TECHNOLOGY EDUCATION

Grades 9-12

PROGRAM/COURSE Electronics/Audio

DRAFT

INDUSTRIAL ARTS EDUCATION
Module of Instruction

PHASE - Concentration ELEMENT - Technology

AREA OF CONCENTRATION: Electronics

MODULE: **4.0 Audio Electronics**

SUB-MODULE: **4.1 Amplification Systems**

TOPICS: Amplifier Theory
Amplifier Applications

PREREQUISITES: None

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TOTAL TEACHING TIME: 30 Hours (8 Weeks)

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INDUSTRIAL ARTS EDUCATION
MODULE OF INSTRUCTION

PHASE - CONCENTRATION
ELEMENT - TECHNOLOGY
AREA OF CONCENTRATION - Electronics
MODULE - Audio Electronics
SUB-MODULE - Amplification Systems
TOPICS:
Amplifier Theory
Amplifier Applications

OVERVIEW OF SUB-MODULE

DESCRIPTION

This is the first of two sub-modules in Audio Electronics covering the topics of Amplifier Theory and Amplification Systems. The student will be exposed to sound theory, amplifier devices, basic amplifier circuits and amplification systems found in home and commercial sound equipment. Topics are arranged to progress from basic concepts to more advanced theories and applications.

It is suggested that a student may satisfactorily complete the Applied Electronics Math module (1.0) and the Basic Electronic Systems module (3.0) as a foundation for this sub-module.

GOAL

Upon the completion of both topics in this sub-module, the student will develop the necessary background knowledge and skills that are required to purchase and operate amplifier devices and circuits with a reasonable degree of technical competence.

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MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

Estimated Teaching Time

Amplifier Theory	15 Hours	(4 Weeks)
Amplifier Applications	15 Hours	(4 Weeks)

Prerequisites

None

Emphasis

The content of this sub-module should reflect applications of current audio electronics technology and include experiments with newly emerging technology. Emphasis is to be placed on the identification and understanding of amplifier components and their use in amplification systems.

The estimated teaching time includes both instruction and safe laboratory hands-on activity for each topic in this sub-module. When planning instruction, this time estimate should be adjusted according to the student's background, experiences, acquired competencies and laboratory facilities available. Attention should also be given to special student populations to be served.

COMPETENCIES TO BE DEVELOPED

Upon satisfactory completion of this sub-module, each student should have acquired the following competencies:

1. Know and apply the concepts relative to accident cause and prevention in the electronics laboratory, and develop a positive attitude towards safe behavior and practices in the use of tools, machines and equipment.

2. Know and accurately identify the fundamental kinds of electrical currents, circuit quantities, terms, and measurements.

3. Be familiar with basic electronic components and graphic representation, and capable of assembling basic amplifier circuits from schematic diagrams.

4. Be familiar with the physics of sound and understand its relevance to the development of amplifier devices, circuits and systems.

5. Know and accurately identify the specifications for common amplifier devices and their application to the performance of amplifier circuits and systems.

6. Be familiar with the theory and operation of microphones, headphones, loudspeakers, tape recording and playback units used with common amplifier circuits and systems.

7. Be capable of safely using common audio test equipment to analyze circuits and components, and verify the principles audio amplification.

8. Be capable of assembling and/or constructing simple power supply and amplifier systems representative of low and high power audio amplification systems.

9. Be familiar with career opportunities in the field of audio electronics technology and the educational requirements for job entry.

10. Know and accurately identify the environmental pollution problems generated by the manufacture and use of audio equipment.

11. Be familiar with the consumer aspects of manufacture, purchase and operation of audio equipment.

MODULE - Audio Electronics
TOPIC - Amplifier Theory SUB-MODULE - Amplification Systems

CONTENT OUTLINE

1. Safety Education
   a. Safety theory
      . Cause and prevention
   b. Safety applications
      . Eye safety
      . Tool and machine safety
      . Soldering safety
      . Human safety
      . Laboratory rules and regulations

2. Audio Theory
   a. The physics of sound
      . Sound theory
      . Basic components and symbols
      . Schematic diagrams
      . Wiring from diagrams
   b. Measuring sound and distortion

3. Amplifier Devices
   a. Amplification theory
   b. Amplification devices

4. Power Supply Systems
   a. Power supply theory and circuits
   b. Power requirements and regulation

5. Amplifier Circuits
   a. Basic circuit configurations
   b. Basic amplifier systems

6. Stereo Integrated Circuits
   a. Single stereo integrated circuits
   b. Basic stereo controls

7. Bridged Stereo Amplification IC's
   a. Bridged amplifier circuits
   b. Bridged amplifier controls

8. Multi-stage IC Amplifiers
   a. Driver and power IC circuits
   b. Complex amplifier controls

9. Audio Project Construction
   a. Planning a project
   b. Project construction

MODULE - Audio Electronics
TOPIC - Amplifier Theory SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 1:

Given an electronics laboratory situation, the student will work and behave in a safe and orderly manner and will participate in the upkeep and cleanliness of the facility to a degree of effort and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Identify common causes of accidents.

b. Describe the mental makeup of accident prone individuals.

c. Identify accident prevention measures.

d. List tool and machine safety rules.

e. Demonstrate safe machine practices and operations.

f. Demonstrate safe use of electronic equipment.

g. List reasons for wearing eye protection at all times.

h. List steps in care and handling of safety glasses and shields.

i. Interpret and follow general safety rules and regulations.

j. List lab emergency procedures.

k. Perform specific duties of assigned clean-up jobs.

l. Describe the physiological effects of electric current.

m. Demonstrate first aid practices for shock victims.

INSTRUCTIONAL STRATEGIES:

1. Group discussion - causes and prevention of common accidents; mental states.

2. Hand outs - safety rules and regulations, emergency procedures, clean-up responsibilities, and first aid.

3. Demonstrations - safe use of tools, machines and equipment.

4. Audio/visuals - films, slides, etc. on eye safety; transparencies for physiological effects of current and lab safety program.

5. Bulletin board - safety posters and slogans.

6. Performance testing - use of tools, machines and equipment.

7. Include safety and laboratory maintenance in regular student evaluations.

PERFORMANCE OBJECTIVE No. 2:

Given an amplifier, signal generator, oscilloscope and appropriate input and output devices, the student will make connections, observations and measurements of frequency, volume, wave distortion and noise to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Balance and adjust an oscilloscope to observe waveforms.

b. Define the nature of sound in terms of wave travel, frequency, amplitude, resonance, harmonics and distortion.

c. Diagram and describe the audio frequency spectrum.

d. Define and interpret the measurement of sound in decibels.

e. Operate an audio signal generator.

f. Interconnect components and equipment to make observations and measurements.

g. Interpret, diagram and label waveforms and measurements.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explore the basic nature of sound and identify basic sources of sound.

2. Audio/visual materials - transparencies or slides to illustrate production of sound by plucking a string, blowing a horn, etc. and interaction of sound waves to produce harmonics; waveform terminology and measurements such as attack, sustain, decay, peak and peak-to-peak; sources of noise and distortion in audio equipment.

3. Demonstrations - use of oscilloscope, audio signal generator, and interconnection of components and equipment to make observations and measurements.

MODULE - Audio Electronics
TOPIC - Amplifier Theory SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 3:

Given a variety of amplifier devices (tubes, transistors, IC's) on a lab board, the student will identify the component, connect it in an amplifier circuit according to a schematic diagram and record input/output signals to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Identify components and symbols for common amplifier devices.

b. Define bias and it effects on amplifier operation.

c. Explain the effect of load resistance on amplification and gain.

d. Use an oscilloscope to measure input/output signals and waveforms in an amplifier and record observations.

e. Determine the amount of amplification in terms of current and voltage gain and output power in watts.

f. Calculate signal-to-noise ratio in decibels.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - basic operating principles of individual amplifier devices.

2. Home study - definitions of load, bias, current gain, voltage gain, output power, etc.; completion-type questions.

3. Hand outs - complete schematic diagrams of simple and complex audio amplifiers (tube, transistor and IC's). Use for home study and discussion.

4. Audio/visual - transparencies, slides, filmstrips, etc. illustrating amplifier devices, symbols, common circuits.

5. Demonstrations - fabricating amplifier circuits and use of test equipment to make required measurements and observations.

6. Computer assisted instruction - waveforms and measurements. Calculations of amplifier gain and S/N ratios.

MODULE - Audio Electronics
TOPIC - Amplifier Theory SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 4:

Given a schematic diagram and appropriate components on a lab board, the student will assemble and test a variable regulated power supply for use with amplifier circuits and systems to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Diagram and describe the operation of common and bipolar power supply circuits.

b. Diagram and describe voltage regulation using voltage regulator IC's and interpret component specifications.

c. Diagram and describe a variable output voltage regulated power supply.

d. Measure and adjust the output of a power supply to satisfy amplifier circuit requirements.

e. Explain thermal shutdown, and identify methods of heat sinking voltage regulator IC's.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - basic principles of rectification and regulation in a power supply system.

2. Audio/visuals - transparencies of standard and bipolar power supply circuits. Overlays to illustrate voltage regulation and variable output control.

3. Home study - pictorial diagrams of power supply parts with accompanying schematic diagram. Have students complete wiring connections on pictorial to satisfy schematic.

4. Instruction sheets - a variety of common power supply circuits used in audio equipment.

5. Lab experiment(s) - adjusting a power supply to satisfy current and voltage requirements for an amplifier device or circuit. Breadboard basic amplifier and power supply.

MODULE - Audio Electronics
TOPIC - Amplifier Theory SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 5:

Given a low power stereo amplifier IC and associated components on a lab board, the student will assemble and test-operate the circuit to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Determine the pin-out, functions and heat sinking requirements of a stereo amplifier integrated circuit.

b. Define the meanings of negative and positive input, bias, feedback and compensation relative to an audio IC.

c. Interpret power requirements and operating parameters for a stereo amplifier IC.

d. Assemble a basic stereo amplifier system from a schematic diagram and test-operate with a signal source and loudspeakers.

e. Use an oscilloscope to observe, measure and record amplifier performance.

f. Add controls, input and output circuits to complete the amplifier.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - characteristics of an audio amplifier; monophonic and stereophonic IC's.

2. Audio/visuals - transparencies, overlays to illustrate pin-out configurations, functions, negative/positive inputs, bias, compensation, feedback and operating parameters.

3. Demonstration - assembling and testing low power stereo amplifier IC. Adding controls, input/output circuits.

4. Lab experiment(s) - student performance and testing.

PERFORMANCE OBJECTIVE No. 6:

Given two medium power stereo IC's (4-6 Watts) and associated components on a lab board, the student will assemble and test-operate a stereo bridged amplifier system to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Diagram and describe the operating principles of a bridged amplifier circuit.

b. Determine the power and heat sink requirements for the system.

c. Add external controls to the amplifier system.

d. Add input/output circuits to the amplifier system.

e. Use a scope to test, observe, measure and record circuit performance.

INSTRUCTIONAL STRATEGIES:

1. Demonstration/discussion - assemble, operate and test a bridged amplifier system. Compare to low power stereo amplifier system.

2. Transparencies - block and schematic diagrams of bridged amplifier system. Use for demonstration, discussion and lab experiments.

3. Instruction sheets - schematics, pin-outs and operating parameters of common IC bridged amplifiers.

4. Lab experiment(s) - student performance and testing.

MODULE - Audio Electronics
TOPIC - Amplifier Theory SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 7:

Given a stereo driver IC and two stereo power IC's, the student will assemble and test-operate a complete audio amplifier system including volume, balance, bass/treble controls and complex input/output circuits to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Read and interpret a schematic diagram of a complete audio power amplifier system (50-Watts or more).

b. Determine the power and heat sink requirements for the amplifier system.

c. Diagram and explain a balance circuit for a stereo amplifier system.

d. Diagram and explain a bass/treble control network for a stereo a amplifier system.

e. Diagram and explain complex impedance-matching input and crossover-network output circuits.

f. Assemble and test-operate a stereo power amplifier system employing integrated circuits.

INSTRUCTIONAL STRATEGIES:

1. Demonstration/discussions - assembling and test-operating a complete stereo power amplifier system. Include testing procedures to locate defects and to measure sound levels and S/N ratio.

2. Audio/visuals - slides, transparencies or other large print materials to illustrate block and schematic diagrams for driver/power amplifier system, bass, treble, balance, impedance-matching and crossover-network circuits.

3. Lab experiment(s) - student performance and testing.

4. Computer assisted instruction - as an aid for students to calculate signal gain and distortion and/or component parameters for special circuits and networks.

MODULE - Audio Electronics
TOPIC - Amplifier Theory SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 8:

Given a schematic diagram, pictorial layout, appropriate components, tools and materials, the student will develop a plan and construct an audio project to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:

In order to do this, the student must be able to:

a. Read and interpret schematic and pictorial diagrams.

b. Develop a step-by-step procedure for fabricating and assembling an audio electronic circuit.

c. Design and produce a printed circuit board.

d. Fabricate and solder an electronic circuit on a PC board.

e. Design and construct a cabinet for the project.

f. Use test equipment to insure proper circuit functions and performance.

g. Complete assembly and evaluation of the project.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - project selection in relation to content outline and consumer aspects of materials and components. How to develop a plan sheet, bill of materials and step-by-step procedures.

2. Demonstrations - where appropriate according to student progress:
   a. Designing and producing a PC board.
   b. Hand tool and machine operations.
   c. Fabricating and soldering a circuit.
   d. Operation testing and troubleshooting.

3. Audio/visuals - slides, transparencies, mock-ups and models to illustrate design, fabrication, and assembly techniques.

SUGGESTED PROJECTS:

Stereo Amplifier, PA System, Speaker Crossover, Preamplifier, Mixer, Light Organ, Sound Synthesizer, Theremin, Fuzz Box, Reverb, Equalizer, dB/VU meter.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

CONTENT OUTLINE

1. Intercom Systems
   a. Intercom theory
   b. Intercom circuits and systems

2. Amplifier Systems
   a. Stereo amplifier systems
   b. Quadraphonic amplifier systems

3. Public Address Systems
   a. Simple PA systems
   b. Complex PA systems

4. Tape Recording/Playback Systems
   a. Tape recording theory
   b. Record/Playback systems

5. Speaker Systems
   a. Transducer theory
   b. Common speaker systems

6. Stage Sound Systems
   a. Stage sound system theory
   b. Common stage sound systems

7. Consumer Education
   a. Equipment specifications and features
   b. Equipment construction and purchase

8. Career Education
   a. Audio electronics careers and occupations
   b. Local opportunities and requirements

9. Environmental Education
   a. Manufacturing pollution
   b. Sound pollution

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 1:

Given a schematic diagram, a monophonic operational amplifier IC and the necessary switching components on a lab board, the student will assemble and test-operate a basic two-way intercom system to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Diagram and explain the principle of two-way switching for a basic intercom system.

b. Explain input/output impedance matching for an intercom system.

c. Define master/slave terminology in intercom systems.

d. Read and interpret block and schematic diagrams for intercom systems.

e. Operate and interpret a signal generator and scope to observe and troubleshoot basic intercom performance.

f. Diagram and explain how to add more channels to an intercom system (multiple-channel systems).

g. Diagram and explain the addition of AM/FM stereo capability to a multiple-channel intercom system.

h. Diagram and explain the operation of power line and wireless intercom systems.

i. Assemble and test-operate a basic intercom using an operational amplifier IC on a solderless socket board.

INSTRUCTIONAL STRATEGIES:

1. Demonstration/discussion - assembling and test-operating basic and multiple-channel intercom systems.

2. Audio/visuals - charts, transparencies, slides, etc. illustrating block and schematic diagrams for simple, multiple-channel and AM/FM stereo intercom systems.

3. Home study - pictorials of intercom components with accompanying schematic where students complete wiring on pictorial to satisfy schematic.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 2:

Given a schematic diagram and pictorial layout with the necessary stereo IC amplifier module, preamp, speakers and tuner/turntable unit, the student will assemble and test-operate the system to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:

In order to do this, the student must be able to:

a. Explain the purpose of a preamp in a stereo amplifier system.

b. Diagram and describe the operating principles of a stereo turntable pickup cartridge.

c. Explain stylus/pickup arm weight conditions on a turntable.

d. Diagram and describe turntable speed and stylus angle (skate).

e. Explain care and handling procedures for stylus, discs and cartridge/arm assembly.

f. Read and interpret diagrams for the interconnection of all system components.

g. Diagram and explain room resonance and system positioning.

h. Diagram and explain AM/FM antenna location, line impedances and connection to a stereo system.

i. Diagram and explain speaker system phase relationships and resulting system performance.

j. Diagram infinite baffle wall mounted speaker systems and describe the resulting system performance.

INSTRUCTIONAL STRATEGIES:

1. Demonstration/discussion - connecting, handling and caring for the total stereo system and its components.

2. Visuals - transparencies, slides, etc. to illustrate all aspects of component and system terminology and operation.

3. Home study - students will collect performance specifications for home stereo system components where avai for class discussion and clarification.

4. Student constructed teaching aids - diagrams, mock-ups models to illustrate disc tracking, drives, speaker enclosures and baffle systems.

5. Lab experiment(s) - for student performance and testing.

6. Instruction sheets - stereo system terminology and specifications with definitions. Use for handling and care procedures as well.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 3:

Given a schematic diagram, mono high power IC Op Amp, junction boxes, cables, microphones and speakers, the student will assemble and test-operate a public address system to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:

In order to do this, the student must be able to:

a. Read and interpret a diagram of the layout for a multichannel public address system.

b. Diagram and describe a mic mixer junction box for the purpose of controlling microphone operation and avoiding signal interaction.

c. Explain forms of audio feedback and methods of correction.

d. Diagram and identify location of PA components to optimize room size and shape.

e. Explain the use of shielded cable to reduce crosstalk and feedback problems.

f. Test a PA system with signal generator and detector/tracer.

INSTRUCTIONAL STRATEGIES:

1. Demonstration/discussion - operation and testing of a complete PA system including use of signal detector/tracer.

2. Transparencies - block and schematic diagrams of complete multichannel PA system; FET signal mixing circuits and switching systems; methods of reducing crosstalk and feedback problems.

3. Field trip - observation of building or auditorium PA system to demonstrate multichannel switching and balancing circuits.

4. Lab experiment(s) - for student performance and testing.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 4:

Given a schematic and pictorial diagram, a tape head assembly, and drive system with a stereo IC, the student will assemble and test-operate a tape record/playback system to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:

In order to do this, the student must be able to:

a. Identify and differentiate between the qualities and applications of three types of recording tape.

b. Diagram and explain the operation of common types of tape heads.

c. Identify common types of tape cartridge and drive systems, and list the advantages and disadvantages of each.

d. Diagram and explain tape head tracking/alignment.

e. Explain the care and cleaning of tape head assemblies.

f. Define the amplification requirements for tape record/playback systems in terms of gain, impedance matching and noise reduction circuitry.

g. Read and interpret audio level meters for record and playback functions.

h. Read and interpret diagrams for the interconnection of tape system components used to record, playback copy and monitor tape program materials.

i. Diagram and describe a laser pickup and playback system for tape equipment.

INSTRUCTIONAL STRATEGIES:

1. Demonstration/discussions - connection and operation of tape record/playback systems. Include adjustment, tape head alignment and testing procedures to determine equipment performance.

2. Visuals - magnetic and laser tape head assemblies and principles of operation; tape bias and equalization; tape cartridge and tracking; Dolby noise reduction systems.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 5:

Given a schematic diagram, three audio transducers and appropriate crossover components, the student will assemble and test-operate a complete speaker system to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:

In order to do this, the student must be able to:

a. Diagram and explain transducer crossover points.

b. Explain the operating principles of a common speaker and list the construction features that determine frequency range and power output.

c. Read and interpret graphic representations of speaker resonance and frequency response.

d. Identify and explain the operating principles of speaker enclosure contruction features including baffles, air suspension, ports, and compartmented.

e. Describe the considerations for construction of a speaker enclosure in terms of materials, dimensions, lining, ports, tuning procedures and wiring.

f. Diagram and explain the operating principles of a phase-linear speaker enclosure.

g. Interpret the specifications for a crossover network and calculate the values of the components required.

h. Differentiate between coaxial and electrostatic speaker construction and define speaker designation according to frequency of operation.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - use visuals to illustrate principles of operation, terminology, specifications and construction of speakers and enclosures.

2. Demonstrations - opening and tuning a port in a speaker baffle; testing system for proper crossover points.

3. Audio/visuals - procedures for planning, constructing, wiring and tuning a speaker enclosure. Commercial design and manufacture of speaker systems.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 6:

Given a schematic and pictorial diagram, appropriate microphones, amplifiers, mixer and speakers, the student will assemble and test-operate a basic stage sound system to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Identify and describe the basic elements of a stage sound system.

b. Diagram and explain the interconnection of stage sound equipment.

c. List the features and demonstrate the operation of a basic audio mixing board (console).

d. Explain the makeup and importance of a "snake".

e. Describe the operating principles of a transmitter stage sound system.

f. List the job responsibilities of a stage sound engineer.

g. Identify common brand names of stage sound equipment.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explain assembly and operation of a complete stage sound system. Identify duties of a stage sound engineer.

2. Demonstration - operation of a stage audio mixer.

3. Visuals - diagrams of stage sound system and layouts. Manufacturers and features of commercial sound equipment.

4. Home study - completion questions about stage sound equipment, system wiring and test procedures.

5. Audio/visuals - films, filmstrips, slides, etc. illustrating construction and operation of sound stage system.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 7:

Given an item of audio equipment, an accompanying manual with a description of equipment functions, construction features, and technical specifications, the student will analyze the equipment performance and construction to make a purchase decision to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:

In order to do this, the student must be able to:

a. Identify and define common audio specifications to be considered when analyzing and purchasing equipment.

b. List and describe common operational features to be considered when comparing audio equipment.

c. List and describe construction materials and design concepts to be considered when comparing audio equipment.

d. Identify and describe consumer protection concepts to be considered when purchasing audio equipment.

e. Recognize components, assembly techniques, and manufacturers of audio equipment that determine cost and durability.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - technical specifications and definitions that determine equipment performance. Include construction and operating features that affect cost, durability and maintenance.

2. Home study - develop a guide for analyzing audio equipment before purchase by comparing specifications, features, construction, warranty/guarantee, and purchase price.

3. Bulletin board display - consumer publications, articles and illustrations about audio equipment.

4. Audio/visuals - films, filmstrips, slides, transparencies featuring consumer awareness for purchasing audio equipment.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 8:

Given a choice of a specific career in the field of audio electronics in the local community (50-mile radius), the student will identify requirements for job entry, specific working locations and develop a step-by-step procedure for obtaining the desired position to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:

In order to this, the student must be able to:

a. Identify and describe a minimum of five specific occupations in the technical field of audio electronics.

b. List and describe educational opportunities both in school and after graduation that would be beneficial to preparing for a career in audio electronics.

c. Identify local occupational sites that employ personnel in the audio electronics career of his/her choice.

d. Develop a step-by-step procedure to prepare and apply for a specific audio electronics job in the local area.

e. Prepare and write a personal resume and letter of application to a potential employer in the local area.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - identify career clusters and specific occupational titles in audio electronics. Develop list of potential employers in local area and educational requirements for job entry.

2. Computer assisted instruction - data bank listing of industries, job titles, entry skills.

3. Visuals - locate local audio electronic job sites on a map. Have students develop their own step-by-step procedures on transparencies for class discussion. Common formats for resumes and letters of applications.

4. Home study - have students prepare occupational guides, resumes and letters of application. Research job titles and local sites at library.

TOPIC - Amplifier Applications

MODULE - Audio Electronics
SUB-MODULE - Amplification Systems

PERFORMANCE OBJECTIVE No. 9:

Given a list of pollution problems created by manufacturers and consumers of audio products and equipment, the student will recommend solutions for existing problems and suggest means of preventing future problems to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:

In order to do this, the student must be able to:

a. Identify specific kinds of pollution caused by man.

b. Describe specific damage to the environment caused by the manufacture of semiconductors and other common electronic components.

c. Identify and describe specific solutions to problems of chemical pollution caused by electronic manufacturing.

d. Describe sound pollution and the resulting physiological and psychological affects on humans.

e. List and explain pollution responsibilities in terms of government, industry and the individual.

f. Identify means of enforcing environmental protection laws.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - identify forms of pollution resulting from electronic manufacture and related to the use of audio products and equipment. Discuss methods of prevention and control.

2. Visuals - sound decibel chart and relationship to physiological and psychological affects on humans. Sources of environmental pollution in your local area.

3. Audio/visuals - films, filmstrips etc. on enviromental protection.

4. Resource personnel - environmental protection agency, local citizen groups, news personnel.

5. Home study - develop idea(s) for solutions to pollution problems and/or prevention.

INDUSTRIAL ARTS EDUCATION
Module of Instruction

PHASE - Concentration ELEMENT - Technology

AREA OF CONCENTRATION: Electronics

MODULE: **4.0 Audio Electronics**

SUB-MODULE: **4.2 Sound Generation and Control Systems**

TOPICS: Sound Generation Theory
Audio Processing Systems

PREREQUISITES: 4.1 Amplification Systems Sub-Module

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TOTAL TEACHING TIME: 30 Hours (8 Weeks) Date: February 1984

INDUSTRIAL ARTS EDUCATION
MODULE OF INSTRUCTION

PHASE - CONCENTRATION
ELEMENT - TECHNOLOGY
AREA OF CONCENTRATION - Electronics
MODULE - Audio Electronics
SUB-MODULE - Sound Generation and Control Systems
TOPICS:
Sound Generation Theory
Audio Processing Systems

PREREQUISITE - Amplification Systems Sub-Module

OVERVIEW OF SUB-MODULE

DESCRIPTION

This is the second of two sub-modules in Audio Electronics. It covers the topics of Sound Generation Theory and Audio Processing Systems. The student will investigate the basic principles of operation for audio processing circuits and systems through class discussions, laboratory activities and the completion of a take-home project illustrating sound generation, control and/or alteration. Special purpose integrated circuits designed for these circuits and systems are also included.

The content outline and objectives are arranged in a logical sequence proceeding from the simpler concepts to the more advanced theories and applications. The student should have satisfactorily completed the Amplification Systems sub-module prior to taking this sub-module.

GOAL

Upon completion of both topics in this sub-module, the student will have developed the necessary background knowledge and skills that are required to work with sound generation circuits and control systems with a reasonable degree of confidence and competence.

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MODULE - Audio Electronics
SUB-MODULE - Sound Generation and Control Systems

Estimated Teaching Time

Sound Generation Theory	15 Hours	(4 Weeks)
Audio Processing Systems	15 Hours	(4 Weeks)

Prerequisites

Amplifier Theory	15 Hours	(4 Weeks)
Amplifier Applications	15 Hours	(4 Weeks)

Emphasis

The content should reflect applications of current sound generation electronic technology. Emphasis is placed on the fundamental processes of sound generation and control through the use of specially designed integrated circuits. Further emphasis must be placed on student abilities to experiment with and construct audio processing circuits and systems.

The estimated teaching time includes both instruction and laboratory hands-on activity for each topic in this sub-module. When planning instruction, this time estimate should be adjusted according to the student's background, experiences, acquired competencies and laboratory facilities available. Attention should also be given to special student populations served.

COMPETENCIES TO BE DEVELOPED

Upon satisfactory completion of this sub-module, each student should have acquired the following competencies:

1. Understand the basic principles of electronic sound generation and be familiar with common devices and circuits employed.

2. Be familiar with special purpose integrated circuits developed for audio processing circuits and systems.

3. Be capable of reading and interpreting graphic symbols and diagrams representative of audio processing circuits and systems.

4. Be capable of assembling, constructing, testing and measuring basic sound generation, control, alteration and filter circuits in a laboratory setting.

5. Be familiar with common commercial and consumer applications of sound generation, synthesizing, control and alteration circuits and systems.

6. Be knowledgeable in the terminology and parameters of sound including frequency, level, attack, sustain and decay.

7. Know and accurately identify sources of noise and distortion in an audio system and methods of reduction.

8. Be familiar with the basic principles of sound equalization, distribution, mixing and noise reduction in audio systems.

9. Be knowledgeable in the basic principles and operation of sound level indicator and distribution/mixing systems.

10. Be familiar with careers in the field of audio electronics related to sound generation and control.

TOPIC - Sound Generation Theory

CONTENT OUTLINE

1. Sound Generation Theory
   a. Physics of sound
   b. Oscillator circuits

2. Sound Generating Integrated Circuits
   a. Simple sound generating IC's
   b. Complex sound generating IC's

3. Sound Alteration Integrated Circuits
   a. Multi-tone circuits
   b. Timing and sequencing circuits

4. Electronic Musical Instruments
   a. Simple organ and theremin circuits
   b. Complex musical instruments

5. Commercial Sound Generation Systems
   a. Band and orchestra sound synthesizers
   b. Complex studio sound synthesizers

6. Career Education
   a. Careers in sound generation and control
   b. Educational preparation and requirements

MODULE - Audio Electronics
SUB-MODULE - Sound Generation and Control Systems
TOPIC - Sound Generation Theory

PERFORMANCE OBJECTIVE No. 1:

Given a schematic diagram and the necessary components, tools and equipment to perform an experiment, the student will assemble and test a basic audio generator circuit (audio oscillator) to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this the student must be able to:

a. Explain the electronic principles of operation for a basic audio oscillator circuit.

b. Describe the physical nature of sound generated by the audio oscillator circuit.

c. Use an oscilloscope to observe, measure and record the oscillator output waveform.

d. Identify and measure sine, square, sawtooth and triangular waveforms on an oscilloscope.

e. Modify audio oscillator circuit values to control output frequency.

f. Add amplification and volume control to a basic audio oscillator circuit.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explain audio oscillator operation and control of frequency and waveform.

2. Demonstration/discussions - use of the oscilloscope to measure and record oscillator output waveforms, frequency and amplitude; how to add amplification and volume control; practical applications of simple audio oscillator circuits (Morse Code, alarm, indicator, etc.).

3. Visuals - slides, transparencies, charts, etc. illustrating circuit and component graphic symbols and diagrams, waveforms and test equipment operation.

4. Home study - completion questions about terminology and measurements related to experimentation.

5. Lab experiment(s) - for student performance and testing.

TOPIC - Sound Generation Theory

PERFORMANCE OBJECTIVE No. 2:

Given schematic diagrams for simple and complex sound generating integrated circuits and the necessary components, tools and equipment to perform a laboratory experiment, the student will assemble and test two circuits to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Identify the specific sound function(s) of common sound generating integrated circuits.

b. Determine the pin-out functions and connections for an integrated circuit from appropriate graphic materials.

c. Assemble and test a simple and a complex sound generating circuit employing IC's from a schematic diagram.

d. Add appropriate switching to control sound functions and mix output signals for a sound generating IC.

e. Add amplification and volume control to a sound generating circuit.

f. Use an oscilloscope to observe, measure and record audio signals from an IC sound generator.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explain basic principles of sound generation and control employing common IC's. Use transparencies, etc. to instruct students about each sound function and interpreting pin-out diagrams.

2. Demonstration/discussions - assembling and testing a sound generation system with switching and amplification.

3. Lab experiment(s) - for student performance and testing.

4. Home study - complete a wiring diagram on a pictorial from an accompanying schematic for a sound generating circuit employing IC's.

MODULE - Audio Electronics
SUB-MODULE - Sound Generation and Control Systems
TOPIC - Sound Generation Theory

PERFORMANCE OBJECTIVE No. 3:

Given a schematic diagram of a sound alteration circuit employing an IC and the necessary components, tools and equipment to perform an experiment, the student will assemble and test the circuit to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Diagram and describe the addition of a sound alteration IC to a sound generating circuit to obtain a specific effect.

b. Diagram and explain the basic operating principles of an octave generator IC.

c. Diagram and explain the basic operating principles of a delay line IC.

d. Diagram and describe the addition of a tremolo circuit to a sound generating IC.

e. Explain the basic operating principles of a timing IC to control the occurrence of output tones.

f. Add a sequential control to a sound generator and describe its operation.

g. Diagram the addition of amplification and volume control to a sound generator/alteration system.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explain the principles of sound alteration by the application of octave generator, delay line and tremolo circuits to sound generating circuits. Use transparencies to illustrate principles of operation and circuit configurations.

2. Demonstration/discussions - add various sound alteration circuits to the sound generating IC and illustrate their effects with an oscilloscope.

3. Lab experiment(s) - for student performance and testing.

TOPIC - Sound Generation Theory

PERFORMANCE OBJECTIVE No. 4:

Given a schematic diagram and the necessary components, tools and materials to perform an experiment, the student will assemble and test a simple electronic musical instrument to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Diagram and explain the operation of a basic single-oscillator toy organ with independently switched tone capacitors.

b. Diagram and explain the operation of a multiple oscillator organ with chord capability.

c. Diagram and describe the addition of tremolo to a simple multiple oscillator organ circuit.

d. Diagram and describe the addition of complex musical instrument circuity to an organ system.

e. Diagram and explain the operating principles of a body capacitance theremin circuit.

f. Assemble and test a simple electronic musical instrument from a schematic diagram.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explain the operation of simple one stage toy organ circuits using discrete components and/or integrated circuits. Progress to multiple oscillator, musical instrument and tremolo circuits. Use transparencies to illustrate principles of operation and circuit configurations.

2. Demonstration/discussions - assembly and operation of an electronic muscial instrument. Use oscilloscope to observe output waveforms.

3. Lab experiment(s) - for student performance and testing.

4. Student constructed teaching aids.

TOPIC - Sound Generation Theory

PERFORMANCE OBJECTIVE No. 5:

Given a pictorial diagram of system components and a commercial sound synthesizer unit, the student will interconnect all of the system components and test-operate the complete system to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Identify the specific function of each component circuit in a synthesizer system.

b. Read and interpret a block diagram illustrating the interconnection of components in a synthesizer system.

c. Assemble a synthesizer system from a pictorial diagram.

d. Use an oscilloscope to observe, measure and record synthesizer output waveforms.

e. Explain the commercial and consumer applications of synthesizer systems.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explain synthesizer components and functions. Use transparencies to illustrate circuits and system diagrams. Include commercial, consumer and research applications of sound synthesizers.

2. Demonstration/discussion - assembly and operation of synthesizer system.

3. Audio/visuals - films, filmstrips, etc. illustrating applications of sound synthesizer systems.

4. Lab experiment(s) - for student performance and testing.

TOPIC - Sound Generation Theory

PERFORMANCE OBJECTIVE No. 6:

Given an outline of the essentials of career planning and a list of the potential careers in audio electronics related to sound generation and control, the student will develop a tentative career plan to a degree of completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Describe the work responsibilities of employees in sound generation and control occupations.

b. Locate and interpret job information about a particular occupation in the audio electronics field.

c. Plan for the development of strategies to achieve an occupational position in audio electronics.

d. Prepare a personal resume and letter of application.

e. Identify and list educational strategies which will increase his/her potential for employment in the audio electronics technology.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - identify career clusters related to sound generation and control. Discuss job descriptions, opportunities, requirements and sources of information.

2. Career training/orientation films or filmstrips.

3. Resource personnel - local industry or commercial enterprise. Discuss work responsibilities.

3. Slide discussion - review strategies for developing a career plan, how to prepare a resume and letter of application.

4. Field trip - to observe a location where a complex sound syntesizer or other sound equipment is in use (university, orchestra, sound studio, etc.).

5. Bulletin board - display of occupational titles and locations of employment in your area related to sound generation and control.

TOPIC - Audio Processing Systems

CONTENT OUTLINE

1. Distortion Reduction Systems
   a. Simple noise filters
   b. Dolby noise reduction systems

2. Frequency Alteration Systems
   a. Equalizers
   b. Crossover networks
   c. Compression/Expansion amplifiers

3. Sound Alteration Systems
   a. Fuzz - distortion systems
   b. Tremolo systems
   c. Echo systems
   d. Reverberation systems
   e. Phase shift systems

4. Sound Trigger Systems
   a. Sound activated systems
      . Burglar alarms
      . Light organs
      . Toys
   b. Tone decoder systems

5. Sound Combining Systems
   a. Switching - junction boxes
   b. Electronic mixer systems

6. Sound Indicator Systems
   a. VU meters
      . Analog
      . Digital - LED
   b. dB meters

MODULE - Audio Electronics
SUB-MODULE - Sound Generation and Control Systems
TOPIC - Audio Processing Systems

PERFORMANCE OBJECTIVE No. 1:

Given sources of noise in laboratory audio equipment and signal sources, the student will construct a minimum of two noise reduction circuits and observe their effectiveness to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Identify and describe sources of noise in common audio equipment components.

b. Explain the generation of noise and distortion in common audio signal sources.

c. Define and measure signal-to-noise (S/N) ratio in dB as it relates to electronic audio systems.

d. Assemble a noise reduction/filter circuit from a schematic diagram and test its performance with an audio amplifier.

e. Explain the basic principles of operation for scratch filters, rumble filters, hum reduction circuits and pop/click suppressors.

f. Identify four Dolby noise reduction systems and describe the basic operating principles of each.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - identify and explain common sources of of noise and distortion in audio equipment. For each, illustrate a common filter or suppression circuit used to reduce its effects. Use transparencies to show waveforms and circuit construction.

2. Demonstration - construction and operation of simple interference reduction circuit and Dolby noise reduction board.

3. Audio/visuals - film or filmstrip about Dolby NR systems.

4. Home study - use completion type questions for students to identify or define terminolgy and calculate S/N ratios.

5. Lab experiment(s) - for student performance and testing.

MODULE - Audio Electronics
SUB-MODULE - Sound Generation and Control Systems
TOPIC - Audio Processing Systems

PERFORMANCE OBJECTIVE No. 2:

Given a schematic diagram for a frequency divider or an automatic audio level compression/expansion circuit with the necessary components, tools and equipment to perform an experiment, the student will assemble and test-operate the circuit to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Explain the theory of frequency separation by bands in an equalizer circuit.

b. Read and interpret a schematic diagram for a frequency divider and an automatic audio level control circuit.

c. Assemble and test a basic equalizer and expansion/compression amplifier (compander) circuit with an audio signal generator and scope.

d. Explain the basic theory of operation of audio compander circuits.

e. Perform measurements of frequency and amplitude of audio signal waveforms using an oscilloscope.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - describe principles of operation and circuit construction for equalizers and companders. Use transparencies to illustrate frequency division and expansion/compression concepts, and their application to the schematic diagrams.

2. Demonstration - operation of equalizer and compander circuits, and use of scope to measure and observe performance.

3. Lab experiment(s) - for student performance and testing.

4. Home study - use worksheets with pictorial(s) and schematic diagram(s) for students to practice wiring and/or identifying circuit functions.

TOPIC - Audio Processing Systems

PERFORMANCE OBJECTIVE No. 3:

Given a selection of five sound alteration circuits with the necessary components, tools and materials, the student will assemble and test-operate one circuit to a degree of completeness and accuracy considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Identify and explain the basic operating principles of a fuzz, tremolo, echo, reverb and phase shift circuit from a schematic.

b. Assemble one of the above sound alteration circuits on a solderless-socket board and observe its operation in an audio amplifier.

c. Observe and record the effects of a fuzz, tremolo, echo, reverb or phase shift circuit on an audio signal.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - discuss theory of operation for each of the five basic sound alteration circuits. Use transparencies to illustrate schematic and pictorial diagrams of each. Explain connections of each circuit in an audio amplifier system.

2. Audio recordings - to illustrate the effects of each circuit when used with a musical presentation (local band or orchestra).

3. Demonstration(s) - assembly and test-operation of each circuit in a laboratory setting.

4. Lab experiment(s) - for student performance and testing.

TOPIC - Audio Processing Systems

PERFORMANCE OBJECTIVE No. 4:

Given a selection of four sound activated circuits with the necessary components, tools and equipment to perform an experiment, the student will assemble and test-operate one circuit to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Explain the principle of sound activation and amplification to trigger a thyristor and control an alarm, light(s), appliance or toy.

b. Read and interpret block diagrams of sound activated systems.

c. Assemble and test a sound activated control circuit from a schematic diagram.

d. Diagram and describe a frequency-selective circuit for a sound activated color organ.

e. Diagram and describe a tone decoder circuit, and identify five practical applications.

f. Diagram and describe a sound activated alarm system.

g. Use test equipment to check thyristor and sound activated circuit performance.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explain basic sound pickup systems and their operation in sound activated control circuits. Discuss common applications, using transparencies to illustrate principles of operation.

2. Demonstration(s) - use of thyristor switching circuits in sound activated systems; frequency-selective networks for color organs; tone decoder circuits.

3. Audio/visuals - films, filmstrips, or slides to illustrate color organ operation.

4. Home study - block diagrams of sound activated systems for students to identify and describe functions.

MODULE - Audio Electronics
SUB-MODULE - Sound Generation and Control Systems
TOPIC - Audio Processing Systems

PERFORMANCE OBJECTIVE No. 5:

Given a schematic diagram of a sound junction box and/or audio mixer circuit with the necessary components, tools and equipment to perform an experiment, the student will assemble and test-operate one of these circuits to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Diagram and describe a resistance/capacitance signal source coupling circuit for a common audio junction box.

b. Explain the disadvantages of direct coupled signal sources in terms of system efficiency and distortion.

c. Diagram and explain the operating principles of an FET audio mixer system.

d. Read and interpret schematic diagrams for sound combining systems.

e. Assemble and test-operate an audio junction or FET mixing circuit.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - describe methods of coupling and mixing audio signals from different sources in terms of efficiency and preventing crosstalk or distortion. Use transparencies to illustrate circuit functions and operation.

2. Demonstration - assembly and operation of an FET audio mixer circuit.

3. Lab experiment(s) - for student performance and testing.

4. Field trip - sound recording/production studio to observe commercial mixing circuits.

MODULE - Audio Electronics
SUB-MODULE - Sound Generation and Control Systems
TOPIC - Audio Processing Systems

PERFORMANCE OBJECTIVE No. 6:

Given a schematic of a sound level indicator circuit with the necessary components, tools and materials to perform an experiment, the student will assemble and test-operate the circuit with an audio amplifier system to a degree of accuracy and completeness considered acceptable to the instructor.

SUPPORTING COMPETENCIES:
In order to do this, the student must be able to:

a. Identify and describe the operation of an LED.

b. Differentiate between digital and analog audio level indicator circuits.

c. Explain the sensitivity of VU and dB meter movements.

d. Diagram and describe the operation of a comparator LED audio level indicator circuit.

e. Diagram and describe the operation of a transistorized VU/dB meter system.

f. Assemble and test-operate an audio level indicator circuit with an audio amplifier system.

INSTRUCTIONAL STRATEGIES:

1. Lecture/discussion - explain the operation of a voltage comparator IC and its application to digital audio level indicator circuits. Compare digital and analog type measuring circuits using transparencies to illustrate circuit construction and function.

2. Demonstration - identify need for VU/dB indicator circuits and illustrate operation with record/playback, mixing or other audio processing system. Differentiate between O-level and sensitivities of dB and VM meters.

3. Audio/visuals - film, filmstrip, slides, etc. to demonstrate operation and/or application of audio level indicator systems.

4. Lab experiment(s) - for student performance and testing. Have students use a VU/dB recording device to check for sound pollution at various locations around school, home and/or community.