written Specifications	V-TECS-50/200
Write Operational Procedures	V-TECS-51/203
Write Summary Report of Operational Tests	V-TECS-52/204
Design Circuits from Engineering Specifications	V-TECS-53/205

E. Performing Environmental Tests

Perform Corrosive Test	V-TECS-54/208
Perform Maximum Power Test	V-TECS-55/210
Perform Pressure Test	V-TECS-56/213
Perform Shock (Impact) Test	V-TECS-57/215
Perform Temperature Test	V-TECS-58/218

F. Administering Personnel

Administer Diagnostic Tests to Prospective Employees	V-TECS-27/221
Conduct Instruction by Demonstration/ Performance	V-TECS-28/224
Evaluate Employee Performance	V-TECS-29/226
Evaluate Training Program	V-TECS-30/229
Evaluate Personnel Safety Violations	V-TECS-31/231
Interview Prospective Employees	V-TECS-32/234
Maintain Work Records of Employees	V-TECS-33/236
Monitor Programmed Instructions	V-TECS-34/237
Orient Personnel To Procedures	V-TECS-35/240
Plan Work Schedules	V-TECS-36/241
Report Equipment Related Safety Violations	V-TECS-37/244

APPENDIX B

DEFINITION OF TERMS

APPENDIX B
DEFINITION OF TERMS

The following terms are supplied to establish operational definitions as they apply to this study.

CAREER LADDER: A vertical arrangement of jobs within an occupational area to indicate skill distinction and progression.

CATALOGS: A comprehensive collection of performance objectives, performance guides, criterion-referenced measures, and related data organized by a job structure or career ladder within a domain of interest.

CONSORTIUM: A group of state agencies, institutions, or other entities which have been legally constituted through letters of commitment, agreements, or by assignment of higher authorities to work together toward the solution of problems in education. A membership from autonomous agencies and institutions which cuts across state boundaries as they attempt to solve problems or meet goals.

D.O.T. CODE: A nine-digit number used to identify a specific job within a given domain.

INSTRUCTIONAL SYSTEM DEVELOPMENT (ISD): A deliberate, orderly process for planning and developing instructional programs which insures that personnel are taught the knowledge, skills, and attitudes essential for successful job performance. Depends on a decription and analysis of the tasks necessary for performing the job, objectives, evaluation procedures to determine whether or not the objectives have been reached, and methods for revising the process based on empirical data.

OCCUPATIONAL INVENTORY (TASK INVENTORY BOOKLET): A survey instrument containing tasks performed by job incumbents within D.O.T.'s complete with background information and a list of tools and equipment.

PERFORMANCE-BASED INSTRUCTION: Instruciton which, when properly designed and applied, results in the learner's demonstration of certain abilities. The desired abilities are selected before the instruciton is designed and are clearly defined as observable performance objectives. In V-TECS catalogs, the abilities are primarily psychomotor. This type of instruction is also referred to as competency-based instruciton.

PERFORMANCE GUIDE (PG): A series of steps, arranged in a sequence ordinarily followed, which when completed may result in the performance of a task. Also, called "teaching steps."

PROJECT: An occupational domain area selected by a V-TECS member state for catalog development based upon the U.S. Department of Labor's Dictionary of Occupational Titles (D.O.T.).

STATE-OF-THE-ART (SOA STUDY): Research conducted to determine the current status of performance-based instructional materials and practices in the domain area under study and to obtain other information that might be useful in catalog development.

TASK: A unit of work activity which constitutes logical and necessary steps in the performance of a duty. A task has a definite beginning and ending point in its accomplishments and generally consists of two or more definite steps.

TASK ANALYSIS: A characteristic of a task statement which makes its accomplishments crucial to the acceptable performance of a worker or student. A method of analysis which identifies the critical tasks and aids in determining the consequence of poor performance or lack of performance by a worker or student.

WRITING TEAM: A team of people representing instructors with subject matter expertise, persons having knowledge and experience in developing criterion-referenced measures, local or state supervisors of incumbent workers whose function is to analyze occupational data and develop performance objectives and criterion-referenced measures for specific D.O.T. areas.

APPENDIX C

TOOLS AND EQUIPMENT

EQUIPMENT

Equipment Number	Equipment Description	Percentage Using	Number Using
71	Ohmmeter	94.26	115
76	Pliers, Longnose	94.26	115
72	Oscilloscope	93.44	114
111	Voltmeter	91.80	112
89	Screwdrivers	90.98	111
52	Iron, Soldering	89.34	109
113	Wrench, Allen, Assorted	88.52	108
25	Crimper, Terminal	86.89	106
75	Pliers, Diagonal	86.89	106
95	Solder	86.89	106
112	Wrench, Adjustable	86.89	106
29	Drill, Electric	85.25	104
99	Strippers, Wire	85.25	104
26	Desoldering Tool	83.61	102
74	Pliers, Combination	83.61	102
21	Clamps, Alligator, Assorted	81.97	100
92	Screwdriver, Phillips	80.33	98
41	Glasses, Safety	79.51	97
102	Test Leads	79.51	97
90	Screwdriver, Offset	77.87	95
2	Ammeter	77.05	94
28	Drill Bits, #80 to 3/8"	77.05	94
23	Cord, Extension	76.23	93
24	Counter, Frequency	76.23	93

EQUIPMENT

Equipment Number	Equipment Description	Percentage Using	Number Using
31	Epoxy	75.41	92
32	Fasteners, Assorted	75.41	92
35	Flashlight	75.41	92
84	Rags, wiping	75.41	92
114	Wrench, End, Set 1/4" to 13/16" by 16ths	75.41	92
115	Wrench, Socket, 1/4" Drive	75.41	92
48	Hammer, Ballpeen	73.77	90
67	Multimeter, Digital	73.77	90
73	Pencil, Soldering	73.77	90
47	Hacksaw, Adjustable	72.13	88
33	Files, Set, Mill (6" to 12")	69.67	85
1	Alignment Tools	68.85	84
12	Cables, Adapter	68.85	84
46	Gun, Soldering	68.03	83
70	Nutdriver, Hollow Shaft, Set 6/32" to 18/32"	68.03	83
40	Glass, Magnifyng	67.21	82
49	Headset, Earphones and Microphone	64.75	79
55	Lamp, Magnifying, Bench	64.75	79
65	Milliammeter	64.75	79
110	Vise, Machinists, Swivel Base, Table	64.75	79
42	Glue	63.93	78
56	Lubricant, Silicon Compound	63.93	78

EQUIPMENT

Equipment Number	Equipment Description	Percentage Using	Number Using
69	Nutdriver and Spline	63.93	78
91	Screwdriver, Offset Phillips	63.11	77
77	Pliers, Snapring	59.84	73
39	Generator, Signal	58.20	71
50	Sinks, Heat	58.20	71
53	Kit, First Aid	58.20	71
80	Puller, Fuse	58.20	71
8	Braid, Soldering	56.56	69
108	Vacuum Cleaner, Hand Held, Small Attachments	56.56	69
30	Drill, Hand	55.74	68
66	Mirrors, Small	55.74	68
36	Generator, Audio (Sine and Square Wave)	54.92	67
37	Generator, Pulse	54.10	66
78	Probe, High Voltage	51.64	63
83	Punches, Set (Center, Pin, Prick)	51.64	63
68	Nibbling Tools	48.36	59
101	Tap and Die Set, Electricians	48.36	59
11	Brush, Wire	47.54	58
107	Tweezers	47.54	58
10	Brush, Point (Small)	46.72	57
54	Knife Set, Exacto	46.72	57
27	Drill Press, Bench Model, 15", Slow Speed	45.90	56

EQUIPMENT

Equipment Number	Equipment Description	Percentage Using	Number Using
116	Wrenches, Socket, Metric, 1/4" Drive Set	45.90	56
82	Punches, Chassis, Round, Set	45.08	55
94	Snips, Tin, 6" or Smaller	43.44	53
58	Meter, Decibel	40.16	49
85	Reamer, Hand, 1/8" Tip, 5 1/2" Long	39.34	48
7	Box, Substitution, Resistor and Capacitor	36.07	44
9	Bridge, Wheatstone	36.07	44
38	Generator, R-F	36.07	44
43	Graph Paper	35.25	43
63	Meter, Watt	35.25	43
88	Rust Remover/Preserver	35.25	43
17	Checker, Capacitor	34.43	42
81	Puller, Tube	34.43	42
44	Grinder, 6", 1/2 HP	33.61	41
64	Micrometer	33.61	41
79	Probe, R-F	33.61	41
59	Meter, Distortion	32.79	40
45	Gun, Rivet	31.97	39
51	Heater, Transistor	30.33	37
96	Solder Pot	30.33	37
20	Circuit Chiller	29.51	36
93	Scope, Victor	29.51	36

EQUIPMENT

Equipment Number	Equipment Description	Percentage Using	Number Using
87	Rivets	28.69	35
105	Tester, Tube	28.69	35
19	Chisel, Cold, Set	27.87	34
97	Straightener, Tube Pin	27.87	34
13	Calculator, Programmable	27.05	33
15	Calipers. 6" or Smaller	27.05	33
18	Checkers, Module	27.05	33
57	Marker Adder	27.05	33
22	Coil, Degaussing	25.41	31
106	Tracer, Transistor Curve	25.41	31
34	Filter, Universal Tuning Range to 60KHZ	24.59	30
104	Tester, Transistor/FET with Dynaflex Probe	24.59	30
86	Recorder, X-Y	23.77	29
109	Vector Board and Clip	22.95	28
16	Cathode Follower	22.13	27
14	Calibrator Crystal	20.49	25
60	Meter, Field Strength	19.67	24
100	Strobe Disc	19.67	24
5	Battery Eliminator	18.85	23
98	Stand, Turntable Repair	18.85	23
103	Tester, Microwave	16.39	20
3	Awl	14.75	18
6	Box, Bias	14.75	18

EQUIPMENT

Equipment Number	Equipment Description	Percentage Using	Number Using
61	Meter, Grid Dip	12.30	15
62	Meter, Q	11.48	14
4	Battery Carrier	10.66	13
117	Insulation Tester	6.56	8
118	Logic Probe	0.82	1
119	Spectrum Analyzer (RF)	0.82	1
120	Logic Chip	0.82	1
121	Modulation Scope	0.82	1
122	Tuned Caviteis (RF)	0.82	1
123	Deviation Monitor	0.82	1
124	Circulators/Isolators	0.82	1
125	ASM Tester	0.82	1
126	Diagnostic Tester	0.82	1
127	Signature Analyzer	0.82	1
128	Experimental Board	0.82	1
129	Wire Wrap Gun	0.82	1
130	Cable Stripper	0.82	1
131	Chassis Punch	0.82	1
132	Roto-Hammer	0.82	1
133	Sewing Needle	0.82	1
134	Cable Reel Stand	0.82	1
135	Calculator Hex	0.82	1
136	Screw Holder	0.82	1
137	Thermometer, Centigrade	0.82	1

EQUIPMENT

Equipment Number	Equipment Description	Percentage Using	Number Using
138	Densitometer	0.82	1
139	Digital Display Scope, 16 Trace	0.82	1
140	Pulse Counter	0.82	1
141	Pulse Trap	0.82	1
142	Strip Chart Recorder, High Speed	0.82	1

TOTAL RESPONDENTS 122.

APPENDIX D

SOURCES FOR STANDARDS

SOURCES FOR STANDARDS

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APPENDIX E

STATE-OF-THE-ART LITERATURE

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APPENDIX F

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BIBLIOGRAPHY COMPILED BY THE SOUTH CAROLINA WRITING TEAM

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APPENDIX G

WRITTEN EVALUATION QUESTIONS AND ANSWERS

WRITTEN EVALUATION QUESTIONS

I. Adjusting/Aligning/Calibrating Electronic Circuitry

V-TECS 01	1.	What is the regulation percent with no load voltage 25V and full load voltage 24V?
V-TECS 01	2.	How may the output of the constant speed generator be controlled?
V-TECS 01	3.	Define: cycle, frequency, period, and amplitude of an AC wave.
V-TECS 02	4.	For what purpose are signal generators used in troubleshooting amplifiers?
V-TECS 02	5.	Explain how the frequency response of an amplifier may be determined.
V-TECS 02	6.	How is it possible to isolate a defective amplifier stage with a signal generator?
V-TECS 02	7.	What is the most commonly used method of controlling the gain of a transistor stage?
V-TECS 03	8.	Hysteresis is the result of ________________.
V-TECS 03	9.	The TRIAC is primarily ______________________.
V-TECS 03	10.	Phase control means ______________________.
V-TECS 03	11.	Varying the phase of the trigger voltage controls the __________.
V-TECS 04	12.	When is the audio stage properly adjusted?
V-TECS 04	13.	What should the undistorted output be?
V-TECS 04	14.	What should the bias of the pre-amp be?
V-TECS 04	15.	Are the output stages in phase?
V-TECS 04	16.	What does increasing the AF generator frequency prove?
V-TECS 04	17.	Calculate the output power (EO/RL).
V-TECS 05	18.	The AGC in television serves the same purpose as the ________________ in radio receivers.
V-TECS 05	19.	The purpose of AGC is to provide a constant output from the ________________.
V-TECS 05	20.	This is accomplished by rectifying the ____________ signal to produce a ______________ voltage
V-TECS 05	21.	The voltage is applied to the bias of the previous amplifier stages to change their ______________.
V-TECS 06	22.	What should the bias of a silicon transistor be?
V-TI S 06	23.	What is the status of the NPN transistor if 1.5 volts is applied to the base and 0.9 volts at the emitter?
V-TECS 06	24.	What should the bias of the germanium transistor be?
V-TECS 06	25.	With PNP transistor has V_e = 1.8V, V_B = IV, V_C = 15V, what is its status?
V-TECS 06	26.	The collector voltage is the same AS Vcc, one cause could be:
V-TECS 07	27.	What does the term Dielectric Material mean?
V-TECS 07	28.	What does an adjustable capacitor do in a simple radio receiver?
V-TECS 07	29.	How many microfarads are there in a variable capacitor that is rated at 350 picofarads?
V-TECS 08	30.	An antenna transformer would be considered a slug turned circuit. (True or False)
V-TECS 08	31.	What does the term "loose coupling" mean?
V-TECS 08	32.	An intermediate-frequency transformer can be considered as a slug tuned circuit. (True or False)

V-TECS 08 33. A high-voltage "flyback" transformer can be considered as a slug tuned circuit. (True or False)

V-TECS 09 34. In a series-connected generator the ________, ________, and external circuit are connected in series.

V-TECS 09 35. In a shunt-connected generator the ________ are placed directly across the full output voltage of the ________.

V-TECS 09 36. The compound-connected generator employs both the ________ and ________ fields.

V-TECS 09 37. In the compound-connected generator the ________ field provides the main magnetic field for the generator, while the ________ field acts as a controlling device that determines the characteristics of the output voltage under load conditions.

V-TECS 09 38. In the shunt type, the ________ decreases as the ________ increases.

V-TECS 10 39. Name the essential parts of a portable electric drill.

V-TECS 10 40. Gears are used in equipment to provide speed ________ and ________.

V-TECS 10 41. Ball bearings are used on gear assemblies to reduce ________.

V-TECS 11 42. Focus is sharpest in the center area. (True or False)

V-TECS 11 43. What method of focusing do CRTs use?

V-TECS 11 44. When adjusting the focusing control, what is on the screen that you seek fine detail?

V-TECS 11 45. How many scanning lines are there in a frame?

V-TECS 11 46. How many scanning lines are there in a field?

V-TECS 12 47. Does the vertical linearity affect the height or the width of the picture?

V-TECS 12 48. Does the horizontal linearity affect the height or the width of the picture?

V-TECS 12 49. When adjusting the linearity controls, it is necessary to adjust the height control too. (True or False)

V-TECS 13 50. Write the formula fir determining impedance when inductive reactance and resistance values are known.

V-TECS 13 51. If it is desired to match the impedance of a source to the primary of a transformer, this can be accomplished by varying the load on the ________.

V-TECS 13 52. When inductive reactance and resistance are both present in a circuit, their total opposition to current is called ________, the letter symbol for which is ________.

V-TECS 13 53. Impedance is measured in ________.

V-TECS 13 54 In a series RL circuit, L = 2H, R = 500 ohms, E_s = 100V 60Hz A.C. Find X_4, I, and Z.

V-TECS 14 55. In a radio broadcasting studio, the process of molding, or regulating, the election stream for speech or music is called ________.

V-TECS 14 56. A ________ is an electrical device which causes speech, music, or picture information to combine with the carrier wave.

V-TECS 14 57. The process of modulation allows the carrier wave to convey, or pass, information from one location to another by ________ energy.

V-TECS 14	58.	The process of ________ results in the separation of an audio signal from the carrier signal used in radio or TV.
V-TECS 14	59.	The semiconductor used to demodulate the audio signals is a ________.
V-TECS 15	60.	What function does the transistor of the Hartley oscillator serve?
V-TECS 15	61.	What components determine the frequency of the Hartley oscillator?
V-TECS 15	62.	What does feedback actually achieve in the operation of the oscillator?
V-TECS 15	63.	What is the major difference between the Hartley and Colpitts oscillators?
V-TECS 15	64.	Why are crystals used in oscillators?
V-TECS 16	65.	The NPN transistor is forward biased when ________.
V-TECS 16	66.	In a switching circuit, the lamp current is controlled by ________.
V-TECS 16	67.	In a controlled circuit, the lamp is brightest when the collector to emitter resistance is ________.
V-TECS 17	68.	DC — DC converters are basically known as ________.
V-TECS 17	69.	The complete conversion cycle of a DC — DC converter is from:
V-TECS 17	70.	DC — DC converters usually operate at frequencies:
V-TECS 17	71.	To prevent frequency discrimination when pulses, square waves, and other complex waveforms are being measured, what type of probe should be used?
V-TECS 18	72.	A shielded probe, without compensation, that is connected directly to the test point is what kind of probe?
V-TECS 18	73.	Some probes have a switch located on it indicating the ratios of 1:0 and 10:1. What do they mean?
V-TECS 18	74.	What is the purpose of the intensity control on an oscilloscope?
V-TECS 19	75.	The ability of a radio receiver to select a single frequency and only one frequency is called ________.
V-TECS 19	76.	The ability of a receiver to respond to weak incoming signals is called ________.
V-TECS 19	77.	What purpose does a variable capacitor serve?
V-TECS 19	78.	Name the synonymous circuit for tuning section.
V-TECS 19	79.	The combination coils L_1 and L_2 are usually called the ________.
V-TECS 20	80.	What type of material causes information to be recorded on a magnetic tape?
V-TECS 20	81.	What tool is used on the head to "neutralize" any magnetic field that it may contain?
V-TECS 21	82.	The drive wheel is not engaged during a playback. (True or False)
V-TECS 21	83.	The voltage decrease under load, to the power supply voltage with no load, when expressed as a percentage, is called the ________.
V-TECS 21	84.	A load resistor serves a threefold purpose. List them.

V-TECS 21	85. Name an electronic device used as a voltage regulator.
V-TECS 21	86. How can voltage be raised without the use of a transformer?
V-TECS 21	87. What type of resistor may be used if intermittent adjustments of voltage are required?
V-TECS 22	88. What purpose does the pre-amp stage serve?
V-TECS 22	89. What caues amplifier distortion?
V-TECS 22	90. What is IF voltage gain high?
V-TECS 22	91. How many IF transformers does the two stage amplifier have?
V-TECS 22	92. What procedure should be followed when aligning the receiver?
V-TECS 23	93. What is the free running multivibrator called?
V-TECS 23	94. What is one thing the bistable multivibrator may be triggered by?
V-TECS 23	95. What is another name for the astable multivibrator?
V-TECS 23	96. What stage is the monostable multivibrator in before an input trigger?
V-TECS 23	97. R = 10K, C = 0.05 micro farad, what is the width of the output pulse?
V-TECS 24	98. The maximum rise of a waveform represents the ____________ of the wave and the ____________ voltage or current.
V-TECS 24	99. The ____________ of cycles of events increases with the speed increase of rotation.
V-TECS 24	100. ________________ are used to represent magnitude and direction of a force.
V-TECS 24	101. What type of waveform is produced by a generator?
V-TECS 24	102. The period of one cycle consists of how many degrees?
V-TECS 25	103. A signal generator is a test instrument used to supply output voltages of various ____________.
V-TECS 25	104. The heart of a typical signal generator is an ____________ circuit.
V-TECS 25	105. The timing clock pulses generate ____________ wave forms.
V-TECS 25	106. Varying the frequency of the signal generator will vary the ______________ produced on the oscilloscope.
V-TECS 25	107. The binary numbers representing clock pulses are binary ______________ and binary ______________.
V-TECS 26	108. What type signal does the vertical module receive?
V-TECS 26	109. What voltages on a Zenith television are present in the vertical module?
V-TECS 26	110. Where is the vertical module output used?
V-TECS 26	111. What type signal is received by the deflection yoke?
	II. Administering Personnel
V-TECS 27	112. The first step in taking a test is to ______________.
V-TECS 27	113. Any vacant room is suitable for administering a test. (True or False)
V-TECS 27	114. What is the last step in administering a test?
V-TECS 28	115. Resistors can be used to control either ____________ or ____________.
V-TECS 28	116. The first two color bands on a resister represent the actual ______________ for that color band.
V-TECS 28	117. The third color band on a resistor represents the ____________ used for determining the ohmic value of a resistor.

V-TECS 28	118. The silver or gold band represents the ____________ value when located as the fourth band on a resistor.
V-TECS 28	119. Resistors using color bands are called ____________ resistor.
V-TECS 29	120. Evaluating an employee requires knowledge of ____________.
V-TECS 29	121. ____________ ____________ method is a good evaluating technique.
V-TECS 29	122. The rating should coincide with ____________.
V-TECS 30	123. How do you know the objectives to be covered in the electronics course?
V-TECS 30	124. What types of equipment are used in the electronics course?
V-TECS 30	125. How do you determine the cost of equipment used in the electronics course?
V-TECS 30	126. How do you determine the budget needed for each year?
V-TECS 31	127. Why are safety glasses worn when soldering?
V-TECS 31	128. What is the purpose of positive safety regulations?
V-TECS 31	129. Every safety violation needs to be suggested by a ____________.
V-TECS 32	130. It is okay for the applicant to smoke during an interview. (True or False)
V-TECS 32	131. It is okay for the interviewer to smoke. (True or False)
V-TECS 32	132. Should an application be written or printed?
V-TECS 32	133. Should a pen or pencil be used in completing an application?
V-TECS 32	134. How should the interviewer be dressed?
V-TECS 32	135. You should consider a quiet place important for an interview. (True or False)
V-TECS 33	136. How should records for employees be filed in a file cabinet?
V-TECS 33	137. How should records be marked?
V-TECS 33	138. What information is necessary to record on employees?
V-TECS 33	139. How often should records be updated?
V-TECS 34	140. What is the advantage of program instruction over the conventional method?
V-TECS 34	141. What, if any, advantage does program instruction give the slower student?
V-TECS 34	142. What role does the classroom instructor play in the program instructions?
V-TECS 35	143. How would you dress to present policies and procedures to employees?
V-TECS 35	144. How important is your manner of speech?
V-TECS 35	145. Would it be a good idea to pass out copies of the policies and procedures (prior to) (after) the meeting?
V-TECS 35	146. In reference to question 145, explain why.
V-TECS 36	147. List the types of work to be performed in class.
V-TECS 36	148. What is the purpose of posting a work schedule?
V-TECS 36	149. How do you determine the number of people needed for the assigned tasks?
V-TECS 36	150. When is it permissable to use a tool with a damaged extension cord?
V-TECS 37	151. When connecting any electrical wire into the circuit the power should be ____________.

V-TECS 37	152.	A report can be written in general terms. (True or False)
V-TECS 37	153.	A report should be written if an ohmmeter is connected into the circuit only with the power on. (True or False)
	III.	**Designing Equipment and Circuitry**
V-TECS 38	154.	It is okay to use a pen when taking an inventory. (True or False)
V-TECS 38	155.	It is necessary to note any defects in the equipment during an interview. (True or False)
V-TECS 38	156.	If a piece of equipment is not on the inventory it is not necessary to record it.
V-TECS 39	157.	It is necessary to have extensive varieties of wiring diagrams to properly use a specific diagram. (True or False)
V-TECS 39	158.	When would one obtain a wiring diagram for a specific step?
V-TECS 40	159.	Xc = XL are ____________ and ____________ in phase.
V-TECS 40	160.	At frequencies other than resonance, line current will be either ____________ or ____________ depending on which current, I_L or I_C is greater in the tank circuit.
V-TECS 40	161.	At the resonant frequency, f_r, the voltage across a tank circuit is at ____________.
V-TECS 40	162.	The impedance at resonance is ____________ in a tank circuit.
V-TECS 40	163.	How could you determine the impedance for the tank circuit.
V-TECS 41	164.	It is not important for convectors to be properly abridged. (True or False)
V-TECS 41	165.	Continuity is vital when measured by an ohmmeter. (True or False)
V-TECS 42	166.	Using the scale of "1/4 inch = 1 foot", what would an inch and a half represent in feet?
V-TECS 42	167.	What is the name of the drafting tool that makes circles?
V-TECS 42	168.	What instrument is used when making long horizontal lines?
V-TECS 43	169.	It is necessary to have extensive tests on certain products. (True or False)
V-TECS 43	170.	What is an electronic drawing indicating current paths and components called?
V-TECS 43	171.	Where would one get specifications?
V-TECS 44	172.	Draw the symbol for a PNP transistor.
V-TECS 44	173.	Describe the current flow in a circuit containing an NPN transistor.
V-TECS 44	174.	The use of a schematic diagram makes it possible to trace the ____________ of a circuit from beginning to end.
V-TECS 44	175.	The dot symbol is used to show that wires are electrically ____________ at that point.
V-TECS 44	176.	A schematic diagram does not show the actual ____________ of components or the ____________ of the wire runs used to connect the components.
V-TECS 45	177.	Why is it necessary to establish a quality control system?
V-TECS 45	178.	How are time standards established?
V-TECS 45	179.	All subassemblies pass through the quality control station. (True or False)

V-TECS 45 180. How are performance checks established?

V-TECS 45 181. It is necessary to keep statistics on problem areas. (True or False)

V-TECS 46 182. Where do you obtain information for preparing cost reports.

V-TECS 46 183. What information is essential for determining cost factors?

V-TECS 46 184. If factors of demand are greater than supply, what change is necessary?

V-TECS 46 185. How can production time be determined?

V-TECS 46 186. What is the value of keeping cost factor reports?

V-TECS 47 187. The ____________ time is the actual time it takes to do the operation.

V-TECS 47 188. Time estimates are checked against the ____________ and corrected when necessary.

V-TECS 47 189. ________________ is considered to be a concern of all persons in the company rather than of one person or department.

V-TECS 47 190. The three items listed under the standard time column on a manufacturing process sheet are ______________, ______________, and ______________.

V-TECS 48 191. Why should parts be listed separate from the schematic?

V-TECS 48 192. Which would be more difficult to revise, schematics or a parts list?

V-TECS 48 193. The following is the description of a resistor sufficient for a parts list. (True or False)

"1000 ohmn 1/2 watt carbon resistor"

V-TECS 49 194. Two important documents that have been developed to control product manufacturing are the ____________ and ____________.

V-TECS 49 195. The information needed for production of a part are ____________, ____________, ____________, and ____________.

V-TECS 49 196. The purpose of ____________ is to achieve high-grade production of all manufactured products.

V-TECS 49 197. The product manufacturing process involves five steps: (1) ____________, (2) ______________, (3) ______________, (4) ____________, and (5) ______________.

V-TECS 50 198. What is the precautioning value given on the Transistor Specification Sheet?

V-TECS 50 199. Transistor parameter symbols are indicated ____________ on the graphs.

V-TECS 50 200. If the transistor is used as an electric switch what two characteristics would be important?

V-TECS 50 201. The transistor is a ______________ ______________ and a ______________ device.

V-TECS 51 202. Why is it important to write the procedures in sequence?

V-TECS 51 203. Once the procedure is written, why is it necessary to test them out?

V-TECS 51 204. What is a schematic?

V-TECS 52 205. A summary should be written as lengthy as possible. (True or False)

V-TECS 52 206. When writing a report on operational tests it is necessary to sequence the report. (True or False)

V-TECS 52	207.	Instruments are necessary for operational tests. (True or False)
V-TECS 53	208.	How do you determine minimum and maximum operating points?
V-TECS 53	209.	Name the point on the characteristic curve that the report anc output signal swings about.
V-TECS 53	210.	In a push-pull power amplifier the collector signals are:
	IV.	**Performing Environmental Tests**
V-TECS 54	211.	What is the primary cause of corrosion on iron?
V-TECS 54	212.	What causes corrosion build up on copper and aluminum wiring connections?
V-TECS 54	213.	What is the purpose of a climatically controlled chamber?
V-TECS 55	214.	What temperatures are desirable for best transistor operation?
V-TECS 55	215.	I_C is determined by what formula?
V-TECS 55	216.	Using the curve, $V_{ce}=8V$, $I_c=3.1mA$, $I_b=$?
V-TECS 55	217.	With $V_{ce}=24V$, $I_c=12.5mA$. What is the value of R_L?
V-TECS 55	218.	What type of circuit is used for this operation?
V-TECS 56	219.	A circuit which exhibits a very high frequency stability is the ________________.
V-TECS 56	220.	A voltage applied to the surfaces of a crystal will produce ________________.
V-TECS 56	221.	Crystals are made from ______________, ______________, or ________________.
V-TECS 56	222.	Draw the symbol for a crystal used in an electrical circuit.
V-TECS 56	223.	________________ is the property of certain crystalline substances of changing shape when an emf is impressed upon crystal.
V-TECS 57	224.	The maximum ratings of a transistor are normally used as:
V-TECS 57	225.	Transistor Specification sheets are useful in the:
V-TECS 57	226.	Maximum ratings are important when a transistor is used as an:
V-TECS 58	227.	At RF (Radio Frequency) currents the ____________ reactance of the meter coil is high and the ____________ reactance of the capacitance between the turns of the coil is low.
V-TECS 58	228.	The thermocouple meter avoids the reactance problem by ____________ the basic movement from the RF currents.
V-TECS 58	229.	The thermocouple meter uses a ____________ meter movement connected to a thermocouple.
V-TECS 58	230.	A thermocouple is a device that converts ____________ energy into ____________ energy.
V-TECS 58	231.	The ______________ meter can accurately respond to very high frequency curves.
	V.	**Maintaining Electronic Devices**
		(Use a working drawing to answer the following 5 questions).
V-TECS 59	232.	How is the field core constructed?
V-TECS 59	233.	What is the assembly attached to in the drawing?
V-TECS 59	234.	How is armature connected to assembly?
V-TECS 59	235.	Th ushes are made of ________________.
V-TECS 59	236.	The commutator is constructed of ________________.
V-TECS 60	237.	Why would a solid state system have a need for forced air?
V-TECS 60	238.	A dirty filter affects the operation of an electronic system. (True or False)

V-TECS 60 239. How often should a filter be checked?

V-TECS 61 240. A dirty chassis will cause a circuit to be faulty. (True or False)

V-TECS 61 241. It is okay to use any cleaning agent. (True or False)

V-TECS 61 242. As long as the set is disconnected, the receiver is safe to work on. (True or False)

V-TECS 62 243. How often should the air system be checked?

V-TECS 62 244. What could be a problem if the fan and air chamber are always collecting lint and dirt?

V-TECS 62 245. Chemicals should be sprayed on the fan while operating. (True or False)

V-TECS 63 246. The purpose of the contacts on a relay is to __________ the circuit when the relay is energized.

V-TECS 63 247. The __________ rating of its contacts indicates the maximum safe load current the relay can handle.

V-TECS 63 248. The contacts of a relay are often described as being __________ or __________.

V-TECS 63 249. The important advantage of a relay is that it allows the control of a large load current at a __________ voltage, using only a small relay energizing current at a __________ voltage.

V-TECS 64 250. The motor and mechanisms necessary to pull the tape from the feed reel past one or more tape heads to take up reel are called the __________ or __________.

V-TECS 64 251. The tape can be set to run at any one of three standard speeds, __________, __________, or __________ inches per second.

V-TECS 64 252. Tapes operated at __________ inches per second have superior sound reproduction.

V-TECS 64 253. __________ are used to record sounds on the tape.

V-TECS 65 254. What type of solution is used to clean the mirror?

V-TECS 65 255. Why is it important to keep the mirror clean?

V-TECS 65 256. What is the most important safety measure you must take before dismantling the equipment.

V-TECS 66 257. Why is it necessary to clean a tape head?

V-TECS 66 258. What type of swab is used to clean a video head? What type of swab is used to clean an audio head?

V-TECS 66 259. Safety must be practiced at all times when working with any type of cleaning agent and on electrical circuits.

V-TECS 66 260. What is the number one rule?

V-TECS 67 261. A degausser is the same as a demagnetizer. (True or False)

V-TECS 67 262. What type of cleaning solution is used on a tape reader?

V-TECS 67 263. A tape reader is the same as a tape head. (True or False)

V-TECS 68 264. What type of contacts can you use an eraser to clean?

V-TECS 68 265. What are the main causes for contacts in tuners to get dirty?

V-TECS 68 266. Name the two types of tuners that might be found in a TV set?

V-TECS 68 267. What do the letters VHF stand for?

V-TECS 69 268. A potentiometer controls which of the following in an electrical circuit?

- a. Voltage
- b. Current
- c. Resistance
- d. None of the above.

V-TECS 69	269.	What does a rheostat control in an electrical circuit? Is it true that a rheostat can replace a potentiometer? (True or False)
V-TECS 69	270.	What instrument would be best to test a potentiometer?
V-TECS 69	271.	In a radio receiver what control is a potentiometer?
V-TECS 70	272.	The main purpose of using fault guides is to speed up the troubleshooting process. (True or False)
V-TECS 70	273.	TV block diagrams are fault guides. (True or False)
V-TECS 70	274.	Name two places where fault guides can be located.
V-TECS 71	275.	What preparation must be made of the hoist?
V-TECS 71	276.	Why would it not be permissible to leave the hoist up after completing the lift?
V-TECS 71	277.	Why is it necessary to replace the RT package occasionally?
V-TECS 72	278.	In the typical meter, a mechanism called the ___________ reacts to the flow of current and rotates a shaft to which is connected a pointer.
V-TECS 72	279.	The amount of current necessary to move the pointer to the maximum reading on the meter scale is called the full-scale ___________ current of the meter.
V-TECS 72	280.	The _____________ can be used to measure voltage, current, and resistance.
V-TECS 72	281.	_____________ are single-purpose instruments made to be mounted on test equipment or instrument panels.
V-TECS 72	282.	A typical ammeter is connected in __________ with the load.
V-TECS 72	283.	When must splices be used?
V-TECS 73	284.	Explain procedures used for joining two conductors together.
V-TECS 73	285.	List at least three tools that are used for splicing conductors.
V-TECS 73	286.	Where are splices used?
V-TECS 74	287.	Why is it necessary to use a heat sink?
V-TECS 74	288.	What is the purpose of a desoldering tool?
V-TECS 74	289.	Describe the appearance of a properly soldered component.
V-TECS 74	290.	Describe the appearance of an improper soldered component.
V-TECS 74	291.	What size soldering gun is used to replace components on a printed circuit board?
	V.	**Replacing Components**
V-TECS 75	292.	The heat sink is a mass of metal used to carry heat ___________.
V-TECS 75	293.	What size soldering gun is used to replace the transistor?
V-TECS 75	294.	What effect does heat have upon the transistor?
V-TECS 75	295.	It is possible to replace the amplifier in an IC. (True or False)
V-TECS 75	296.	It is necessary to check the entire circuit when replacing an amplifier. (True or False)
V-TECS 76	297.	The most dangerous element of a CRT is ______________. (Explosion or Implosion)
V-TECS 76	298.	Name at least one accessory that you might have to remove from the CRT.
V-TECS 76	299.	In a black and white CRT, how many "guns" are there?
V-TECS 76	300.	Due to the possibility of what could happen as per question 1, what major safety rule should be followed?
V-TECS 77	301.	It is necessary to observe the connections of a capacitor if it is non-polarized. (True or False)

V-TECS 77 302. What is another name for a polarized capacitor? It is dangerous to connect a 16 volt capacitor in a 20 volt circuit. (True or False)

V-TECS 77 303. What does the term "dielectric material" mean?

V-TECS 77 304. What is the unit of measurement for capacitance?

V-TECS 77 305. If capacitors are connected in parallel, do they add or divide?

V-TECS 78 306. If segments a, c, d, f, and g are lit, the decimal number is __________.

V-TECS 78 307. The letters "LED" stand for __________.

V-TECS 78 308. The letters "LCD" stand for __________.

V-TECS 78 309. The seven-segment displays that give off a red glow are of what type?

V-TECS 78 310. Which type of display is used where bright light will be a factor?

V-TECS 79 311. What is the purpose of the degaussing coil?

V-TECS 79 312. What does CRT mean?

V-TECS 80 313. What device could be used to convert low voltage D.C. to high-voltage D.C.?

V-TECS 80 314. In an A.C. motor -- D.C. generator set, would it be better to start the motor with the generator load on or off?

V-TECS 80 315. What adjustment should be used to change the voltage output?

V-TECS 81 316. If the value of the voltage is less than ____% of the open circuit voltage, the cell or battery should be replaced.

V-TECS 81 317. The voltage test must be made with the __________ connected.

V-TECS 81 318. If a dry cell or battery is not in good condition, its internal resistance is high due to the drying out of the __________.

V-TECS 81 319. The shelf life of a cell is that period of time during which the cell can be stored without losing more than approximately _____% of its original capacity.

V-TECS 81 320. List three types of energy storage cells.

V-TECS 82 321. All filters can be thrown away. (True or False)

V-TECS 82 322. How should the filter be installed into the air handler?

V-TECS 82 323. How are the electrostatic air filters cleaned?

V-TECS 83 324. A generator may be operated by rotating coils of wire through a __________ or by rotating a __________ past coils of wire.

V-TECS 83 325. The operation of a generator is based on the principles of __________.

V-TECS 83 326. A generator may be defined as a machine which converts __________ energy into __________ energy.

V-TECS 83 327. A commutator is used in a __________ generator.

V-TECS 83 328. The frequency of the alternating current produced by the generator depends upon the speed of the __________ and the number of magnetic __________ formed by the field windings.

V-TECS 84 329. A __________ is a safety device which operates as a switch to run a circuit off when the current exceeds a specified value.

V-TECS 84	330.	________________ fuses are most often used in motor circuits.
V-TECS 84	331.	________________ fuses are mounted in clip holders.
V-TECS 84	332.	Never replace a fuse of the proper size with one that is ________________ in size.
V-TECS 84	333.	The ________________ fuse is designed to prevent a fuse from being replaced with one of a different electrical size.
V-TECS 85	334.	Two precautions to take when replacing an IC are:
V-TECS 85	335.	How are IC chips identified to determine proper installation?
V-TECS 85	336.	What test equipment is most used to check IC chips?
V-TECS 85	337.	What tools are required to remove an IC from a circuit?
V-TECS 86	338.	In what direction do you turn a lamp to tighten? (Clock-wise or counter clock-wise).
V-TECS 86	339.	What instrument is used to test a lamp?
V-TECS 86	340.	A lamp operates if the filament is opened. (True or False)
V-TECS 87	341.	What type device is required to carry energy of frequencies higher than 3GHz?
V-TECS 87	342.	Why is it necessary to protect the wave guide or Klystron flange from scratches?
V-TECS 87	343.	Which voltage should be applied to the Klystron first? a. Reflector voltage b. Beam voltage c. Filament voltage d. Collector voltage
V-TECS 88	344.	It is not necessarily essential to discharge the magnetron capacitor when replacing the magnetron. (True or False)
V-TECS 88	345.	How do you check the magnetron for proper operation?
V-TECS 89	346.	A microphone changes the energy of sound waves into ________________ energy.
V-TECS 89	347.	The microphone is called a ________________.
V-TECS 89	348.	List two types of microphones. a. ________________ b. ________________
V-TECS 89	349.	When the crystal is vibrated mechanically, an alternating voltage is developed. This is known as the ________________ effect.
V-TECS 89	350.	Good quality dynamic microphones can respond to frequencies ranging from approximately ____________ to ____________ Hz.
V-TECS 90	351.	What determines the oscillations in the LC oscillator?
V-TECS 90	352.	What determines the phase shift of the oscillator?
V-TECS 90	353.	How many RC sections must be used to provide an inphase feedback to the input of the oscillator?
V-TECS 90	354.	What is the frequency of the oscillator, if T = 10 micro seconds?
V-TECS 90	355.	Why was a heat sink used during replacement of the oscillator?
V-TECS 91	356.	When replacing parts on a PC board, it is not acceptable practice to crush the defective part with pliers. (True or False)
V-TECS 91	357.	Excessive heat can cause the foil on the PC board to separate from the board. (True or False)
V-TECS 91	358.	The most common type of PC board is the "etched" circuit. (True or False)

V-TECS 91 — 359. An acceptable method for locating a suspected open conductor is to attach a jumper wire while the circuit is turned on. (True or False)

V-TECS 92 — 360. Photocells belong to a group of devices which are called __________.

V-TECS 92 — 361. Describe the operation of a photoconductive cell.

V-TECS 92 — 362. What happens in a system when the path between the light source and the photocell is interrupted?

V-TECS 92 — 363. The relay acts as an __________ to activate counters, alarm systems, inspection or supervision equipment and other devices.

V-TECS 93 — 364. What instrument would be best to test the rectifier diode?

V-TECS 93 — 365. It is necessary for a power supply to have a transformer. (True or False)

V-TECS 93 — 366. What is the minimum amount of diodes necessary for a full-wave rectifier?

V-TECS 93 — 367. How many diodes does a bridge rectifier use?

V-TECS 93 — 368. Looking at the schematic symbol for a diode, does current flow through a diode against the arrow or with the arrow?

V-TECS 94 — 369. The belt is connected to the __________ and the drive mechanism in a tape recorder.

V-TECS 94 — 370. The belt should be replaced when it becomes __________ or __________.

V-TECS 94 — 371. List the advantage of a belt system on a recorder.

V-TECS 95 — 372. On a relay the part that is attracted to the coil when current is flowing is called __________.

V-TECS 95 — 373. When replacing a relay, what type of solder should be used?

V-TECS 95 — 374. The relay is what type of switching device.

V-TECS 95 — 375. What does NC mean?

V-TECS 95 — 376. What is the purpose of a relay?

V-TECS 96 — 377. Why are roller guides used in the electric dryer?

V-TECS 96 — 378. What indication would a broken or binding roller give?

V-TECS 96 — 379. It is necessary to remove the dryer tub to replace a roller. (True or False)

V-TECS 97 — 380. How much AC should be applied to the transmitter?

V-TECS 97 — 381. The __________ and __________ conventions must allow the servomechanism to function according to circuit specifications.

V-TECS 98 — 382. What identifies the cathode of most diodes?

V-TECS 98 — 383. What does the arrow in a diode symbol represent?

V-TECS 98 — 384. What is a characteristic of a good semiconductor?

V-TECS 98 — 385. What is the voltage drop across a silicon diode?

V-TECS 98 — 386. What is the voltage drop across a germanium diode?

V-TECS 99 — 387. What instrument would you use to test a switch for continuity?

V-TECS 99 — 388. How many connections does a SPDT switch have?

V-TECS 99 — 389. What is the purpose of a SPST switch?

V-TECS 100 — 390. A misaligned tape head will cause what problem?

V-TECS 100 — 391. What type of coating is used on a "magnetic tape?"

V-TECS 100 — 392. Tape heads are quite tough and can withstand rough handling. (True or False)

V-TECS 101 — 393. Circuit breakers are rated in terms of the amount of current in __________ which can pass through them before they are tripped.

V-TECS 101 — 394. A circuit breaker can be __________ or __________ after being tripped.

V-TECS 101	395.	A ___________ is a mechanical device which performs the same protective function as a fuse.
V-TECS 101	396.	A circuit breaker can serve as an ___________ switch.
V-TECS 101	397.	Thermal control of switching action uses a ___________ element.
V-TECS 102	398.	When used as an input device, the crystal transducer acts as a:
V-TECS 102	399.	The magnetrostrictive transducer is widely used in the field of:
V-TECS 102	400.	Maximum power exist when load impedance is equal to:
V-TECS 103	401.	In testing a transformer, a check of the secondary voltage indicates 0 volts. Are the transformer windings opened or shorted?
V-TECS 103	402.	It is necessary to observe polarity when connecting the leads. (True or False)
V-TECS 103	403.	What instrument is best suitable to test a transformer?
V-TECS 103	404.	A transformer primary winding is 1000 turns and the secondary winding has 200 turns. Assuming that the input voltage is 120 VAC, what would the output voltage be?
V-TECS 103	405.	In question 404, what would the turns ratio be?
V-TECS 104	406.	What is the purpose of soldering braid?
V-TECS 104	407.	What is the purpose of a heat sink?
V-TECS 104	408.	What type of solder should be used on electrical connections?
V-TECS 104	409.	Name the three elements of a transistor?
V-TECS 104	410.	Name the type of crystals that may be used in transistors.
V-TECS 104	411.	What is the phase relationship in a common emitter amplifier?
V-TECS 105	412.	What is the purpose of the grid in the Triode vacuum tube?
V-TECS 105	413.	What safety measure must be made before handling a beam power tube?
V-TECS 105	414.	A four element tube is better known as ___________.
V-TECS 105	415.	If a filament is opened in one tube, the remaining tubes that were connected in a series circuit would remain lighted. (True or False)
V-TECS 105	416.	What is the emitter called in a vacuum tube?

WRITTEN EVALUATION ANSWERS

I. Adjusting/Aligning/Calibrating Electronic Circuitry

1. 4.1%
2. Increasing resistance in series with the source and field windings.
3. a. Set of events occurring in sequence.
   b. Number of complete cycles per second.
   c. Time for one complete cycle.
   d. Extreme range of varying quantity.
4. Signal generators are used to generate a signal of frequencies within the audio range.
5. If the volume control on the signal generator is set for a definite value, the amount of amplification can be determined by comparing the signal input of an amplifier with the output as indicated by the A.C. voltmeter. By plotting a graph denoting amplitude, the range of the amplifier will be indicated by the portion of the graph with a flat response.
6. By beginning at the input of the last stage and progressing to the input of the first stage, any inoperative stage may be this isolated.
7. Volume controls, potentiometers, are placed in either the input or output circuits of a stage to control gain.
8. Misalignment of ON-OFF trigger voltage.
9. An AC power control device.
10. Limiting conduction time by controlling the phase of the trigger voltage.
11. Conduction angle
12. Maximum current flows.
13. 4.4 volts pk.-pk.
14. 0.6 volts
15. 180 degree out
16. The amplifier circuit is working.
17. 61.5 millivolts
18. AVC
19. Detector
20. Video, negative
21. Gain
22. 0.5 — 0.7 volts
23. Conducting
24. 0.2 — 0.5 volts
25. Conducting
26. Emitter open
27. The insulating material between the plates
28. Tune the radio in on station.
29. .000350 microfarads
30. True
31. That the coupling between the coils is decreased so only the signals turned by the secondary can reach the circuit.
32. True
33. False
34. Armature, field coils
35. Fields, armature
36. Series, shunt
37. Shunt, series
38. Voltage, load

39. a. Chuck
    b. Universal motor
    c. Gear assembly
    d. Electric power cord and switch
40. Ratio, torque
41. Friction
42. True
43. Electrostatic focus
44. Scanning lines
45. 525
46. 262½
47. Height
48. Width
49. True
50. $Z = \sqrt{X_L^2 + R^2}$
51. Secondary winding
52. Impedance, Z
53. Ohms
54. $X_L = 2\pi fL = 2(3.14)(60)(2) = 753.6\ \Omega$
    $Z = \sqrt{X_L^2 + R^2} = \sqrt{(753.6)^2 + (500)^2} = \Omega$
    $I = \frac{E_S}{Z} =$
55. Modulation
56. Modulator
57. Electromagnetic
58. Demodulation
59. Detector diode
60. A switch
61. Coil, capacitors and transistor
62. To produce VHF and stable frequencies
63. Oscillations
64. Colpitts is a tapped coil.
65. The base is positive with respect to the emitter.
66. The base to emitter current
67. Minimum
68. Oscillators
69. DC to AC to DC
70. Between 60Hz and 3KHz
71. Low-capacitance
72. Direct
73. Indicates the multipling factor
74. To increase the brightness of the trace
75. Selectivity
76. Sensitivity
77. A variable capacitor and is used to vary the resonant frequency of the tank.
78. Tuning or station selector section of the radio receiver
79. Antenna coil
80. Iron oxide
81. Demagnetizing probe
82. False
83. Percentage of voltage regulation

84. 1. Bleeder
    2. To improve regulation
    3. As a voltage divider
85. Zener diode
86. Through the use of voltage doublers
87. A sliding tap resistor
88. To amplify the audio signal.
89. Input signal is too large.
90. At the IF frequency
91. Three
92. A logical step-by-step.
93. Astable
94. An external signal
95. One-shot
96. State or law
97. 0.5 micro second
98. Amplitude, peak
99. Frequency
100. Vectors
101. A sine wave
102. 360°
103. Frequencies
104. Oscillator
105. Square
106. Waveforms
107. 1,0
108. Positive sync pulse
109. +24V, +35V, -35V and +135V
110. Vertical section of the deflection yoke.
111. Sawtooth

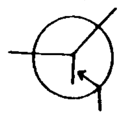
II. Administering Personnel

112. Read the instructions.
113. False
114. Collect the test
115. Voltage, current
116. Number
117. Multiplier
118. Tolerance
119. Carbon-composition
120. The employee's performance
121. Observation and rating devices
122. Ratings of other evaluators
123. The text book contents, curriculum guide and the trainee manual.
124. Oscilloscope, meters for current, voltage, resistance, and power and electronic components.
125. Checking inventory sheet for course and updated price sheet for replacement parts.
126. Cost of repairs for equipment, prices for needed new equipment, advisory council recommendation cost or replace text books and instructional supplies.
127. Protect the eyes.

128. Legal protection and safety awareness
129. Written report
130. False
131. False
132. Printed
133. Pen
134. Neat, clean, (should be dressed in the manner of the position and company they represent).
135. True
136. In alphabetical order and by shift, group, division, etc.
137. By name and number
138. Type work performed, time worked, pay schedule, and insurance information.
139. Daily or whenever progress is reported.
140. They give every student a chance to progress at their own rate.
141. They do not have to progress at the same rate as the faster student as in the conventional methods.
142. Monitor and advisor, he also revises programs to suit the particular situation.
143. Clean, neat and in a manner that is acceptable to the occupation.
144. Very important that you are understood and your points are getting across.
145. Prior to
146. Because they can go through the list as you explain. This will make the presentation more readily understood.
147. a. Lab area to be swept and put in order.
     b. Equipment to be turned off and put away.
     c. Furniture arranged in instructed order.
148. Planned work schedules and in keeping down confusion. Everyone knows what to do and when to do it.
149. Evaluate the task involved and assign the number of workers to a particular task to accomplish it.
150. Never
151. Off
152. False
153. True

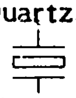
III. Designing Equipment and Circuitry

154. False
155. True
156. False
157. True
158. Manufacturers
159. Equal, opposite
160. Inductive, capacitive
161. Maximum
162. Maximum
163. Using the Ohm's Law equation
     $Z_T = E_T / I_{Line}$
164. False
165. True
166. 6 feet
167. Compass

168. T-Square
169. True
170. Schematic
171. From the manufacturer or data books
172. 

173. Current flows through the emitter, to the base, to the collector when the transistor is conducting.
174. Operation
175. Connected
176. Location, location
177. Check for any faults or components installed on the assembly line.
178. Under controlled environment
179. True
180. Through an operational station, system is checked for established operations.
181. True
182. Good filing systems
183. Material cost, manpower required, new equipment cost, overhead cost, and production time estimate.
184. More manpower or new equipment to increase production
185. Divide total cost by quantity produced per given period.
186. To keep from going bankrupt or to increase profit margin.
187. Standard
188. Pilot run
189. Quality control
190. Standard unit, hours/unit, total
191. It keeps the schematic from being cluttered.
192. Schematics
193. False
194. Manufacturing process sheets, manufacturing process specifications.
195. Name, number, standard time of manufacture, routing.
196. Quality control
197. Sales, engineering, prototype development, production, shipping.
198. Maximum rating value
199. Abbreviations
200. On-off, maximum rating
201. Semi-conductor, bi-polar and current controlling
202. So when someone operates the device it is done properly and in order.
203. To be sure they are operational.
204. A diagram of an electrical circuit showing components
205. False
206. True
207. False
208. From the engineering specifications
209. Operating point
210. Out of phase with each other

IV. Performing Environmental Tests

211. Moisture and air
212. Oxidation, because of bonding unlike metals.
213. To prevent moisture and air from causing corrosion built up on metals.
214. 25 degree celsius
215. $I_C = \frac{\text{rated mW}}{V_{ce}}$
216. 25 micro amps
217. 1920 ohms
218. CE (common emitter)
219. Crystal-controlled oscillator
220. Distortion
221. Quartz, tourmaline, Rochelle salts
222. 
223. Piezoelectric effect.
224. Design limits
225. Design of a circuit
226. Electronic switch
227. Inductive, capacitive
228. Isolating
229. D'Arsonval
230. Heat, electrical
231. Thermocourse

V. Maintaining Electronic Devices

232. Using band iron and bending in the shape of a horseshoe, wrap with tape and wrap three layers of magnet wire.
233. Wood base (3/4" x 4½" x 6")
234. Soldered to shaft
235. Sheet brass
236. Tin plate
237. To cool down the excessive heat that builds up in inclosed areas.
238. True
239. At least twice per year, more often in high lint or dust areas.
240. True
241. False
242. False
243. Twice a year or more often in high lint or dust area.
244. Dislodged or torn filter
245. False
246. Complete
247. Current
248. Normally open, normally closed
249. High, low
250. Tape transport, deck
251. 1 7/8, 3 3/4, 7 1/2
252. 7½
253. Take heads
254. Freon, alcohol, cleaning solution for camera lenses, etc.

255. It could cause the reflected beam to be misaligned, or in such a state that the beam will not reflect bright enough.
256. Deenergize the equipment. (Pull the plug).
257. To remove any traces of tape material, dirt, lint, etc.
258. Buckskin swabs
259. Cotton swabs
260. Wear safety glasses.
261. True
262. Alcohol or tape head cleaning agent.
263. True
264. Turret
265. Dirt -- grease
266. VHF and UHF
267. Very High Frequency
268. Current
269. True
270. VOM -- Ohmmeter
271. Volume control
272. True
273. True
274. Manufacturers & Schematics
275. The hoist has to be raised above the tower platform to give clearance for movability of the RT package.
276. It would create frequency pulling when the antenna sweeps through it.
277. The package has to be pulled and returned for depot repair every 1000 hours of operation.
278. Meter movement
279. Deflection
280. Multimeter
281. Panel meters
282. Series
283. Splices are used when two or more conductors need to be joined together to complete a circuit.
284. To join conductors together, strip insulation from each conductor approximately one inch, cross one conductor over the other holding ends of insulation together, then twist stripped ends together. Next, cut the twisted stipped ends back to approximately three quarters inch and twist wire nuts on tightly.
285. Three commonly used tools for splicing conductors are wire strippers, linesmen pliers and wire cutters.
286. Splices are joined together in junction boxes to prevent fire hazards.
287. A heat sink removes the heat to prevent damage to a component being soldered.
288. A desoldering tool is used to remove the solder when heated so the component can be removed more easily.
289. A properly soldered connection will have a shiny appearance with no cracks.
290. An improperly soldered connection will have a dull appearance or a crack at the edges.
291. A 25 to 30 watt soldering gun.

VI. Replacing Components

292. Away from the component
293 25 — 30 watts
294. Increases current flow
295. False
296. True
297. Implosion
298. Yoke — Focus coil — Magnet
299. One
300. Wearing of safety glasses
301. False
302. Electrolytic capacitor
303. True
304. It is the insulating material between the plates. Farads
305. Add
306. The number 5
307. Light Emitting Diode
308. Liquid-crystal display
309. LED
310. LED
311. Demagnetizes
312. Cathode Ray Tube
313. Dynamotor
314. Off
315. Generator — shunt field exortation
316. 80
317. Load
318. Electrolyte
319. 10
320. a. Nickel calmium cell
    b. Mercury cell
    c. Alkaline cell
321. False
322. Arrows on the filters edge mark the direction of installation.
323. Water and a good cleaning detergent
324. Magnetic field, magnet
325. Magnetism
326. Mechanical, electrical
327. D.C.
328. Rotor, magnetic poles
329. Fuse
330. Dual-element
331. Cartridge
332. Larger
333. Tamperproof
334. a. Disconnect power (never plug or unplug).
    b. Insure faults do not exist in the external part. You run a risk of destroying a new IC if faults exist.
335. One end of an IC will be notched or have a painted dot to indicate the number sequence of the pins.
336. An oscilloscope is widely used to troubleshoot IC chips.

337. If an IC is plugged into a socket, an IC chip removal tool or small blade screwdriver should be used for removal of chips. If IC is soldered, a desoldering tool or grounding store along with a heat sink should be used.
338. Clockwise
339. VOM/VTM
340. False
341. Wave guide
342. Prevent radiation leaks
343. a
344. False
345. The magnetron must function according to the design specifications of the circuit.
346. Electric
347. Transducer
348. Dynamic, crystal
349. Piezoelectric
350. 40--15000
351. LC tank circuit
352. Resistors and Capacitors
353. 3 or more
354. 1KHz
355. Dissipate heat
356. False
357. True
358. True
359. True
360. Transducers
361. As light strikes the photocell, its resistance decreases, allowing more current to flow in the circuit.
362. The current in the relay circuit decreases.
363. On-off switch
364. VOM or Ohmmeter
365. False
366. 2
367.
368. Against the arrow
369. Drive motor
370. Worn, torn
371. Ease of adjustment and protection of motor overload
372. Armature
373. Resin core
374. Electromechanical
375. Normally closed
376. To control voltage and current
377. To support the tub
378. The tub would bind or not turn and the drying process would not complete.
379. False
380. 120
381. Armature, stator
382. Circular band

383. Direction of current flow
384. Low forward and high reverse resistance
385. 0.5 volts to 0.7 volts
386. 0.2 volts to 0.5 volts
387. VOM
388. 3
389. To open or close a circuit
390. Distortion
391. Iron oxide
392. False
393. Amperes
394. Reset, closed
395. Circuit breaker
396. On/off
397. Bimetallic
398. Voltage generator
399. Communications
400. Source impedance
401. Opened
402. True
403. VOM — VTVM
404. 24 Volts
405. 5 : 1
406. To absorb the solder from the connection.
407. To absorb the heat away from the transistor.
408. Resin core solder
409. Emitter -- Base -- Collector
410. Germanium -- Silicon
411. 180 degrees out of phase
412. Controls the flow of electrons from cathode to plate.
413. Discharge the tubes anode against the chassis.
414. Tetrode
415. False
416. Cathode