DOCUMENT RESUME

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ABSTRACT

This document contains student progress checks designed for use with individualized modules 20-22 in the military-developed course on basic electricity and electronics. The course is one of a number of military-developed curriculum packages selected for adaptation to vocational instructional and curriculum development in a civilian setting. One experiment and one progress check are provided for each lesson in the modules. Answers are included at the conclusion of each module. (LRA)

ED 190 897

Military Curricula for Vocational & Technical Education

CHIEF OF NAVAL EDUCATION AND TRAINING

MARCH 1977

BASIC ELECTRONICS SCHOOL.

MODULES 20 - 22 POWER SUPPLIES AMPLIFIERS OSCILLATORS

PROGRESS CHECKS.

CE 026 582

THE NATIONAL CENTER FOR RESEARCH IN VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY

PROGRESS CHECK
LESSON II

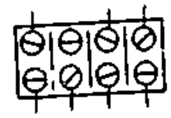
Power Supply Input Stage

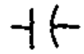
1. State the function of Power Connectors.

____

2. Place a check mark beside the symbol(s) used for power connectors.

_____ a. 

_____ d. 

_____ b. 

_____ e. 

_____ c. 

_____ f. 

3. State the function of circuit breakers.

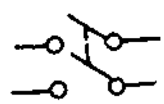
____

4. Identify by name each of the illustrated symbols.

a.  ____________

c.  ____________

b.  ____________

d.  ____________

5. State the function of power switches.

____

6. State the function of indicator lights.

____

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON III.

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction Trades	Heating & Air Conditioning
Clerical Occupations	Machine Shop
Communications	Management & Supervision
Drafting	Meteorology & Navigation
Electronics	Photography
Engine Mechanics	Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
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100 North First Street
Springfield, IL 62777
217/782-0759

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Mississippi State, MS 39762
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Director
1776 University Ave.
Honolulu, HI 96822
808/948-7834

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL

Program Information Office
The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road, Columbus, Ohio 43210
Telephone: 614/486-3655 or Toll Free 800/848-4815 within the continental U.S. (except Ohio)

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The Ohio State University • 1960 Kenny Road • Columbus, Ohio 43210
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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

MODULES

TWENTY

BASIC POWER SUPPLIES

TWENTY-T

VACUUM TUBE POWER SUPPLIES

TWENTY ONE

TRANSISTOR THEORY

TWENTY ONE-T

MULTI-ELEMENT VACUUM TUBES

TWENTY TWO

OSCILLATORS

PROGRESS CHECK BOOKLET

MODULE TWENTY

BASIC POWER SUPPLIES

PROGRESS CHECK BOOKLET

PROGRESS CHECK
LESSON I

Power Supply Functional Analysis

1. The function of a power supply is to supply the correct ________ and ________ for electronic equipment.

2. Four typical functions of the input stage of a power supply are

   a. overload protection, rectification, regulation, on/off indication.

   b. power "on" indication, overload protection, regulation, couple the line voltage to the power supply.

   c. rectification, filtering, regulation, on/off switching.

   d. overload protection, power "on" indication, couple line voltage to the power supply, on/off switching.

3. State the function of the transformer secondary stage of a power supply:

   ____

4. The rectifier stage of a power supply converts ______ voltage to pulsating ______ voltage.

5. The function of the filter in a power supply is to

   a. pass high frequencies and block low frequencies.

   b. smooth pulsating DC into a smoother DC.

   c. convert AC to DC voltage.

   d. pass the AC voltage to the regulator.

6. State the two functions of the voltage regulator stage in a power supply:

   a. ____

   b. ____

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON II.

EXPERIMENT
LESSON II
Input Stage

The purpose of this exercise is to familiarize you with the schematic symbols and physical appearance of some typical parts used in power supplies.

Locate the Parts Identification Board in your learning center. Take this book with you and complete the exercise. You should be looking at the Parts Identification Board.

Procedure

1. Match the names listed below to the components numbered from 1 to 25 on the Parts Identification Board.

   (NOTE: Skip numbers 4, 7, 9, 14, 18 and 24.)

   a. Terminal Board
   b. Switch
   c. Fuse
   d. Indicator light
   e. Transformer
   f. Circuit breaker
   g. Wall plug
   h. Multiple Connector
   i. Fuse holder

Component #		Component #	
1	______	15	______
2	______	16	______
3	______	17	______
5	______	19	______
6	______	20	______
8	______	21	______
10	______	22	______
11	______	23	______
12	______	25	______
13	______		

2. Draw the schematic symbols for each component.

a. Terminal board

b. Switch

c. Fuse

d. Indicator light

e. Transformer

f. Circuit breaker

g. Wall plug

h. Multiple connector

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO THE PROGRESS CHECK II.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

PROGRESS CHECK
LESSON II

Power Supply Input Stage

1. State the function of Power Connectors.

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2. Place a check mark beside the symbol(s) used for power connectors.

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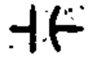
_____ b. 

_____ c. 

_____ d. 

_____ e. 

_____ f. 

3. State the function of circuit breakers.

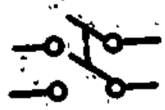
____

4. Identify by name each of the illustrated symbols.

a.  ____________

b.  ____________

c.  ____________

d.  ____________

5. State the function of power switches.

____

6. State the function of indicator lights.

____

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON III.

EXPERIMENT
LESSON III

Power Supply Input and Transformer Secondary Stages

While doing this experiment, you will observe waveforms and measure voltages at various points on the input and transformer secondary stages of the NIDA 201 Power Supply.

SAFETY PRECAUTIONS:

The 115 volt power supply voltage is not a relatively harmless voltage. This voltage has caused MORE FATALITIES in the Navy than any other voltage. BEWARE of 115 VOLT POWER - IT CAN BE A DEADLY SHIPMATE.

EQUIPMENT REQUIRED:

1. Oscilloscope
2. Device NIDA 201 Power Supply
3. PC 201-1 Printed Circuit Card
4. Device NIDA 201L Load Box
5. 10X Probe
6. Multimeter
7. Double Bannna Plug Cable

REFERENCE MATERIAL:

1. Instruction Manual, Power Supply, NIDA Trainer Model 201
2. Instruction Manual, Load Box, NIDA Training Model 201L

PROCEDURE:

1. Following all applicable safety precautions, obtain a line trace on the oscilloscope, center it, and make the following settings:

   a. Sensitivity Control - 10 volts/cm
   b. Sweep Time Control - 5 milliseconds/cm
   c. Channel AC/DC Selector Switch - AC
   d. Trigger Source - Line
   e. 10X Probe - Channel A input jack.

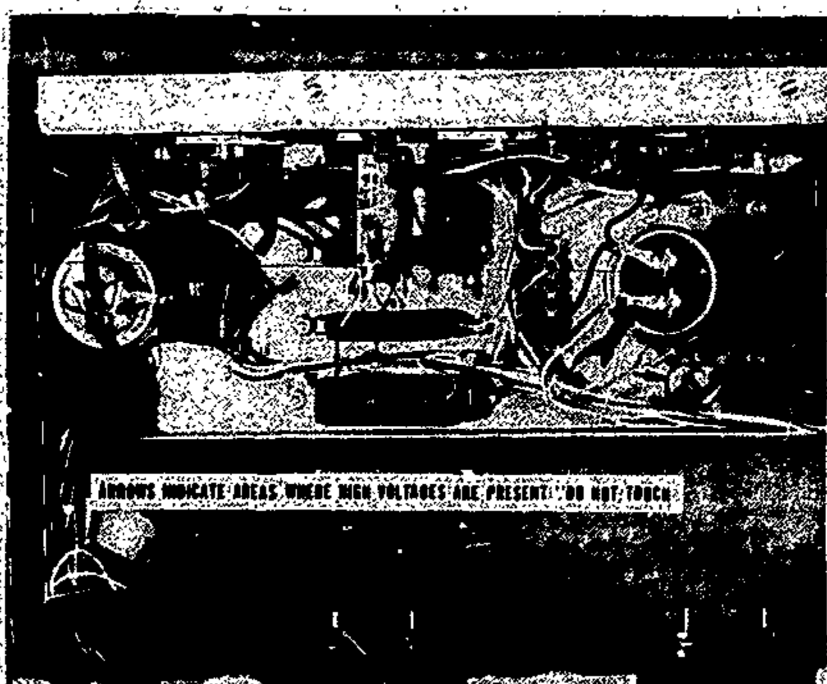
2. Following all applicable safety precautions (don't plug in the power cord yet) set up the NIDA 201 and 201L training devices as follows:

   a. Remove top cover of the NIDA 201 Power Supply and insert PC-201-1 (Half-Full Wave) Board. Remove the bottom cover of the NIDA 201 Power Supply. Turn the NIDA 201 Power Supply chassis on its right side with the bottom of the chassis towards you so the power transformer is located in the top left corner. Connect the 10X probe ground wire to the chassis frame.

b. Look at the dual end of the banana plug cable and notice the tab labelled "ground". Insert the plug into the NIDA 201 Power Supply output jacks with the ground side in the ground jack (white) and the remaining plug in the +DC (red) output jack. Connect the other end of the banana plug cable to the NIDA 201 Load Box with the plug labelled "ground" in the black jack and the remaining plug in the red jack. Note: Insure that a metal strap is connected from the ground terminal to the -DC (black) terminal on the NIDA 201 Power Supply. Place all three NIDA 201 Load Box Switches down and the Selector Switch in the "lamps" position.

c. Plug in the NIDA 201 Power Supply and turn the power switch "on". DANGER: There are now bare connections that may have 115 Volts AC on them. There are numerous connections with DC potential on them.

NOTE: The Electrolytic Capacitors shown in Figure 1 have voltages present at their terminals that can KILL! When taking measurements be extremely careful not to touch these terminals.



TOP

Figure 1

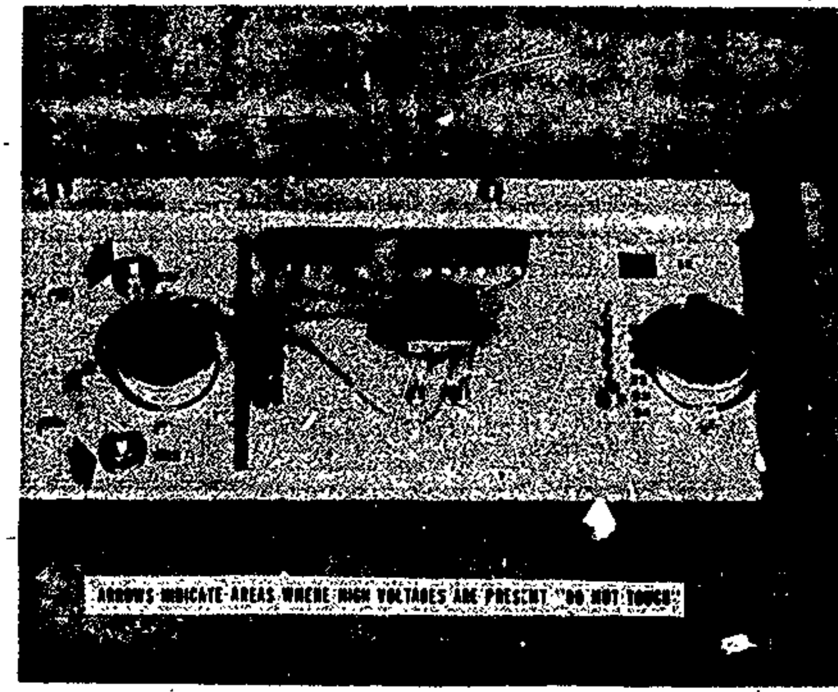


Figure 2

3. a. Locate the fuseholder on the lower left side of the NIDA 201 Power Supply chassis. Touch the oscilloscope probe to the fuseholder connection that has the white/gray color-coded wire attached (end terminal of fuseholder). Refer to the wiring diagram, Figure 3, to aid you in locating the various test points for this experiment. Calculate and record the peak-to-peak voltage at this point on the fuseholder. ______________ volts peak-to-peak.

   b. The peak (+ or -) voltage at this point is ____________ volts peak.

   c. What is the RMS voltage measured in item 3b? __________ VAC (RMS).

   d. Measure the AC voltage at the fuseholder with a multimeter; the VOM reading at the fuseholder is _______ VAC.

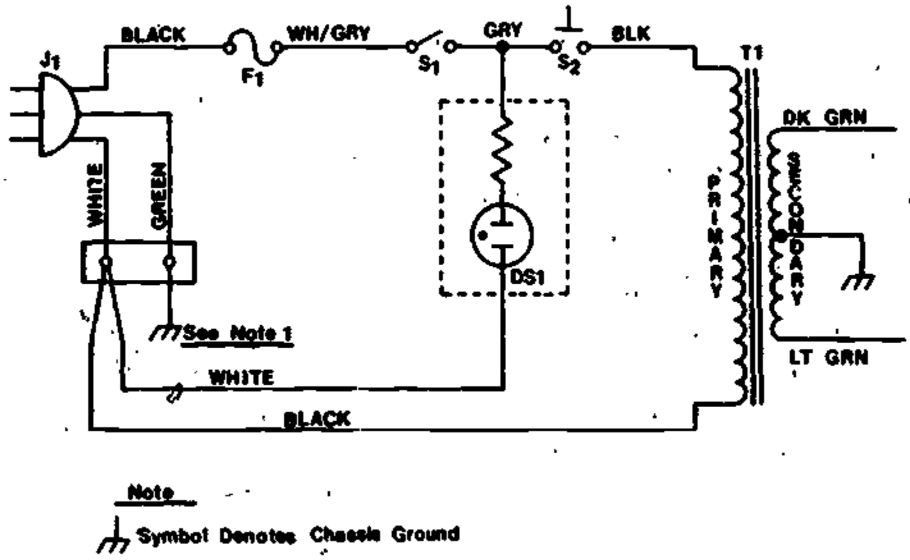


Figure 3

4. Locate the power switch on the lower right corner of the NIDA 201. Power Supply Chassis and trace the gray wire to switch S2. When fuse F1 is installed and the power switch on, there is an AC voltage present at this terminal.

a. The peak-to-peak voltage at this point on switch S2 is ______ __________ VAC p-p

b. With the NIDA 201 power switch in the "on" position, is there a difference in voltages at switch S2 and the fuseholder? (yes/no).

5. Turn the NIDA 201 power switch "off". Is there a difference in the voltage at the fuseholder and the voltage at switch S2? (yes/no)

6. a. Remove the 10X probe and place it on the terminal of S2 that has the black lead attached. Turn the NIDA Power Supply on and observe the waveform and record the voltage (P-P) at this terminal. __________VAC p-p.

b. The black lead on S2 is connected to

(1) the secondary winding of transformer T1.
(2) the primary winding of transformer T1.
(3) switch S1.
(4) lamp DS1.

c. Turn the power switch "off" and remove PC201-1 (half-full wave) circuit board. This circuit board is located on the top of the NIDA 201 Power Supply chassis. Turn the power switch "on" and observe the waveform at the terminal of S2 with the grey lead attached. Do you have a waveform at this point? (yes/no)

d. Move the 10X probe to the terminal with the black lead attached (the other side of S2). Do you have a waveform at this point? (yes/no).

7. Switch S2 is a safety switch that opens and removes power to transformer T1 when PC201-1 printed circuit card is not installed. You will see switches like these used throughout Navy equipment. They are commonly called "interlocks."

8. Refer to Figure 3.

a. Will the "power on" lamp, DS1, glow with fuse F1 open? (yes/no).

b. Will the "power on" lamp, DS1, glow with S2 open? (yes/no).

c. Remove fuse F1 on the NIDA 201 Power Supply and check your answer to 8a.

d. Turn the NIDA 201 Power Supply off and reinstall the fuse. Reinstall PC201-1 printed circuit card. Remove the 10X probe.

9. Turn the NIDA 201 Power Supply up side down with the front panel toward you. Locate diodes CR1 and CR2.

10. a. Turn the NIDA 201 Power Supply "on" then measure and record the peak-to-peak voltage at the terminal of CR-2 with the brown and light green wires attached to it. ______________ VAC (p-p)

b. Is the voltage at the terminal of CR-1 with the grey and light green wires attached to it same as that in step 10a? (yes/no).

11. Compare the peak-to-peak voltage at diode CR1 (step 10a) to the peak-to-peak voltage you observed in step 3a. Are the voltages the same? (yes/no).

12. a. What is the peak-to-peak voltage ratio between the primary and the secondary winding of the transformer? ________________

b. T1 is a (step-up/step-down) transformer.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.

PROGRESS CHECK
LESSON III

Power Supply Transformer Secondary Stage

1. Which waveform characteristic(s) will be changed by a step-up or step-down transformer?

   a. Frequency

   b. Voltage

   c. Shape

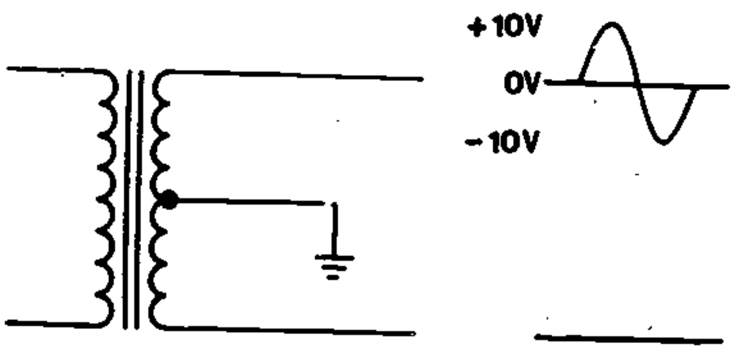
2. The function of a multi-secondary transformer is to:

   a. provide a single output voltage from two or more input voltages.

   b. provide multiple output voltages from a single input voltage.

   c. increase the power of the input voltage.

3. The diagram below shows the waveform available from one end terminal of a center-tapped transformer secondary. Draw the corresponding cycle of voltage available for the other end terminal.



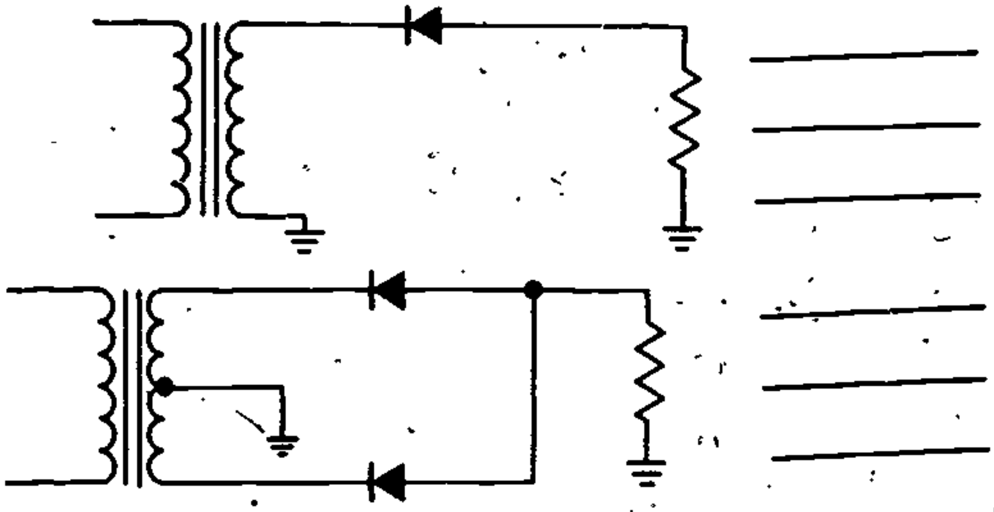
CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON IV.

A V RESPONSE SHEET
LESSON IV

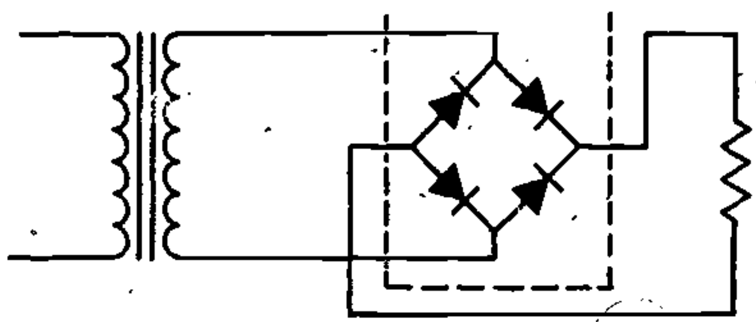
Power Supply Rectifiers

ANSWER THE QUESTIONS IN STATIC/MOTION PROGRAM TWENTY-IV ON THIS RESPONSE SHEET.

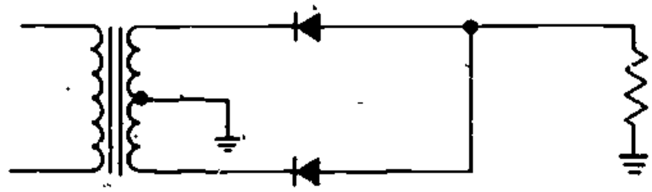
1. Draw the output waveforms and amplitudes for the two circuits shown.

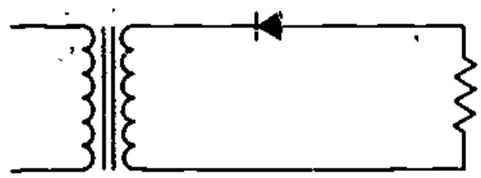


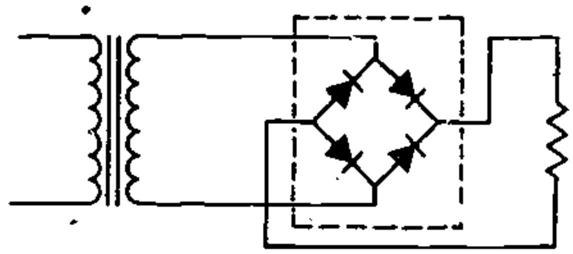
2. Trace current flow in the bridge circuit below.



3. Label each rectifier circuit below, with its proper name (half-wave, etc.) and output polarity (positive or negative).







EXPERIMENT
LESSON IV

PART I

Power Supply Rectifiers

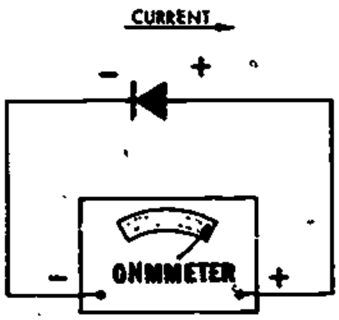
One measure of the condition of a diode is called the front-to-back ratio. As you know, diodes are special devices that allow current to flow in only one direction. Actually, a more realistic statement is that current flows easily in one direction, but with great difficulty in the other. It's like a waterfall: water flows down the waterfall very easily; it is possible to make the water go up the waterfall, but it isn't easy.

According to Ohm's Law (and our practical experience) current flows easily if the resistance is low, and current flow is very limited if the resistance is high. A diode is a device that acts like a high resistance to current flow in one direction and a very low resistance to current flow in the other direction. An ohmmeter can be used to measure this difference in resistance. The ratio of the effective resistance in one direction to the effective resistance in the other direction is called the front-to-back ratio. The ratio is written: $\frac{\text{low resistance}}{\text{high resistance}}$. The ratio of the resistance in the low direction to the resistance in the high direction, the front-to-back ratio, is a measure of how "good" a diode is.

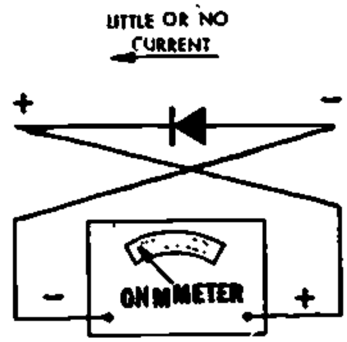
The leads of an ohmmeter are polarized; i.e., one lead is connected to the positive terminal of an internal battery, and the other is connected to the negative terminal of the internal battery.

When an ohmmeter is used to measure resistance, the internal battery tends to cause electrons to flow from the negative meter lead through the resistance to the positive meter lead. The amount of current flow is inversely proportional to the resistance, and the meter face is calibrated in ohms. An ordinary resistor will show the same amount of resistance no matter what direction the current is flowing (meter leads reversed) but a "good" diode will show a low resistance when the leads are applied one way and a high resistance when the leads are reversed:

Note: Most ohmmeters supply positive voltage to the common (black) lead and negative voltage to the red lead.



High current,
Low resistance.



Low current,
High resistance.

Suppose that a diode measures 10 ohms when the ohmmeter leads are applied with one polarity and 10,000 ohms when the leads are reversed. The front-to-back ratio is found by expressing the ratio of the smaller resistance to the larger: $\frac{10}{10,000}$. Dividing both of these numbers by the smaller gives a ratio of 1 : 1000 or 1 to 1000. A common rule of thumb is that a diode is good at a ratio of 1 : 100 or greater.

Equipment Required

Multimeter

Procedure

Now is the time for you to measure some front-to-back ratios. Go to the parts identification board, and when you get there:

a. set the multimeter to measure resistance on the R X 100 scale,
b. measure the resistance of each diode in one direction,
c. measure the resistance in the other direction,
d. record the readings, and reverse the meter leads.

Component #26	Low reading ______,	High reading ______.
Component #27	Low reading ______,	High reading ______.
Component #28	Low reading ______,	High reading ______.
Component #29	Low reading ______,	High reading ______.

Calculate the front-to-back ratios:

Record the front-to-back ratios:

Component #26 ______ 27 ______ 28 ______ 29 ______

Are all of the diodes "good"? ______ (yes/no)

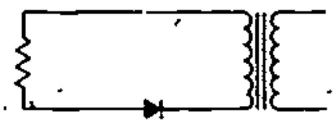
CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO EXPERIMENT TWENTY-IV-2.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

PROGRESS CHECK
LESSON IV

Power Supply Rectifiers

1. Write the name of each of the illustrated rectifier circuits in the space provided.



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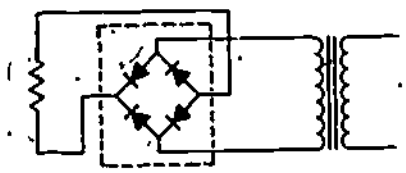

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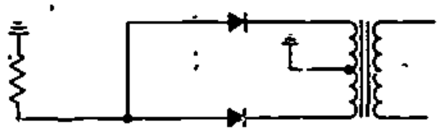


____

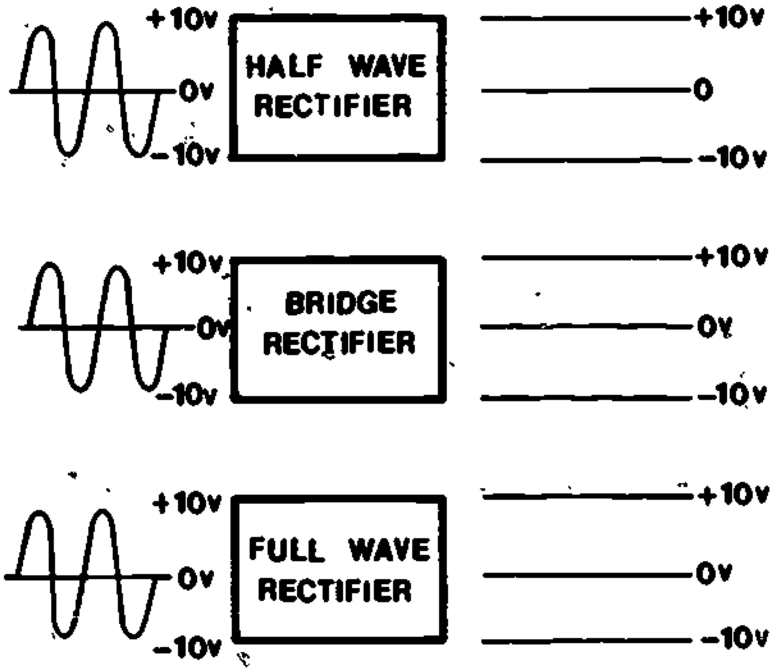
2. One advantage of a full-wave rectifier over a half-wave rectifier is

   a. fewer components.
   b. less voltage variation in the DC output.
   c. higher voltage level for the same transformer secondary voltage.

3. For the same total voltage across the transformer secondary winding, the bridge rectifier will have

   a. twice the DC output voltage as a full-wave rectifier.
   b. half the DC output voltage as a full-wave rectifier.
   c. the same DC output voltage as a full-wave rectifier.

4. Draw the output waveforms for each of these circuits (assume a positive DC output):



CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON V.

A-V RESPONSE SHEET
LESSON V

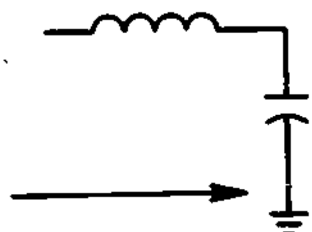
Power Supply Filters

ANSWER THE QUESTIONS IN STATIC/MOTION PROGRAM TWENTY-V ON THIS RESPONSE SHEET.

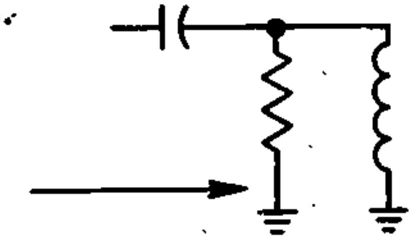
1. ____

____

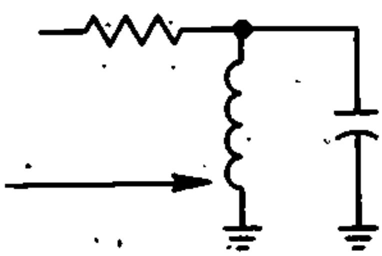
2. a.



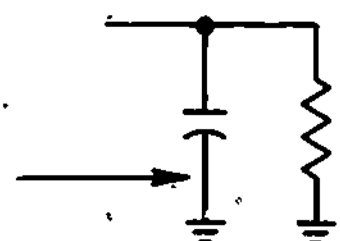
b.



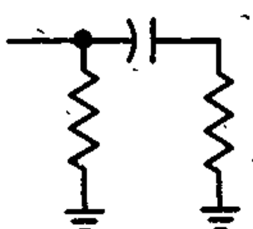
c.



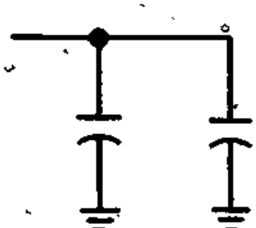
d.



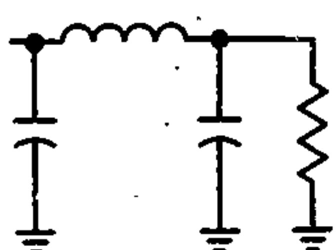
3. a.



b.



c.



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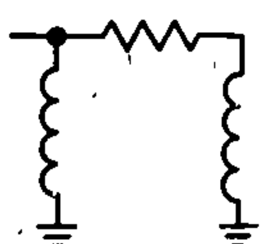


EXPERIMENT
LESSON V

Power Supply Rectifiers and Filters

This experiment will familiarize you with the rectifier and filtering action of a power supply.

SAFETY PRECAUTIONS: Observe all standard safety precautions. Beware of bare connections; an energized circuit may have dangerous voltages in it.

EQUIPMENT REQUIRED

Oscilloscope
NIDA 201 Power Supply
PC201-1 Printed Circuit Card
NIDA 201L Load Box
Banana Plug Cable
10X Probe
Jumper Wires (2)

REFERENCE MATERIAL

Instruction Manual, Power Supply, NIDA Trainer Model 201
Instruction Manual, Load Box, NIDA Trainer Model 201L

PROCEDURE

1. Obtain a NIDA 201 Power Supply and a NIDA 201L Load Box. Connect the load Box to the Power Supply with the Dual Banana Plug Cable. On the Load Box set the LOAD SELECTOR Switch to "lamps" and place all toggle switches to the "down" position.

2. Obtain a line trace and set up the oscilloscope as follows:

   a. SENSITIVITY - 5 volts/cm

   b. SWEEP TIME - 5 milliseconds/cm

   c. CHANNEL SELECTOR - Channel A

   d. CHANNEL A - AC/DC SWITCH - DC

   e. TRIGGER SOURCE - Line

   f. Connect a 10X probe to the Channel A input

   g. Center the line trace

3a. With the Power Supply right side up, remove the top cover and insert PC 201-1 (Half - Full Wave Printed Circuit Card).

3b. Place the HALF WAVE - FULL WAVE Switch, S4, on PC 201-1 in the "Half Wave" position.

3c. Place the 10X probe TP1 with the probe ON ground on any convenient chassis ground.

3d. Ensure all connections are properly made.

Let's now add the rectifier schematic to the schematic of the input transformer secondary we worked with in Figure 3 of Experiment for Lesson III.

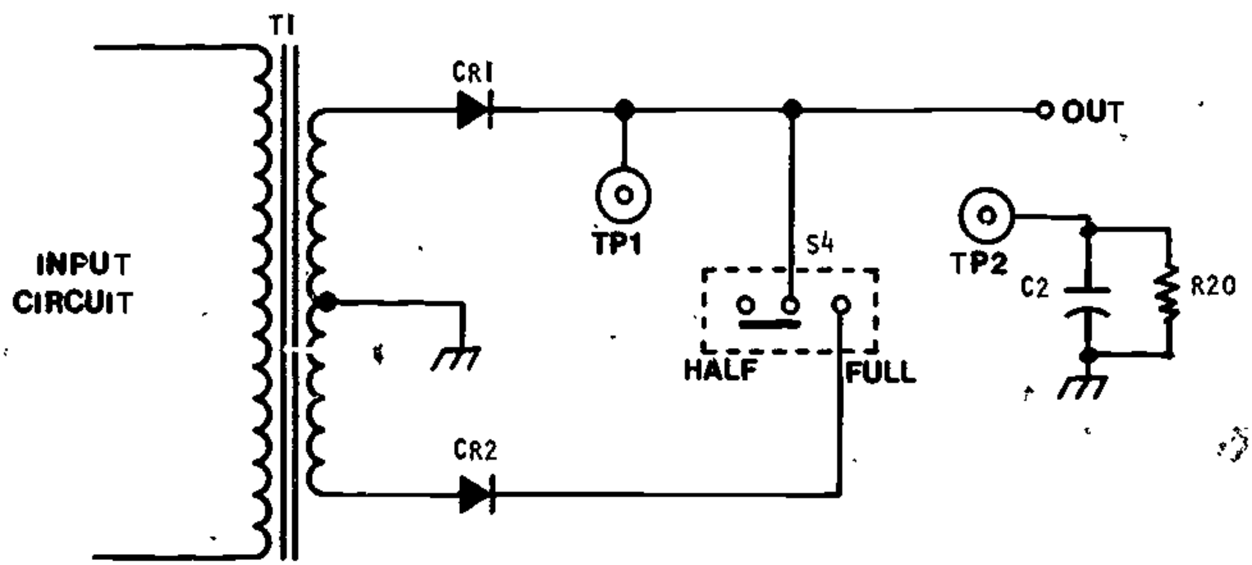


Figure 1

4. The output of the rectifier circuit is from TP1 on circuit board PC201-1 (Half - Fullwave Rectifier). Switch S4 gives us the capability of examining the output from either a half wave or a full wave rectifier. Refer to Figure 1.

5. With S4 in the half wave position, we use diode ____________.

(1) CR1 only
(2) CR2 only
(3) CR1 and CR2

6. Energize the NIDA 201 Power Supply and observe and draw the waveform at TP1.

____________Vp-p ±10%

7a. Place the HALF - FULL WAVE Switch (S4) on PC201-1 in the "FULL WAVE" position. Observe and draw the waveform at TP1.

____________Vp-p ±10%

Answer the following question.

The full wave rectifier output voltage uses

(1) only the positive alternation of the AC input.
(2) only the negative alternation of the AC input.
(3) both the positive and negative alternation of the AC input.

7c. The full wave rectifier output has (half as many/twice as many/the same number of) pulses per cycle as the half wave rectifier output.

8. Record the voltage and current readings from the meters on the front of the Power Supply.

______________________VDC ________________________DC AMPS

9. Notice that the meter on the front of the NIDA 201 doesn't indicate the pulsations (known as ripple) that can be seen on the oscilloscope.

10. Turn off the Power Supply and install a jumper between TP1 and TP2, then reenergize the Power Supply.

11. Measure and record the voltage and waveform at TP1

________________VDC

12. Record the voltage and current readings from the meters on the front of the Power Supply.

__________________________VDC ___________________________DC AMPS

By adding the jumper between TP1 and TP2 you added capacitor C1 to the circuit. (Refer to Figure 2-3 in the NIDA 201 Instruction Manual.) Inserting capacitor C1 into the circuit caused the ripple to ________ and the voltage to __________.

13. While observing the oscilloscope presentation, turn the Power Supply off. Notice that the voltage at TP1 "bleeds" off slowly. This is a very important point to remember. Turning a power supply switch off does not guarantee that you can safely touch the conducting surfaces. Capacitors are capable of storing enough energy to K I L L you long after the circuit has been deenergized. All capacitors must be discharged before you can assume that it is safe to touch conducting surfaces!!! The approved method for doing this is to short each capacitor's positive and negative leads together through a jumper wire. In high voltage circuits it is best to use a low-resistance, high-wattage resistor in series with a jumper. However, when using the NIDA 201 Power Supply, a standard jumper will suffice.

14. With the Power Supply deenergized, obtain a jumper and short TP2 to ground.

Refering to Figure 2-3 on page 2-4 in the NIDA Instruction Manual, which side of C1 (positive/negative) have you jumpered to ground?

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.

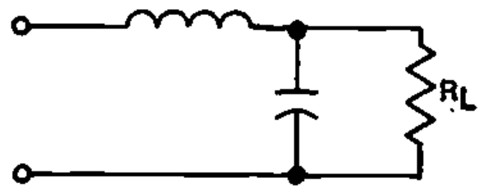
PROGRESS CHECK
LESSON V

Power Supply Filters

1. The purpose of a power supply filter is to

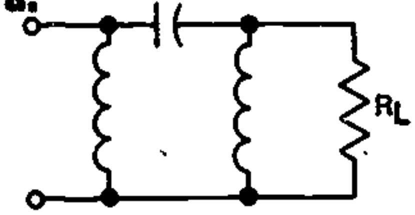
   a. convert AC to DC voltage.
   b. smooth the DC voltage.
   c. maintain the DC voltage at a constant level.
   d. supply the proper AC voltage for equipment operation.

2. The illustrated filter circuit can be classified as a __________ input filter.

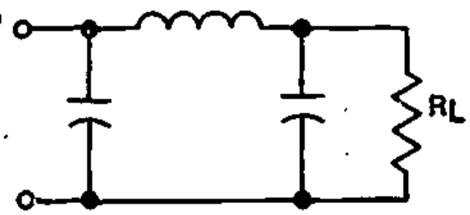


3. Select the correct schematic for a pi filter circuit:

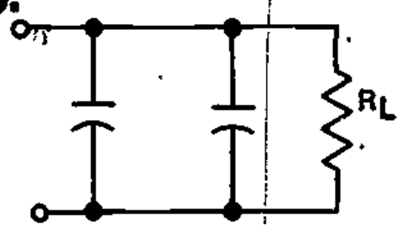
a.



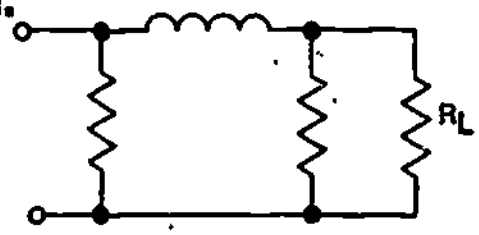
c.



b.



d.



CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON VI.

PROGRESS CHECK
LESSON VI

Power Supply Regulators

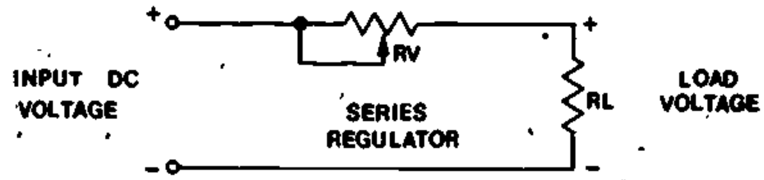
1. Describe the function of a voltage regulator:

____

____

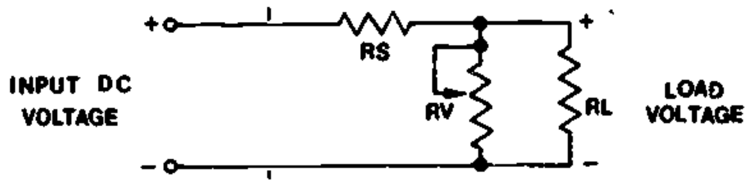
2. If the input DC voltage to the illustrated voltage regulator increases, should RV be increased or decreased to maintain a constant voltage across R_L?

____



3. If the output DC voltage of the illustrated voltage regulator decreases due to load change, should RV be increased or decreased to maintain a constant voltage across R_L?

____



4. The purpose of a Zener diode in a shunt voltage regulator is to

a. convert AC to DC voltage.
b. allow current to flow in only one direction.
c. maintain a constant DC current flow.
d. maintain a constant DC voltage.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON VII.

EXPERIMENT
LESSON VII

Power Supply Regulation and Loading Effects

In this experiment you will;

Use an oscilloscope to measure DC voltages.

Observe how a regulator maintains a constant DC voltage under varying load conditions.

Observe the effect of "loading" on the power supply as you change the current drawn from the power supply.

SAFETY PRECAUTIONS: Beware of bare connections while taking waveform and voltage measurements. Most of these connections have voltages on them that can KILL.

EQUIPMENT REQUIRED

NIOA 201 Power Supply
PC 201-2 Printed Circuit Card
NIDA 201L Load Box
10X Probe
Dual Banana Plug Cable

REFERENCE MATERIAL

Instruction Manual, Power Supply, NIDA Trainer 201
Instruction Manual, Load Box, NIDA 201L

PROCEDURE:

1. Using all applicable safety precautions, obtain a line trace on the oscilloscope.

2. Set up the NIOA 201 Power supply.

   a. Connect the NIDA 201L Load Box to the 201 Power Supply using the dual banana plug cable. Ensure that all toggle switches on the Load Box are in the "down" position and the LOAD SELECTOR SWITCH is in the "lamps" position. Set the parallel - series switch in the series position.

3. Install PC 201-2 (Zener Regulator Printed Circuit Card). You now have added the Voltage Regulator, the final stage, to your power supply. Voltage regulators maintain a constant voltage output under varying load conditions. All voltage regulators have certain operating ranges. If the load varies outside the operating range of the regulator, the voltage will also vary.

4. Ensure all connections are properly made and energize the NIDA 201 Power Supply. Record the voltage and current readings on the front panel meters of the power supply.

______________________ VDC ______________ DC Amps

5. Set up your oscilloscope to measure DC voltages on Channel A.

   a. The oscilloscope can be used to measure DC as well as AC voltage. The following procedure will aid you in measuring DC voltages with an oscilloscope. You will use this method in step 6:

      (1) Place the Channel A AC/DC switch to "DC".

      (2) Connect the probe and its ground lead to convenient ground on the chassis.

      (3) Establish a zero volt reference by aligning the line trace to one of the horizontal graticule lines on the face of the oscilloscope.

      (4) Connect the probe to point to be measured and count the number of centimeters that the line trace is displaced. (Ensure the ground lead is still attached to a chassis ground.)

      (5) Multiply this number by the volts/cm setting on the VERTICAL SENSITIVITY switch. The result will be the amount of DC voltage present.

      (6) Any AC component of the input signal will also be displayed on the oscilloscope with the AC/DC switch in the "DC" position. The sweep reference will move up or down according to the DC voltage present and the AC signal will "ride" on (vary around) this level.

6a. Now, using your oscilloscope measure and record the output voltage of the Zener Regulator PC 201-2. (See figure 2-6 of NIDA Instruction Manual.)
______________ VDC

6b. The voltage you calculated with your oscilloscope should be the same as (within ± 10%) the voltages you obtained in step 4 from the front panel meters.

6c. From this experiment you can see that you can obtain DC measurements with an oscilloscope thus proving that you do not always require a multimeter for DC measurements.

7. Now let's look at the voltage regulator and see how it operates. As you know, when you vary the load on your power supply, the regulator will compensate for the change in voltage caused by the change in load. occasionally the load will increase to the point where the zener can't compensate for the change in the load.

8. We will use the circuit in step 3 as a reference for the following steps.

   a. Measure and record the input voltage to the regulator card. ________VDC (Measured with oscilloscope.)

   b. Observe and record the output from the regulator. ________VDC (Observed on "DC Volts" meter on front panel NIDA 201 Power Supply.)

   c. Calculate the voltage drop across R1 (input voltage minus output voltage). ________VDC.

   d. Using ohms law ($I = \frac{ER1}{R1}$), figure the current through R1. ________Amps.

   e. Observe and record the load current (Read from the "DC Amperes" meter on front panel of the NIDA 201 Power Supply) ________DC Amps.

9. Now you know the current through R1 and the load current. From these currents, find current through the zener.

   a. Using the formula IR1 = ICR1 + IRLoad, figure the current through CR1 ________DC AMPS.

10. The values you have just found will be considered as the values found in the normally loaded power supply.

11. Now watch the meters on the NIDA 201 Power Supply closely while you move the LOAD 1 TOGGLE SWITCH on the NIDA 201L Load Box to the "Load 1 and 2" position. By adding load 2 to the circuit you have varied the load.

   a. Record the voltage and current readings on the power supply meters ________VDC ________DC AMPS

   b. Did the voltage vary appreciably from the reading taken in step 4. yes/no ________

12. Now find the values of ER1 ________ IR1 ________ and ICR1 ________.

13. You'll notice that even though the load current increased, the current through R1 remained the same and the current through CR1 decreased. The Zener diode CR1 (increased/decreased) conduction in order to hold the output voltage constant. There was little or no change in power supply output voltage. The power supply is operating within the control range of our regulator.

14. Again watch your meters while moving the PARALLEL-SERIES on the Load Box to the "PARALLEL" position.

a. Record the voltage and current readings on the Power Supply meters.
______________VDC ____________DC AMPS

b. Did the voltage change from the reading taken in step 11?
______________ (yes/no).

c. Did the current vary? ______________(yes/no).

The relatively large change in the power supply voltage indicates that you have "overloaded" the power supply. By placing LAMPS 1 AND 2 in "PARALLEL" you have caused the load box to draw current that exceeds the operating range of the Zener regulator. The regulator can no longer keep the power supply's output voltage constant and therefore the voltage output decreases.

15. Again by using ohms law you can see what happens in an overloaded power supply. Compute the values for ER1__________ IR1____________ ICR1__________ for the overloaded power supply in step 14.

Notice that the current through series resistor R equals the load current, leaving a negligible current flow through Zener diode CR1. This turns the zener diode off and effectively removes it from the circuit. The power supply is unregulated when this occurs.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.

PROGRESS CHECK
LESSON VII

Power Supply Systems Concept

1. In a power supply system the addition of circuits which cause the the total impedance to change is called ______________.

2. The effect that the filter has on the rectifier stage is called

   ______________.

3. What will the addition of more circuits do to the impedance of a power supply?

   ____

4. a. In an unregulated power supply, what will happen to the current in a fixed branch if current changes in some other parallel branch? ______________

   b. What is this effect called? ______________

5. What will we do to offset the effect that changing current requirements have on the output voltage? ______________

   ____

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MODULE TWENTY-T

VACUUM TUBE POWER SUPPLIES

PROGRESS CHECK BOOKLET

PROGRESS CHECK
MODULE TWENTY-T

Vacuum Tube Power Supplies

1. What is the basic difference and/or similarity between tube and transistorized equipment?

   a. Functionally the same, but different in size and voltage requirements.
   b. Usage and voltage requirements the same.
   c. Functionally different, but size and voltage the same.
   d. There are no differences either functionally or in size requirement.

2. The only difference, if any, between a vacuum tube power supply input circuit and a transistor power supply input circuit is that

   a. vacuum tubes are used instead of transistors.
   b. the components are of different values or size.
   c. the transistor power supply circuit provides greater overload protection.
   d. there is no difference.

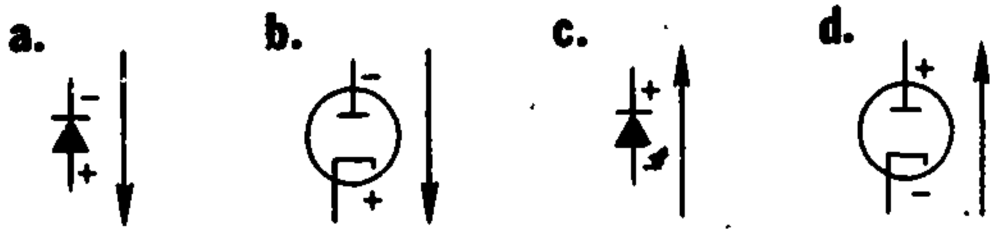
3. Which of the statements below is most correct?

   a. Transistorized power supply transformer secondaries always use step-up and tube power supply transformer secondaries can use either step-up or step-down.
   b. Transistor and tube power supply transformer secondaries can be step-up or step-down, but perform different functions in their power supply.
   c. Power supply transformer secondaries for tube power supplies are multi-lead step-up and step-down, while transistor power supply transformer secondaries are usually step-down.
   d. Tube power supply transformer secondaries use only the primary winding of a transformer to regulate the power supply output voltage.

4. Which of the statements below is most correct?

   a. Tube rectifiers are usually configured as bridge rectifiers whereas transistor rectifiers are usually configured as half-wave rectifiers.
   b. Transistor rectifiers use larger components than tube rectifiers.
   c. Tube rectifiers and transistor rectifiers function the same.
   d. Tube rectifiers rectify current while transistor rectifiers rectify voltage.

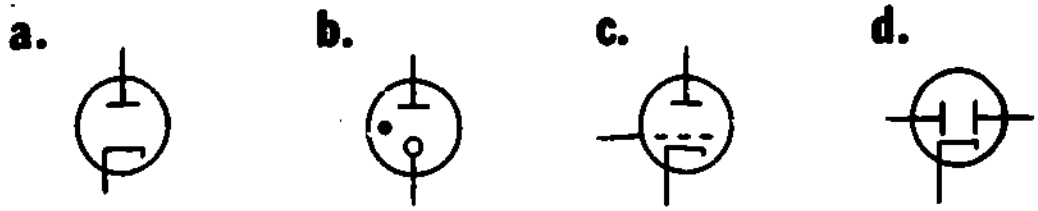
5. Which of the schematic symbols illustrated below indicates correct current flow for a tube diode?



6. Tube power supply filter networks, as compared to transistor power supply filter networks, are

   a. smaller in size, but function the same.
   b. larger in size, but function the same.
   c. identical in function and size.
   d. configured differently and function differently.

7. Which of the tube schematic symbols illustrated below is comparable to a Zener diode regulator?



8. What is the major functional difference, if any, between Zener diode regulators and voltage regulator tubes?

   a. There is no functional difference.
   b. Voltage regulator tubes regulate AC voltage, while Zener diodes regulate DC voltage.
   c. Zener diodes regulate AC voltage, while voltage regulator tubes regulate DC voltage.
   d. Zener diode regulators can be interchanged with voltage regulator tubes.

9. Comparing a basic tube power supply to a basic transistor power supply, which of the following statements is most correct?

   a. Tube power supplies are smaller than transistor power supplies and have completely different functions than transistor power supplies.
   b. Tube power supplies function the same as transistorized power supplies but differ physically.
   c. Tube power supplies are larger than transistor power supplies and have completely different functions than transistor power supplies.
   d. Tube power supplies have no similarity with transistorized power supplies.

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MODULE TWENTY ONE

TRANSISTOR THEORY

PROGRESS CHECK BOOKLET

AUDIO-VISUAL RESPONSE SHEET
LESSON 1

BASIC TRANSISTOR THEORY

1. A B C D (Circle One)

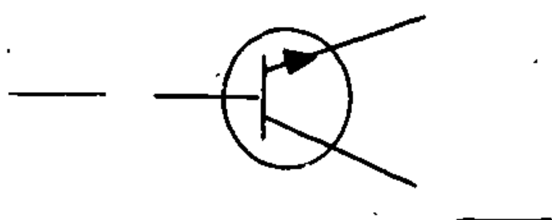
2. A B C D (Circle One)

3. A B C (Circle One)

4. A B C (Circle One)

5. a. ____________________
   b. ____________________
   c. ____________________

6. B ______



7.

8. A B C D (Circle One)

EXPERIMENT
LESSON 1

TRANSISTOR IDENTIFICATION

Many times you will be required to determine whether a transistor is good or bad. Sometimes you must decide this after the transistor has been removed from the equipment. To do this you take front-to-back ratios the same way you did for diodes, but there are six measurements for a transistor instead of the two for diodes. You will also determine what type of transistor you have (NPN or PNP).

> NOTE: This type of check will only indicate if the transistor is open or shorted. If a transistor checks good using this method and the device is still suspected, other methods of testing must be used.

When you use the multimeter to measure the resistance of a diode or transistor, the meter supplies the current that flows through the component being tested. Since the black (common) lead of most multimeters is positive and the red lead is negative when used for resistance measurement, you can predetermine whether the reading should be large or small for a particular type of transistor.

NOTE: The polarity of the leads on a Simpson 260 VOM can be changed with the use of the + and - DC switch. With the switch in +DC position the red lead will be positive.

By knowing the meter lead polarities and the transistor elements (emitter, base, collector) you can determine what type of transistor (PNP or NPN) you have, providing the transistor is good. To do this you take two readings, reversing the meter leads between the emitter and base leads. The smaller of the readings indicates that the emitter to base portion of the transistor is forward biased with this polarity of voltage applied.

Equipment Required

Multimeter AN/PSM-4

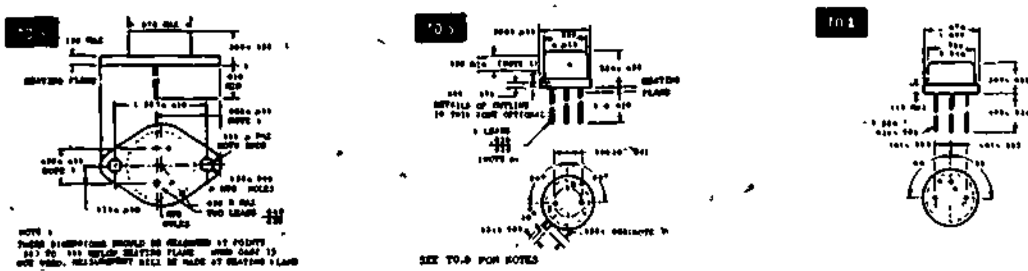
Go to the parts identification board.

Procedure

1. Components 30, 31, 32, 33, and 34 are all transistors. Technical drawings of these transistors are shown in figure 1. From these drawings you can determine physical dimensions, identification and placement of the elements (leads), and the shape of container (TO2, TO3, etc.) in which the transistor is packaged.

1. Closely study the drawings and compare them with the components mounted on the board. Then, label each drawing with the component number.

a. ______ b. ______ c. ______



d. ______ e. ______

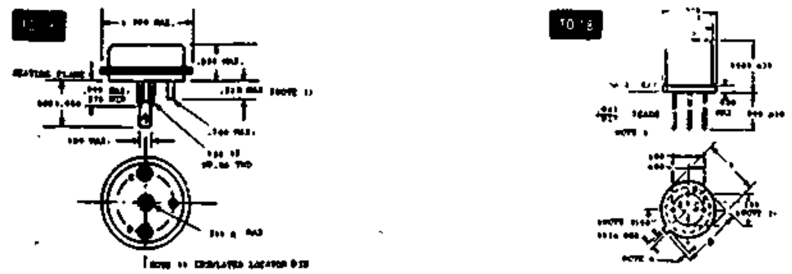


Figure 1

CHECK YOUR ANSWERS AGAINST THOSE IN THE BACK OF THIS BOOK BEFORE PROCEEDING.

Set the multimeter to the RX100 scale. While holding the leads together, zero the meter.

NOTE: Some transistors cannot handle the current provided by the multimeter on the RX1 and RX10 scales. Therefore, when checking transistors with a multimeter you should not use the scales lower than RX100, for fear of damaging the transistor.

In the following chart you will determine what type of transistor you are checking. In the column labeled "Transistor Number" write the number (2NXXXX) found on the transistor that corresponds to each component number. Sometimes you may find a number other than a 2N number. It will be used for the same purpose -- transistor identification.

The next three columns are labeled EB (emitter-base), BC (base-collector), and EC (emitter-collector). Below the column identification there are two sets of letters PN and NP. These letters represent polarities of the multimeter, "P for positive and "N" for negative.

2.

Component Number	Transistor Number	EB	BC	EC	EBC
30.		PN ____	NP ____	NP ____	____
		NP ____	PN ____	PN ____	
31.		PN ____	NP ____	NP ____	____
		NP ____	PN ____	PN ____	
32.		PN ____	NP ____	NP ____	____
		NP ____	PN ____	PN ____	
33.		PN ____	NP ____	NP ____	____
		NP ____	PN ____	PN ____	
34.		PN ____	NP ____	NP ____	____
		NP ____	PN ____	PN ____	

Let's work the first transistor together, then you can proceed on your own. In the first column (labeled EB), the first space has PN next to it. Place the black (positive) meter lead on the emitter and the red (negative) lead on the base. Record your resistive reading in the space next to the PN. Below this is the NP space; place the negative lead on the emitter and the positive lead on the base. Record this reading next to NP.

NOTE: Using the RX100 scale your multimeter may not appear to move. Record your resistance reading to the closest K ohm.

For the next column (labeled BC) do the same thing. First put the negative lead on the base and the positive lead on the collector. Record your reading. Then reverse your leads with the positive on the base and the negative on the collector. Record your reading.

In the column labeled EC do the same, negative on the emitter and positive on the collector. Record. Reverse your leads with positive on the emitter and negative on the collector. Record. You have made a complete front to back ratio check on a transistor.

Do the same for the remaining transistors. When you have completed all the readings, proceed as follows.

You should have one low and one high resistive reading in the EB and BC columns, for each transistor. If you haven't, recheck that transistor.

The EC column may or may not have a large difference in resistive readings, but it should never read an extremely low value (under 50 ohms).

From the EB and BC columns select the PN or NP letters that gave you the lowest resistance readings. Place these in the EBC (emitter, base, collector) column. First from the EB, then from the BC. The two middle letters should be the same; use this letter only once to give you a total of three letters (NPN or PNP). Does this group of letters look familiar? Even though your letters stand for the polarity that gave you the lowest resistance reading (or, using Ohm's Law, the highest current through the transistor), the type of transistor, NPN or PNP, will have the same group of letters.

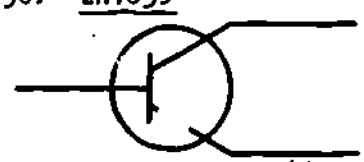
You may now return to your carrel to complete this job sheet using the information you have collected.

3. Using the incomplete schematic symbols below:

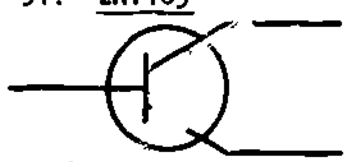
   a. Label the transistor symbol leads B (base), E (emitter), and C (collector).

   b. Draw an arrow pointing in the proper direction on the emitter lead of the transistor symbol.

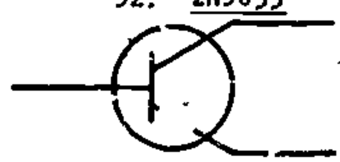
30. 2N1893



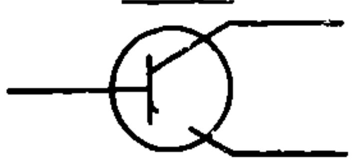
31. 2N1183



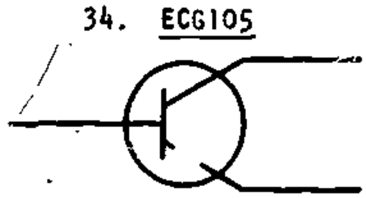
32. 2N3055



33. 2N2222A



34. ECG105

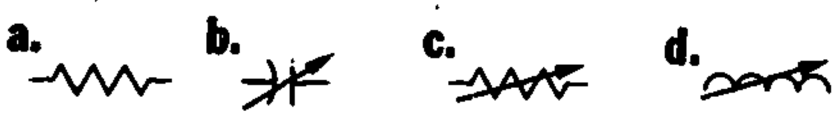


CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO THE PROGRESS CHECK. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

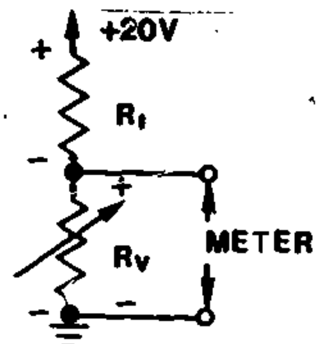
PROGRESS CHECK
LESSON I

Basic Transistor Theory

1. Which of the following components is a functional equivalent of a transistor?



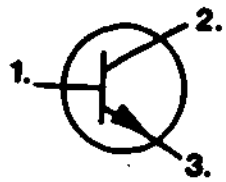
2. When Rv is increased, what happens to the voltage across Rv and the current through Rv? ____________________



3. What happens if a transistor's resistance is increased?

a. Conduction is increased and voltage across the transistor is increased.
b. Conduction is decreased and voltage across the transistor is increased.
c. Conduction is decreased and voltage across the transistor is decreased.
d. Conduction is increased and voltage across the transistor is decreased.

4. Match the correct element names to the numbers on the schematic illustration shown.



1. ____   a. Emitter
2. ____   b. Base
3. ____   c. Collector

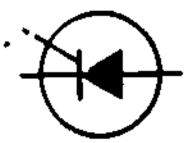
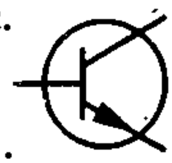
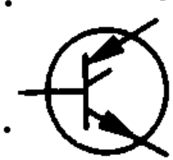
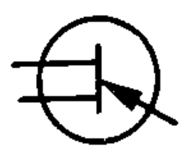
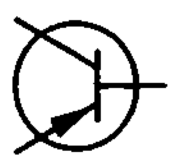
5. The element identification mark on the base of a transistor will

   a. always be nearest the collector.
   b. tell you which type it is.
   c. always be nearest the emitter.
   d. always be nearest the base.

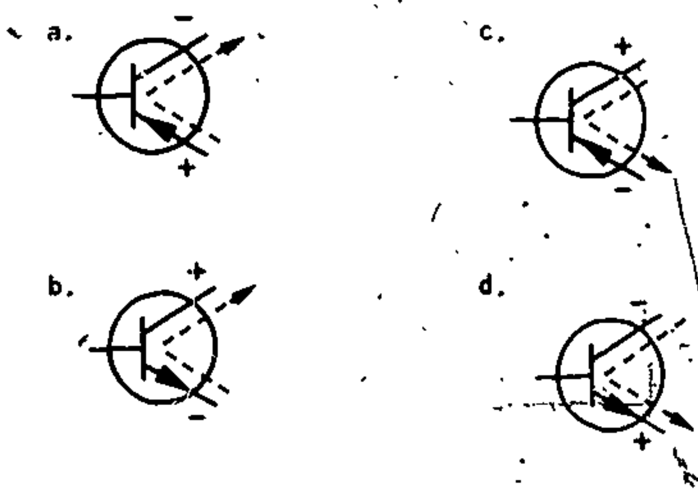
6. Which of the following symbols represents an NPN transistor and which represents a PNP transistor?

   ______ is NPN

   ______ is PNP

1.

2.

3.

4.
5.



7. Which of the following illustrations is most correct? (The arrow indicates direction of current flow.)



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A-V RESPONSE SHEET
LESSON II

Transistor Biasing

1. ____

____

____

2. A B C D (Circle ONE)

3. A B C D (Circle ONE)

4. A B C (Circle ONE)

5. A B C (Circle ONE)

6. A B C D (Circle ONE)

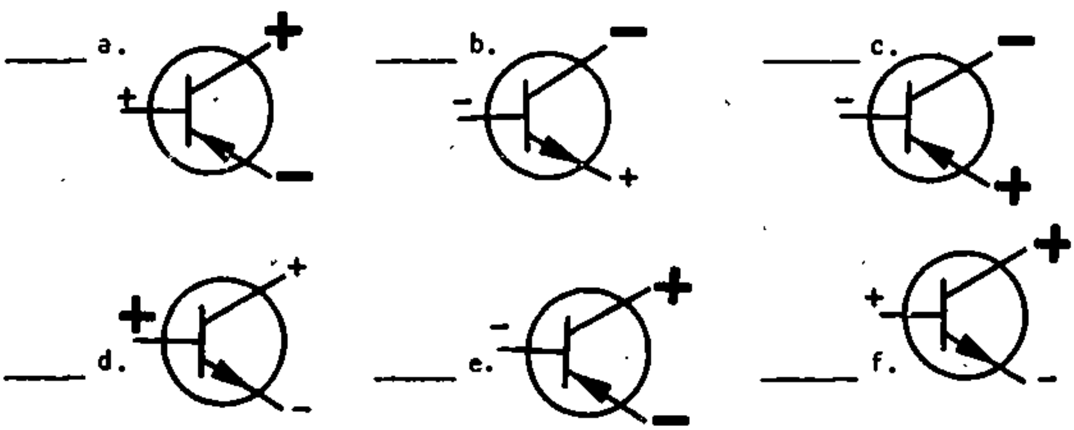
PROGRESS CHECK
LESSON II

Transistor Biasing

1. Bias may be defined as

   a. the D.C. potentials on the base and emitter leads that set the proper amount of conduction prior to the injection of a signal.
   b. the A.C. potentials on each lead that set the proper amount of conduction prior to the injection of a signal.
   c. the D.C. potentials on each lead that set the proper amount of conduction prior to the injection of a signal.
   d. the D.C. potentials on each lead that set the proper amount of resistance after a signal has been applied.

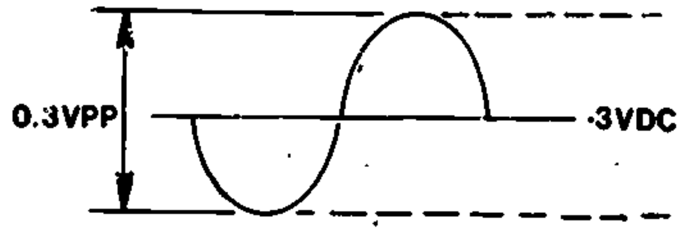
2. Which of the following illustrations shows proper biasing? (There may be more than one correct answer.)



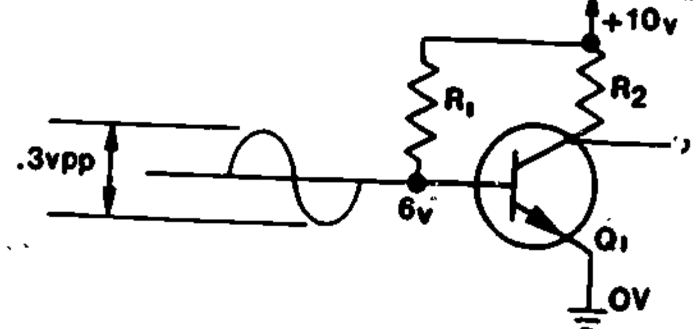
3. Which element has the most control over current flow in a three element transistor?

   a. Collector
   b. Base
   c. Emitter

4. What potential will be on the base of a transistor when the sine wave reaches its peak negative variation? ____________

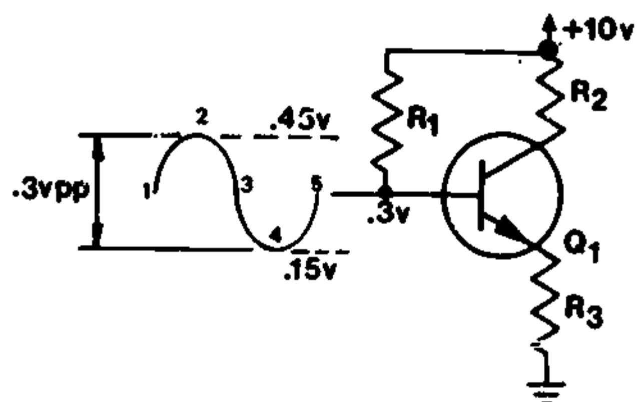


5. When a sine wave input to the base reaches its peak negative variation the NPN transistor's conductivity has ________ and the voltage across the transistor has ____________. (See the circuit illustrated below.)



a. Decreased, decreased
b. Increased, increased
c. Decreased, increased
d. Increased, decreased

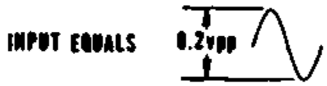
6. In the following illustration the sine wave is injected into the base of a NPN transistor. At time 4 the transistor's conduction is



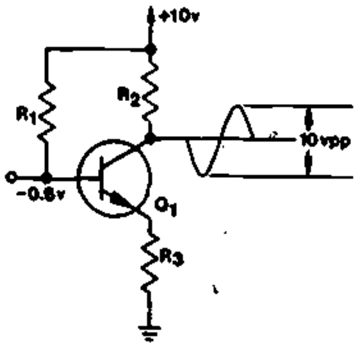
a. at maximum.
b. at minimum.
c. increasing.
d. decreasing.

56

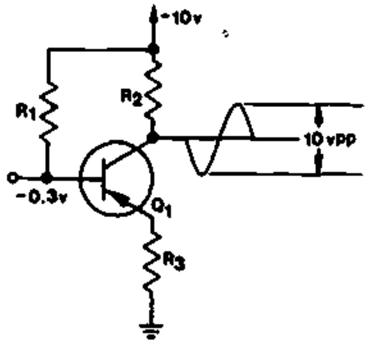
7. Which drawing illustrates correct bias and circuit operation with the input shown?



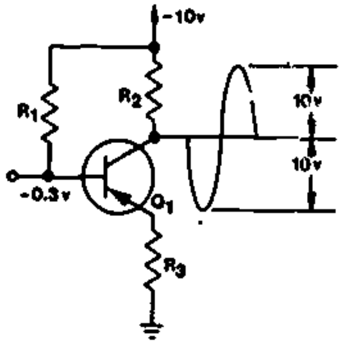
a.



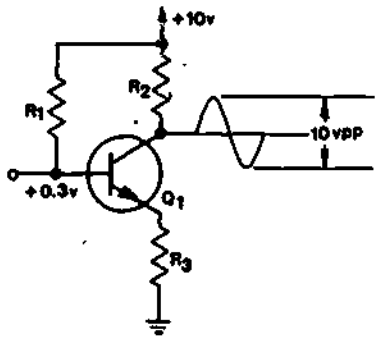
b.



c.



d.



8. Which of the following statements is most correct?

a. Stabilizing components are neither critical nor necessary to the operation of a transistorized circuit.
b. Stabilizing components are critical and necessary to the operation of a transistorized circuit.
c. Stabilizing components are necessary but not critical to the operation of a transistorized circuit.
d. Stabilizing components are not used in a critical transistorized circuit.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON III.

EXPERIMENT
LESSON III

Transistor Amplifier Functional Analysis

In this experiment you will see how temperature will affect the conduction of a transistor, calculate current gain using two multimeters, and observe bias with an oscilloscope.

Equipment Required

Device 6F16
Multimeter (2)
Oscilloscope
10X Probe
1X Probe

Procedure

Turn on your oscilloscope so it can warm up and stabilize while you proceed.

Open the 6F16 training device, being careful that the name plate is upright to insure that the components won't spill out. Disconnect the base from the component storage half. Select the following components, and place the storage section out of your way.

1 power cord

1 Template A

1 2N217 transistor

1 10ufd capacitor

4 shorting strips (sizes as required by template # A)

1 2 Kohm potentiometer

1 2.2 Kohm resistor

1 18 Kohm resistor

Adjust the oscilloscope for a line trace according to procedures posted in your carrel. Set Sweep Time to .5 millisec/cm.

Connect the 10X probe to channel "A" and calibrate it.

Lay template A Common Emitter Amplifier squarely on 6F16 training device and align the holes.

Install three of the plug-in shorting wires marked SS from the components box in locations marked "B", "C", and "G"; transistor 2N217 in space so marked; an 18 Kohm resistor in R2 position; and a 2.2Kohm resistor in RL position. Place a 2 Kohm potentiometer in the space so marked, and adjust it all the way clockwise.

Set one multimeter on each side of the 6F16 chassis. In order to see the entire circuit operation throughout your performance these meters will stay in place. The multimeter on your left will be used to monitor the transistor base current, and the other will be used to monitor the transistor collector current at the same time. Set up the multimeter to measure current. Set the range switch of the base current monitor to 1 ma and the collector current monitor to the 5 ma scale. (10 ma scale using the Simpson 260)

Plug the base current meter into position "A" on the template. The red meter lead will be closest to the transistor. Connect the collector current meter into position "D". The red lead again will be closest to the transistor.

Plug in and energize the 6F16 training device.

Position the line trace of the oscilloscope with the top horizontal mark. Set the AC/DC knob to measure DC; sensitivity at .02 volt/cm.

Connect the 10X probe to the shorting strip in position B, the base of the transistor.

Slowly rotate the 2 Kohm potentiometer counter-clockwise while watching the oscilloscope display.

1. In which direction did your line trace move? (+ or -)

2. Do you have collector current? (Yes/no)

3. Which type of transistor are you using? (NPN/PNP)

Adjust the 2 Kohm potentiometer to its maximum clockwise position. You should have no current reading on the multimeter monitoring base current.

Without adjusting either range switch on the multimeter, record the current readings in the spaces provided.

4. Base current reading ____________ ma.

5. Collector current reading ______________ ma.

Slowly turn the potentiometer counter-clockwise, while watching the collector current meter. Stop at the point where there is no further increase in collector current. Record your reading in the space provided.

6. Base current reading ____________ ma.

7. Collector current reading ______________ ma.

Using the difference between the first and second Base current reading the difference between the first and second collector current reading, calculate the current gain. Record in the space provided below.

$$\text{gain} = \frac{\text{2nd IC} - \text{1st IC}}{\text{2nd IB} - \text{1st IB}}$$

8. gain __________________

You have calculated gain for the circuit as it was designed to function. Next you will see what temperature will do to your equipment.

Adjust the 2 Kohm potentiometer for a small indication of collector current. With your index finger and thumb hold the transistor cap firmly. Watch the collector current monitor meter closely.

9. Did the meter reading increase or decrease? __________________.

The temperature from your body changed the conduction of this transistor.

Not all transistors are this sensitive, and there's not much difference between room temperature and your body temperature. If this circuit were designed for a certain amount of gain, you can see how temperature could cause it to fail. Therefore, transistor equipments are usually designed to operate within specific temperature ranges.

Turn the 2 Kohm potentiometer clockwise

Switch the AC/DC knob on the oscilloscope to AC, and realign your line trace with the top horizontal line on the face of the CRT. Switch the AC/DC knob back to DC. (Your line should be in the same position).

Rotate the 2 Kohm potentiometer fully counter-clockwise. Note the position of the line trace on the CRT. Adjust the 2 Kohm potentiometer for a line trace half way between the last position and the top horizontal line on the CRT (about -.1 volts). You have just set the bias of the transistor for conduction at the center of its range.

Move the 10X probe from position B on the template to the collector side of resistor RL. Change the oscilloscope sensitivity to .2 volt/cm.

Switch the AC/DC knob to AC, readjust the line trace position to the top horizontal line on the CRT. Switch the AC/DC knob back to DC. Record your voltage in the space provided.

10. Collector voltage __________ volts. Deenergize 6F16 training device.

Place the 10 µfd capacitor in the position indicated on the template; place the last shorting strip in position "F". Energize the 6F16 training device.

Connect the 1X probe to the Calibrator 1KHz output volts on the left side of the oscilloscope. Attach the other end to the left side of the 10 µfd capacitor. This is the same as the AC input.

Connect ground strap on probe to shorting strip "G".

Set the calibrator knob to .2 volts p-p.

11. Record your output signal in the space provided. __________ volts p-p.

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WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.

PROGRESS CHECK
LESSON III

Basic Transistor Amplifier Functional Analysis

1. In your own words state the function of an amplifier. ____________

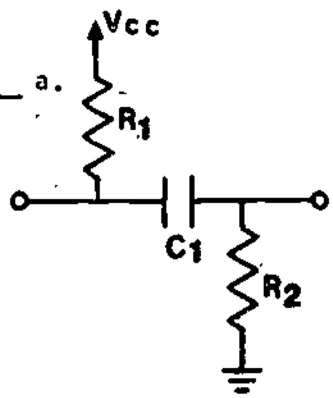
____

2. Match the proper function(s) to the sub-stage. (Some answers may require more than one letter.)

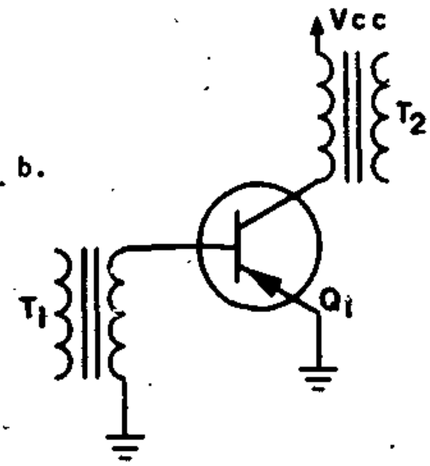
SUB-STAGE	FUNCTION
_____ 1. Input	a. Amplification
_____ 2. Conversion	b. Blocks DC between stages
_____ 3. Output	c. Couples signal

3. Label the two types of commonly used amplifier coupling circuits illustrated below.

_____ a.



_____ b.



4. Select the statement below that best describes the function of the conversion sub-stage of an amplifier.

a. Converts the DC input to an AC output.
b. Increases the strength of the signal input.
c. Supplies DC to the output stage.
d. Suppresses noise.

5. Which statement below best describes the principle of amplification in a transistor amplifier?

a. A small input signal controls a large current flow.
b. A small input signal increases the DC output of a transistor amplifier.
c. A large input signal controls a small current flow.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON IV.

EXPERIMENT
LESSON IV

Transistor Amplifier Circuits

In Lesson IV of the study booklet you were shown different amplifier configurations and what was expected from them with certain input signals. In this experiment you will see most of these circuits again. You will inject a signal into the amplifier and simultaneously measure both the input and the output signals with the oscilloscope. To do this, you must use the dual trace capabilities of the oscilloscope.

SAFETY PRECAUTIONS: Observe all standard safety precautions. There are some specific safety precautions for the NIDA 206 Amplifier. This unit has a +209 Volt DC Power Supply mounted on the chassis. This voltage may be applied to Pin 5 of the PC boards. Insure that the HIGH VOLTAGE switch is "off" unless otherwise directed. This switch removes the +209 Volts DC from the printed circuit card jack. Do Not Remove the bottom cover of the NIDA 206 chassis. The +209 DC supply is energized any time the unit is "on" regardless of the panel switch's position.

EQUIPMENT REQUIRED:

1. Oscilloscope
2. Signal Generator
3. Printed circuit cards: PC206-6 Common Emitter circuit
   PC206-7 Common Collector circuit
   PC206-8 Common Base circuit
4. 1X Probe (2)
5. BNC Cable
6. BNC To phone plug cable (1)
7. BNC TEE Connector
8. NIDA 206 Amplifier

REFERENCE MATERIAL:

NIDA 206 Instruction Manual

PROCEDURE:

1. Energize oscilloscope and signal generator.

2. Set up the signal generator for a 1 KHz audio output as follows:

   a. Set the MOD, XTAL & METER SELECTOR to 1000 hertz.

b. Connect one end of the BNC cable to the AUDIO OUT jack of the signal generator. Connect the other end to one side of the TEE connector.

NOTE: The only controls needed for a 1 KHz output from the signal generator are the METER SELECTOR and AUDIO OUT control. The output is taken from the AUDIO OUT jack. The position of the other frequency controls will not make any difference to the output at the AUDIO OUT jack.

3. Set up the oscilloscope for dual trace operation as follows:

   a. Connect the TEE connector to the EXTERNAL TRIGGER INPUT jack.

   b. Set the TRIGGER SOURCE to "external AC".

   c. Set the CHANNEL SELECTOR to "Channel A" and obtain a line trace. Using the "Channel A" controls set the line trace to the +1 cm line on the CRT. (+1 cm line is the first horizontal line above the center line.)

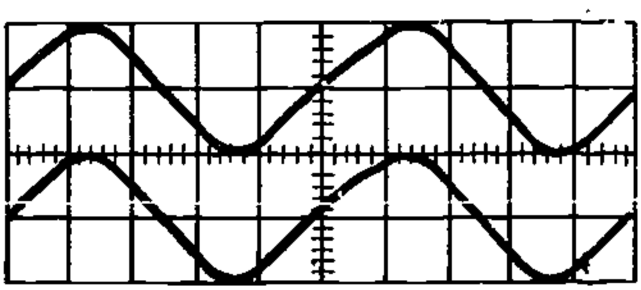
   d. Set the CHANNEL SELECTOR to "Channel B" and obtain a line trace. Using the "Channel B" controls set this line trace on the -1 cm horizontal line.

   e. Set the CHANNEL SELECTOR to "chopped". You are now set up for dual trace operation.

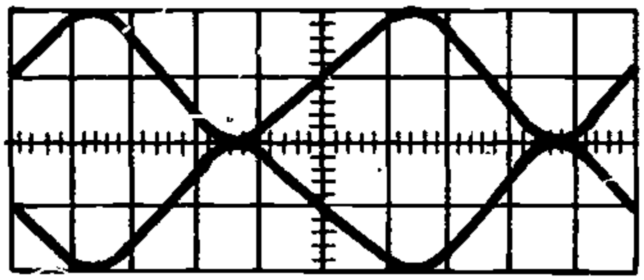
You should have two lines on the oscilloscope, one at +1 cm (channel "A" sweep) and one at -1 cm (channel "B" sweep). You may have to re-adjust the trigger controls to obtain the traces. For sensitivity and position, the Channel "A" controls will control the upper sweep and the Channel "B" controls will control the lower sweep.

When you check for phase relationships between inputs and outputs of the amplifiers you will see traces similar to the ones below.

INPUT AND OUTPUT - IN PHASE



INPUT AND OUTPUT - 180° OUT OF PHASE



4. Loosen the knurled screw on the rear of the Amplifier chassis that holds the top cover. Remove the top cover by sliding the cover to the rear of the unit. Do not remove the bottom cover.

5. Insure the HIGH VOLTAGE SWITCH on the NIDA 206 Amplifier is "off."

6. Turn the SPEAKER SWITCH located on the upper right corner of the Amplifier front panel to "off."

7. You will be working with three different amplifier circuit configfurations in this experiment. Refer to the schematics in the back of the NIDA 206 Technical Manual, and complete the following statements.

a. PC206-6 is a common __________ amplifier. This amplifier (will/will not) invert the input signal.

b. PC206-7 is a common __________ amplifier. This amplifier (will/will not) invert the input signal.

c. PC206-8 is a common __________ amplifier. This amplifier (will/will not) invert the input signal.

NOTE: Perform the following steps as appropriate for one amplifier card at a time.

When you complete the experiment for PC 206-6, return to step 5 and repeat the procedure for PC206-7 and PC206-8.

8. Plug the printed circuit board PC206-6 into the Amplifier at J2 and J3. Insure the pin numbers for J2 and J3 match up with the jack numbers on the PC board.

9. Using the BNC to phone plug cable, connect the BNC end to the TEE connector at the oscilloscope external trigger input. Connect the phone plug to the input jack on the front panel of the amplifier chassis.

10. Using a 1X probe, connect channel "A" of the oscilloscope to pin #3 of the PC Board.

11. Using the other 1X probe, connect channel "B" of the oscilloscope to pin #7 of the PC Board.

12. Plug in and energize the NIDA 206 Amplifier.

13. Set potentiometer R17 on the Amplifier chassis (located to the left of the PC Board) as follows:

   a. PC206-6; R17 fully counter clockwise, then 1/4 turn clockwise.
   b. PC206-7; R17 fully counter clockwise.
   c. PC206-8; Position does not matter.

14. Set the "AUDIO OUT" control on the signal generator for .2V peak-to-peak at the amplifier input (measured on channel "A").

15. PC206-6 ONLY - Check the signal at the amplifier output (Channel "B"). If the sine wave is flattened at the top, turn R17 slightly counterclockwise until a "clean" sine wave is obtained. If flattened at the bottom, turn R17 clockwise. If the sine wave is flattened at both top and bottom reduce the signal input to the amplifier from the signal generator - you are overdriving it.

16. Calculate the voltage gain/loss ratio and the phase relationship of input and output for the amplifier and record below.

	PC206-6	PC206-7	PC206-8
a. Gain/Loss	(gain/loss)	(gain/loss)	(gain/loss)
b. Phase Inversion	(yes/no)	(yes/no)	(yes/no)
c. Ratio			

17. Deenergize the NIDA 206 Amplifier. Go back to step 5 and repeat the procedure using PC206-7 and PC206-8.

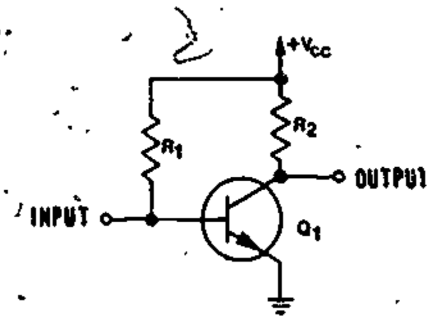
CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.

PROGRESS CHECK
LESSON IV

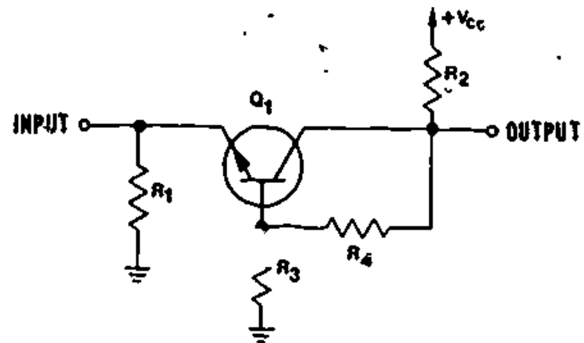
Basic Transistor Amplifier Configurations

1. Identify by labeling the circuits illustrated below:

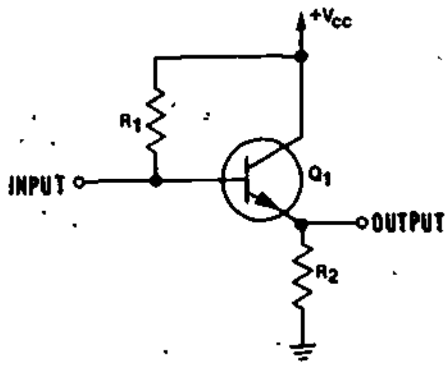
A.



B.



C.



2. Match the amplifier configuration to the amplifier function. (Some answers may require more than one letter.)

FUNCTION	CONFIGURATION
1. Provides phase inversion	a. CB
2. Used as impedance matching device	b. CE
3. Most commonly used configuration	c. CC

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON V.

AUDIO-VISUAL RESPONSE SHEET
LESSON V

BASIC TRANSISTOR AMPLIFIER CIRCUIT ANALYSIS

1. A B C (Circle One)
2. A B C D E F (Circle One)
3. A B C D E F (Circle One)
4. A B C D E F (Circle One)
5. A B C D E F (Circle One)

EXPERIMENT
LESSON V
PART 1

Transistor Amplifier Analysis

In lesson V you learned that a transistor can be biased so it will not conduct (cut off), and it can be biased to full conduction (saturation). You also learned that a transistor could be biased so any portion of the input signal could be amplified. The two classes of operation were class A, where the full input signal is amplified, and class B, where only half of the input signal would be amplified. In this experiment you will see and measure these conditions using an oscilloscope.

Equipment Required

Device 6F16 templates A and B

Oscilloscope

Signal Generator

1X Probes (3)

BNC-BNC cable

BNC Tee connector

Grounding straps (2)

Procedure

Turn on the signal generator and oscilloscope so they can warm up.

Open 6F16 training device carefully, ensuring the name plate is on top so the components will not fall out. Separate the top of the 6F16 from the compo ent compartment.

Place template A on the top portion aligning the holes. Place the following components in the space designated.

Component	Space Marking
2N217 transistor	2N217
2.2 Kohm resistor	RL
27 K ohm resistor	"D"
100 K ohm resistor	"A"
18 K ohm resistor	"B"
10 K Ohm potentiometer	pot
10 µfd capacitor	C1
1 inch shorting wire	C
1 inch shorting wire	F
1 inch shorting wire	G
1 inch shorting wire	R2

70

Adjust the 10 Kohm potentiometer fully clockwise.

Obtain a line trace on the oscilloscope according to standard procedures. Use Channel A only.

Set up the signal generator according to standard procedures for a 1000 Hz, 5% MODULATION LEVEL, audio signal.

Connect the BNC Tee to the TRIGGER SOURCE input on the lower right corner of the oscilloscope. Connect a BNC-BNC cable from the signal generator AUDIO OUT to one side of the BNC Tee. Connect a 1X probe to the other side. This probe will be used to supply a signal to the training device. The audio signal will also trigger the sweep across CRT so that it will be synchronized with the start of the signal on the training device. All this means you will have a true picture of your signal with respect to time.

Set the TRIGGER SOURCE knob to external AC and adjust the TRIGGER LEVEL for a line trace.

Connect a 1X probe to channel A of the oscilloscope, set the SENSITIVITY knob to 1 Volt/cm, and SWEEP TIME to 1 millisec/cm.

Connect the two probes together and adjust signal generator % OF MODULATION for a 1 volt p-p sinewave. Disconnect the probes.

Set the SENSITIVITY knob for 2 volts/cm, Channel A AC/DC knob to DC, and align the trace with the top vertical line on the face of the CRT.

Connect Channel A's probe to the transistor side of the load resistor RL, and its ground wire to position "G".

1. Energize the 6F16 and record the voltage. ________Volts.

2. Is this an indication of cut off or saturation? __________.

Set the SENSITIVITY knob for .1 volts/cm and measure the bias voltage on the base of the transistor.

3. Record voltage reading. ____________ volts

The transistor used is PNP, but the negative voltage on the base isn't large enough to forward bias the transistor. Therefore, the transistor is held at cut off. With no current flowing through the transistor there will be no voltage drop across the collector resistor. Source voltage will be present on the collector of the transistor.

Turn the potentiometer fully counter-clockwise to its stop.

4. Measure the base bias voltage and record. ___________.

5. Measure collector voltage and record. ___________.

6. Is this an indication of cut off or saturation. __________.

You have seen that a small voltage increase on the base caused the transistor to go into saturation. The small voltage on the collector is the voltage drop across the transistor.

Adjust the potentiometer shunt midway between its two stops.

Connect the audio signal to the template's AC input.

Set the oscilloscope sensitivity knob for 2 volts/cm and the AC/DC knob to AC.

Readjust the potentiometer for a good sinewave on the face of the CRT. Previously you turned the potentiometer clockwise to cut off the transistor, and counter-clockwise to saturate it. Now slowly turn the potentiometer clockwise and observe the waveform on the CRT. The negative peaks will flatten out. The more you turn the potentiometer the more the bias is lowered so that the positive peaks of the input signal cut the transistor off.

Turn the potentiometer back (counterclockwise) until the full sinewave appears on the CRT. Continue turning the potentiometer counter-clockwise slowly.

7. In your own words explain what you see on the CRT and why?

____

____

____

Readjust the potentiometer for a full sinewave on Channel "A".

Circuits are designed for a specific class of operation. In lesson V you learned about two classes, A & B. A circuit designed for class A operation will have a bias on the transistor that will allow all ... input signal to be amplified.

Connect your third 1X probe to Channel "B" input. Set the CHANNEL SELECT knob to its chopped position, and position the second line trace below the amplified sinewave; increase the Channel "B" SENSITIVITY to allow both signals to be seen. Set the channel "B" AC/DC knob to DC. Attach a 1X probe to the base side of the 100K ohm resistor in position "A". Adjust the SENSITIVITY knob so channel "B's" sinewave will be about the same height as Channel "A's." You have the input sinewave on Channel "B," and the amplified output sinewave on Channel "A". Notice that the two signals are out of phase with each other. Remember, common emitter amplifiers give phase inversion. The amplifier circuit is now set up for Class A operation. The full input sinewave is being amplified.

Turn the potentiometer back and forth a couple of times. Channel "B" (the input sinewave) increases and decreases, and the output signal goes into saturation and cut off. The input signal increases and decreases because the oscilloscope is monitoring the DC level (bias) on the base of the transistor as well as the AC signal. Turning the potentiometer clockwise increased the DC level and the input signal amplitude drove the transistor into cut off during the positive portion. Turning the potentiometer counter-clockwise, decreased the DC level and the input signal drove the transistor into saturation during the negative position.

8. Class A amplifiers allow (all/part/none) of the input signal to be amplified.

For class B operation of this same circuit all that is needed is to adjust the base bias with the potentiometer so only half of the input sinewave will be amplified. Adjust the potentiometer to display only the negative half of the output signal.

9. Class B operation allows 90°/180°/270°/360° of the input signal to be amplified. Deenergize the 6F16 training device.

In the next part of the experiment we will look at the complementary symmetry circuit. Remove the components from the Common Emitter Amplifier circuit and place them in their proper places in the component half of the 6F16. Exchange template A for B, Forward Biased Complementary Symmetry Amplifier. Build the circuit by placing components in the spaces as marked. Place a 100K ohm resistor in the position marked Rin. Set shorting wires in positions A, B, C, and G. All positions should be filled.

Connect the channel A probe to the emitter side of RL with its ground wire to position "G".

Adjust the signal generator AUDIO OUT modulation to 30%, and connect the generator probe to the input side of Rin.

Connect the channel B oscilloscope probe to the input side of capacitor C1. Energize 6F16 template B: Forward Biased Complementary Symmetry.

The sine waves should be in phase. There is no phase inversion with a common collector circuit, and a complementary symmetry amplifier uses two common collector circuits. The first is Q1, with its collector tied to -4v, the emitter lead to ground through load resistor RL, and the input signal applied to the base. The second common collector is Q2, with its collector connected back through position "C" to +4 volts, emitter lead to ground through load resistor RL, and the input signal applied to its base. The output of both circuits is developed across load resistor RL. Each circuit works only part of the time. Q1 is a PNP transistor; therefore, the negative half of the input signal will cause it to conduct, where Q2 is a NPN type and only the positive portion causes it to conduct. The complete sinewave developed across RL is displayed on Channel "A".

Secure the power to the transistor circuit when removing or replacing transistors. Sudden surges of current through the transistor could destroy it if you don't. Remove Q-1. Reenergize 6F16 training device.

10. Which portion of the sinewave is missing? ______________.

Deenergize 6F16 training device. Replace Q-1.

Remove Q2. Reenergize 6F16 training device.

11. Which portion of the sinewave is missing? __________________.

Each transistor conducts half of the time.

12. What class of operation is their bias? __________________.

If you have noticed, the output signal looks the same amplitude as the input signal. Remember, with the oscilloscope you are looking at voltage. The Complementary Symmetry amplifier is used in place of a push-pull amplifier to give us greater power. Speakers or headsets can be attached directly to the emitters saving the cost of transformers required for a push-pull amplifier.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO PART 2 OF THIS EXPERIMENT. THIS COMPLETES PART 1 OF THIS EXPERIMENT. DO NOT SECURE YOUR TEST EQUIPMENT. SECURE THE 6F16 TRAINING DEVICE, AND RETURN IT TO THE CABINET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

EXPERIMENT
LESSON V
Part 2

Transistor Amplifier Analysis

This experiment will cover phase splitters and push-pull amplifiers. You will be using the NIDA 202 Amplifier. The NIDA 202 Amplifier is similar to the NIDA 206 Amplifier, but it does not have a bias supply or a high voltage supply.

SAFETY PRECAUTIONS:

Observe all standard safety precautions.

EQUIPMENT REQUIRED:

Oscilloscope
Signal generator
NIDA 202 Amplifier
1X Probe (3)
BNC - BNC cable
BNC Tee Connector

1. Set up the oscilloscope for dual trace operation. Connect the signal generator audio output to the EXTERNAL TRIGGER INPUT of the oscilloscope using the BNC cable and BNC "TEE" connector. Connect the three 1X probes to the CHANNEL "A" INPUT, CHANNEL "B" INPUT and the "TEE" connector

2. Set up the NIDA 202 Amplifier as follows:
    1. Remove the top cover and insure that there is no Printed Circuit Card installed.
    2. Remove the bottom cover.
    3. Turn the SPEAKER SWITCH to "off".
    4. Turn the Amplifier over so the bottom is accessible.

3. The schematic for the NIDA 202 chassis and the printed circuit board PC 202 may be found in the NIDA 202 Technical Manual. Using the schematic as a reference, locate the power supply input circuit components. With the NIDA 202 Amplifier plugged in, there is 115 Volts AC on these components, so remember where these components are, and stay away from them. The Voltage is dangerous. Locate CR6 and C2 on the schematic. These components and all the components to the left of CR6 and C2 are associated with the power supply. Locate the power supply area of the PC board. You will not be required to work on the Power Supply now, so, keep clear of these components.

Refer to the Schematic Drawing and complete the following statements.

4. Q2 and its associated circuitry comprise a/an

   a. common base amplifier.
   b. phase splitter.
   c. common emitter amplifier.
   d. emitter follower amplifier.

5. Transformer T2 is used as a/an

   a. power transformer.
   b. phase splitter.
   c. output transformer.

6. Q3, Q4, and their associated circuitry comprise a

   a. complementary-symmetry amplifier.
   b. cascaded amplifier,
   c. phase splitter.
   d. push-pull amplifier.

7. Transformer T3 is used as a/an

   a. power transformer.
   b. phase splitter.
   c. output transformer.
   d. input transformer.

The push-pull amplifier in the NIDA 202 is biased slightly above cutoff with no signal applied. This is done because transistors often have non-linear gain at low signal voltages. Steps 9d and 10a in this experiment show the wave forms for the circuit biased slightly above cutoff (+0.6V) by the voltage drop across CR7 (Step 9d) and the circuit biased at cutoff (Step 10a).

8. Connect the 1:1 probe from the External Trigger Input on the Oscilloscope to the right side of R-3 and energize NIDA 202 Amplifier. Set Signal Generator for a 1KHz Audio Out and set modulation level to 2.3 v p-p as measured at the right side of R-3 on the Oscilloscope with the channel "A" probe. NOTE: Turn the volume control on the front panel fully clockwise (CW), then 1/4 turn counter clockwise (CCW).

9. Energize the NIDA 202, measure waveforms, and answer the following questions:

a. What is the gain of Q2? Connect the channel "A" probe to the left side of R5, and the channel "B" probe to the right side of "R5".
b. What is the p-p voltage and phase relationship between the base signals for Q3 and Q4? ____________V p-p ________phase.

c. What is the p-p voltage and phase relationship between the collector signals of Q3 and Q4? ___________V p-p ________phase.

d. What is the p-p output voltage of the push-pull amplifier? ________________V p-p

10a. Deenergize and unplug the NIDA 202. Use a jumper to short out CR7. Move the input probe (from the signal generator) to the left side of R3 and set the signal generator output for 0.02 v p-p. (Measure on the oscilloscope). Reenergize the NIDA 202 and check the output. Do you now have a "clean" sine wave? ________

10b. What is happening to the conduction times of Q3 and Q4?

a. When Q3 conducts, Q4 conducts.
b. When Q3 cuts off, Q4 conducts.
c. When Q3 cuts off, Q4 does not start conducting immediately.
d. When Q3 conducts, Q4 does not cut off at the same time.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.

PROGRESS CHECK
LESSON V

Basic Transistor Amplifier Circuit Analysis

1. When a transistor is at cutoff the

   a. transistor acts as a short circuit.
   b. output load acts as an open circuit.
   c. transistor acts as an open circuit.
   d. output load acts as a short circuit.

2. If the voltage across a transistor is about equal to Vcc, the transistor is ________________.

3. If the voltage across its collector resistor is about equal to Vcc, a transistor is ________________.

4. Which of the below conditions exists in a Class A Amplifier?

   a. Current flows through the transistor at all times.
   b. Current flows through the transistor only when a signal is applied.
   c. Current bypasses the transistor when a signal is applied.
   d. Current never flows through the transistor.

5. Which of the below conditions exists in a Class B amplifier?

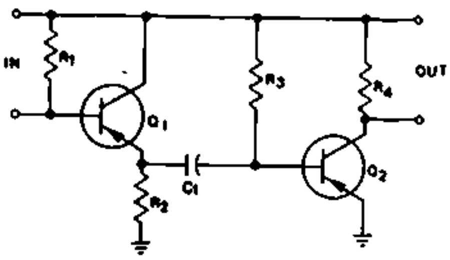
   a. Current flows through the transistor at all times.
   b. Current flows through the transistor only when a proper signal is applied.
   c. Current bypasses the transistor when a signal is applied.
   d. Current never flows through the transistor.

6. A Push-pull amplifier provides

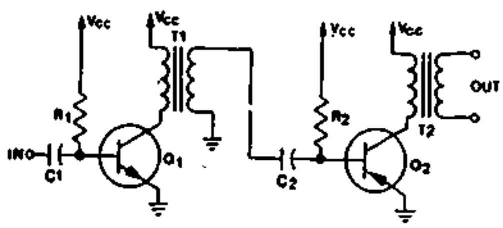
   a. high voltage gain.
   b. high output power.
   c. large DC voltage.
   d. current regulation.

7. Which of the schematics illustrated below represents a Push-pull amplifier?

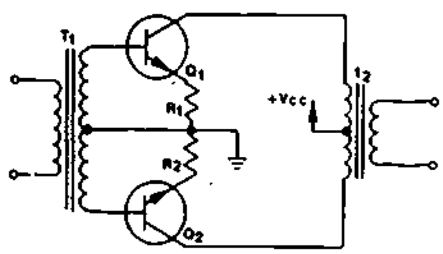
a.



b.



c.



8. The function of a phase-splitter circuit is to

a. provide two equal signals 180° out of phase.
b. provide two equal, in-phase signals.
c. increase the frequency of the input signal.
d. increase the frequency of the output signal.

9. Which of the devices illustrated below could function as a phase-splitter?

a.

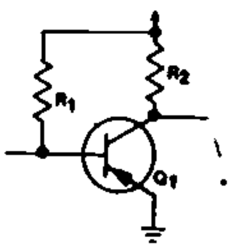
b.

c.

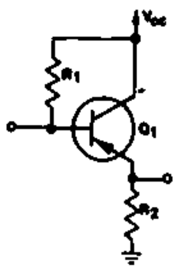
d.

10. Which of the circuits illustrated below could function as a phase-splitter?

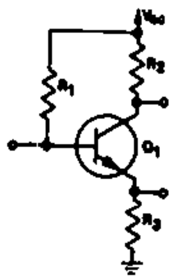
a.



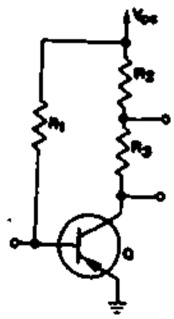
b.



c.



d.

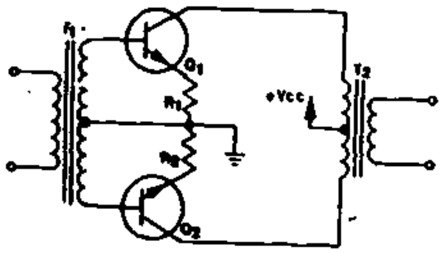


11. A complementary symmetry push-pull amplifier is a push-pull amplifier that uses

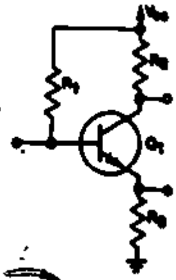
a. two PNP transistors.
b. an NPN or a PNP transistor.
c. an NPN and a PNP transistor.
d. two NPN transistors.

12. Which of the circuits illustrated below represents a complementary symmetry Push-pull amplifier?

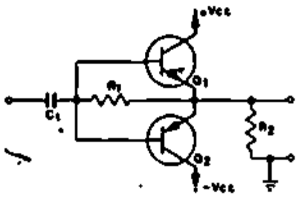
a.



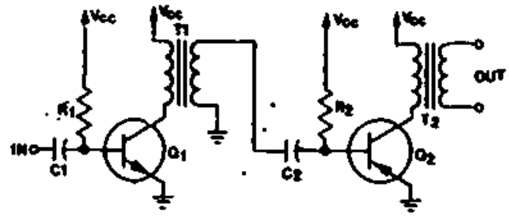
b.



c.



d.



CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, YOU HAVE COMPLETED THIS MODULE. IF YOU FEEL THAT YOUR PROGRESS CHECK RESULTS INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE TESTS, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE END OF MODULE TESTS, YOU MAY REVIEW ANY PART OF THIS MODULE.

82

MODULE TWENTY ONE-T

MULTI-ELEMENT VACUUM TUBES

PROGRESS CHECK BOOKLET

AV RESPONSE SHEET
LESSON I

Multi Element Vacuum Tubes

1. a. b. c. d. (CIRCLE ONE)

2. a. b. c. d. (CIRCLE ONE)

3. a. b. c. (CIRCLE ONE)

4. a. b. c. d. (CIRCLE ONE)

5. a. ____________

   b. ____________

   c. ____________

   d. ____________

6. a. b. c. d. (CIRCLE ONE)

7. a. ____________

   b. ____________

   c. ____________

   d. ____________

   e. ____________

8. a. b. c. d. (CIRCLE ONE)

9. a. b. c. d. (CIRCLE ONE)

PROGRESS CHECK
LESSON 1

Multi Element Vacuum Tubes

1. A triode vacuum tube consists essentially of a diode with a/an _____________ _____________ added.

2. Electron flow through the triode is controlled by varying the voltage on the

   a. plate

   b. control grid

   c. cathode

   d. filament

3. Current flow in a triode vacuum tube will be the same as current flow in a/an _______________ type transistor.

4. Cutoff will occur in a triode vacuum tube when the control grid becomes (negative/positive) enough.

5. Which of the following statements is most correct?

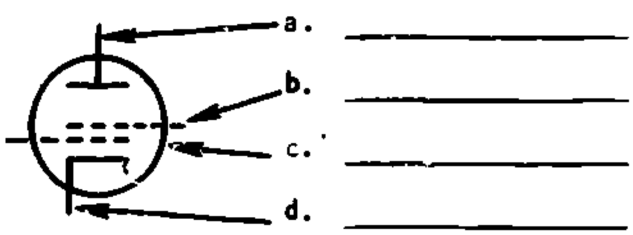
   a. When the control grid potential is negative enough it causes saturation.

   b. When the control grid potential is positive enough it causes saturation.

   c. The cathode is closer to the plate than is the control grid.

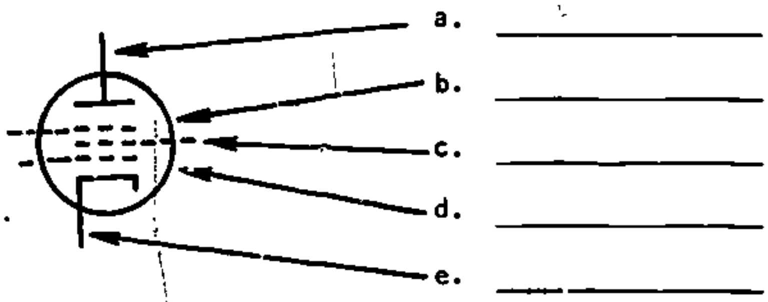
   d. The control grid in a triode is the only element controlling plate current.

6. Label the elements of the vacuum tube schematic symbol below.



7. The (plate/screen grid) voltage has the most effect on plate current.

8. Label the elements of the vacuum tube schematic symbol below:



9. What advantage does a pentode have over a tetrode or a triode?

   a. Linear current increase, decreased plate voltage, extended frequency range.
   b. Limited frequency range, greater available gain, increased plate voltage.
   c. Linear current increase, extended frequency range, greater available gain.
   d. Lower power requirt.ments, linear current increases, extended frequency range.

10. The primary difference between power tubes and reg lar multi-element tubes is

   a. that they require larger power supplies.

   b. the size of the tube elements.

   c. the size of the tube.

   d. their schematic symbols.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON II.

EXPERIMENT
TWENTY ONE-T
LESSON II
PART 1

Vacuum Tube Circuit Configurations

This experiment will familiarize you with some of the basic vacuum tube circuits and point out the tube circuit similarities to transistor circuits.

SAFETY PRECAUTIONS: Observe all standard safety precautions. The NIDA 206 Amplifier has a High Voltage Power Supply located under the bottom cover. Do NOT remove the bottom cover. There is a switch on the chassis that controls High Voltage to the PC Board Plugs.

This experiment will require you to apply high voltage to the PC Board. Never remove the PC Board unless the NIDA 206 Amplifier is deenergized. With the Amplifier energized, approximately +200 VDC is applied to the PC Board in use.

EQUIPMENT REQUIRED:

- NIDA 206 Amplifier
- PC 206-1 Printed Circuit card
- PC 206-2 Printed Circuit card
- PC 206-3 Printed Circuit card
- PC 206-4 Printed Circuit card
- Vacuum Tubes Types 6C4 and 6AU6 (1 each)
- Oscilloscope
- Signal Generator
- 10X probe (1)
- 1X probe (1)
- BNC to BNC Cable (1)
- BNC to Phone Jack Cable (1)
- BNC "TEE" Connector

PROCEDURE:

1. Energize and set up the signal generator for a 1 KHz output. Energize and set up the oscilloscope for dual trace operation triggered externally by the signal generator. Obtain two line traces. Connect the 1X probe to Channel "A". Connect the 10X probe to Channel "B" and calibrate it.
2. Remove only the top cover from the NIDA 206 Amplifier.

Note: Perform steps 3 through 7 for PC 206-1. When you have completed step 7, repeat steps 3 through 7 for PC-206-2, then go through the procedure again with PC 206-3. Refer to the NIDA 206 Instruction Manual for schematic drawings.

3. Install a 6C4 tube in the tube socket on PC Card PC 206-1 (PC206-2, PC206-3). Install this PC card in the NIDA 206 Amplifier. Turn the High Voltage on.
Caution: When the NIDA 206 Amplifier is energized, there will be +200 VDC at pin (5) of the PC Board and various components on the board. Use extreme caution around these points!

4. Using the BNC to Phone Plug Cable, connect the 1 KHz signal generator output to the INPUT jack on the front panel of the Amplifier. Connect the channel "A" probe to the PC board input and the channel "B" probe to the PC board output. Channel "A" 1X probe inserted Channel "B" 10X probe inserted.

5. Plug in and energize the Amplifier. Allow approximately 1 minute for tube warmup before proceeding.

6. Potentiometer R17, located on the chassis to the left of the PC Board, is the bias voltage control. Using R17 and the AUDIO OUT adjustment on the Signal Generator, adjust for maximum undistorted output from the PC board.

7. Answer the following questions:

a. What is the gain of this amplifer?

PC 206-1 ______________________
PC 206-2 ______________________
PC 206-3 ______________________
The tube used may not provide the gain that would be expected from some circuits

b. Does this amplifier invert the signal?

PC 206-1 ______________________
PC 206-2 ______________________
PC 206-3 ______________________

c. What is the transistor circuit equivalent to this circuit?

PC 206-1 common ______________________
PC 206-2 common ______________________
PC 206-3 common ______________________

When you have completed step #7 for one board, deenergize the amplifier, remove the tube and the PC Board. Go back to Step #3 and repeat the procedure using the remaining board(s). When you have completed the preceding steps for all three PC boards, proceed with the rest of the experiment.

8. Insure the amplifier is deenergized. Insert a 6AU6A tube in the tube socket on PC Card PC 206-4. Remove the PC Card in the amplifier and install PC 206-4".

9. Insert the phone plug into the INPUT jack on the Amplifier and connect the oscilloscope Channel "A" and "B" probes to the input and output of the board.

10. Refer to the schematic and complete the following statements:

a. The 6AU6A tube is a

(1) triode.
(2) tetrode.
(3) diode.
(4) pentode.

b. PC 206-4 is a grounded ______________ type amplifier.

(1) control grid
(2) plate
(3) cathode
(4) screen grid

c. The input is applied to the __________________________ grid.

(1) screen
(2) control
(3) ..ressor

d. The __________________ grid is grounded; the __________ grid is at a high D.C. Voltage.

(1) screen
(2) control
(3) supressor

11. Energize the amplifier and adjust the grid bias (R17) and the input signal (from the signal generator) for maximum undistorted output.

12. What is the gain of the amplifier? ______________________.
The output is (in phase/180° out of phase) in respect to the input.

13. Disconnect the signal input to the amplifier. Using the 10X Probe, measure and record the following DC voltages:

a. B+ ________________________ VDC
b. Screen grid _________________ VDC
c. Cathode ____________________ VDC
d. Control grid ________________ VDC
e. Supressor grid ______________ VDC
f. Plate ______________________ VDC

14. The tube is (conducting/cut-off).

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO EXP. TWENTY ONE T-II-2.

EXPERIMENT
LESSON II
Part 2

Operation of the TV-7D/U or TV-10D/U Tube Tester

This experiment will familiarize you with the operation of the tube tester and allow you to practice testing tubes with the equipment.

SAFETY PRECAUTIONS:

Beware of getting burned by hot tubes! The filaments of the tube sometimes cause the glass envelopes to become extremely hot after test. Care should be taken in removing the tube from the tester.

EQUIPMENT REQUIRED:

1. TV-7D/U or TV-10D/U Tube Tester with instruction manual.
2. Box of practice tubes.

PROCEDURE:

1. The operation of this tube tester is described in the following places.

   a. Audio Visual presentation 21 T-III.
   b. Instruction Manual located in the cover of the tube tester.

2. Familiarize yourself with the operation and location of the switches of the tube tester by using either one or both of the sources of information listed above.

3. Test the 5687 tube (if you have already tested this tube in the AV package, go on to step 4.)

4. Test the remainder of the tubes in the box. Use the answer sheet below. DO NOT PROCEED WITH REST OF THE CHECKS IF A SHORTED CONDITION EXISTS.

ENSURE THAT YOU TEST EACH TUBE FOR SHORTS BEFORE CHECKING EMISSION.

TUBE TYPE	SHORT	EMISSION	GAS	
5687				good/bad
				good/bad
				good/bad
				good/bad
				good/bad
				good/bad

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED ON THE SHEET INCLUDED WITH THE BOX OF TUBES. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.

PROGRESS CHECK
LESSON II

Vacuum Tube Circuit Configurations

1. A grounded-cathode tube configuration can be compared to a/an ____________ ____________________ transistor configuration.

2. Input signals to tube circuits are usually (smaller/larger) than the input signals to transistorized circuits.

3. The grounded-cathode configuration has

   a. good voltage gain and poor power gain.

   b. poor voltage gain and poor power gain.

   c. poor voltage gain and good power gain.

   d. good voltage gain and good power gain.

4. The grounded-grid tube configuration is comparable to the ____________ __________________ transistor configuration.

5. A grounded-grid circuit has a (smaller/larger) voltage gain than the grounded-cathode amplifier.

6. The cathode follower configuration is comparable to the ______________ transistor configuration.

7. Push-pull circuits are used as

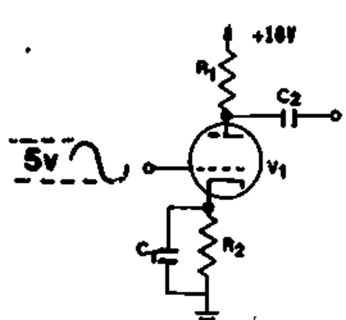
   a. power amplifiers.

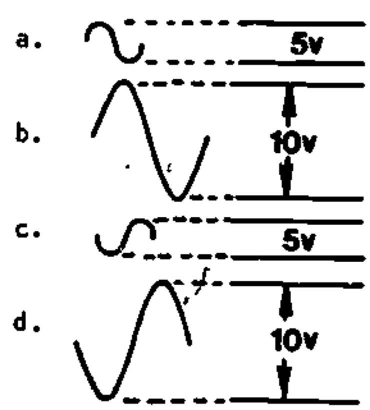
   b. impedence amplifiers.

   c. input amplifiers.

   d. voltage regulators.

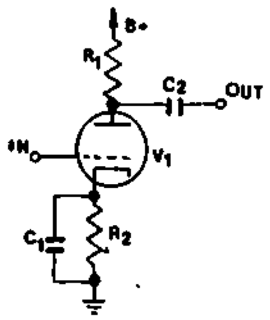
8. Which of the output signals shown below would you expect from a grounded-cathode circuit?



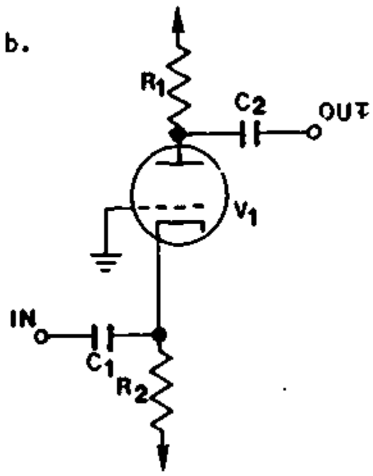


9. Label the types of tube configurations illustrated below:

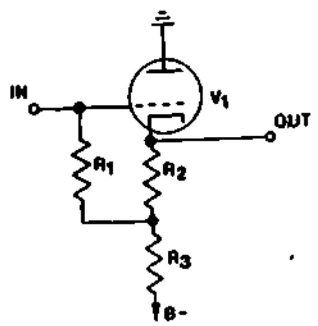
a.



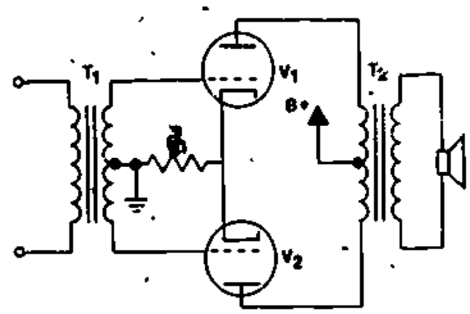
b.



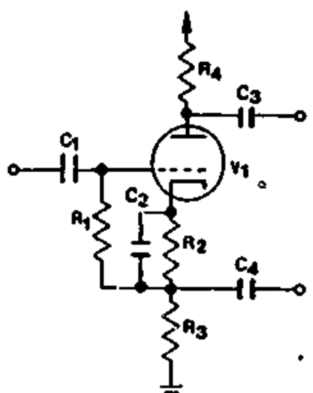
c.



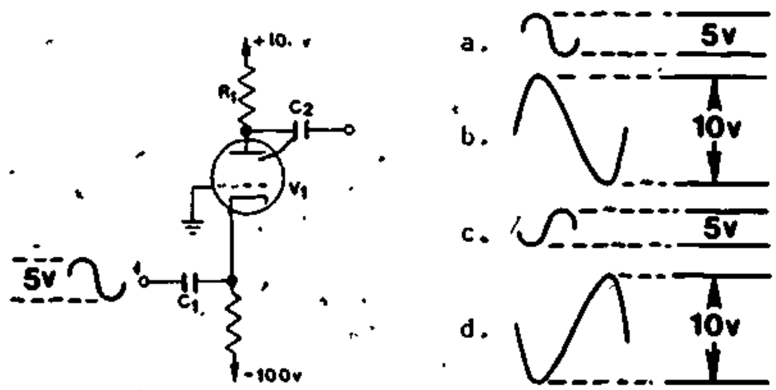
d.



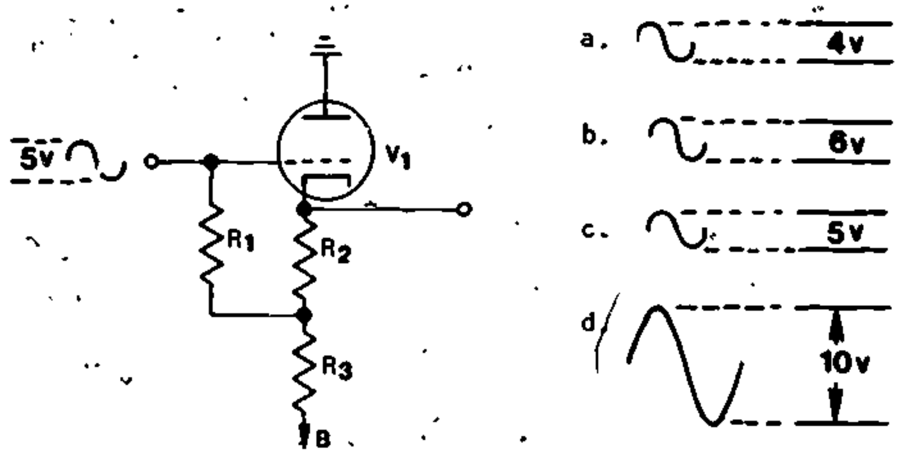
e.



10. Which of the output signals illustrated below would you expect to see from a grounded-grid amplifier?



11. Which of the output signals illustrated below would you expect from a cathode-follower?



CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR ANSWERS AGREE WITH THE ANSWERS, PROCEED TO THE MODULE TEST. YOU HAVE NOW COMPLETED THIS MODULE. IF YOU FEEL THAT YOUR PROGRESS CHECK RESULTS INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE TESTS, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE END OF MODULE TESTS, YOU MAY REVIEW ANY PART OF THIS MODULE.

MODULE TWENTY TWO

OSCILLATORS

PROGRESS CHECKS

AUDIO-VISUAL RESPONSE SHEET
LESSON I

Functional Analysis of Basic Oscillators

ANSWER ALL QUESTIONS FOR THIS STATIC/MOTION PROGRAM ON THIS RESPONSE SHEET.

1. What does an oscillator circuit do?

   a. Change the AC input into a DC output.
   b. Produce a given frequency at constant amplitude.
   c. Changes the DC input into a higher amplitude D. C.
   d. Acts the same as a power supply.

2. Name three essential circuits of a basic oscillator.

   a. ______________________________

   b. ______________________________

   c. ______________________________

3. Why is the tank called the heart of the oscillator?

   a. The tank converts AC to DC.
   b. The tank establishes the output waveform.
   c. The tank establishes the frequency of the oscillator.
   d. The tank determines the frequency of the input.

4. What is the function of the amplifier in the oscillator?

   a. The amplifier decreases the tank's output to prevent waveform distortion and provides energy for the feedback circuit.
   b. The amplifier increases the tank's output to a level sufficient for equipment operation and prevents energy from entering the feedback circuit.
   c. The amplifier decreases the tank's output to prevent waveform distortion and also prevents energy from entering the feedback circuit.
   d. The amplifier increases the tank's output to a level sufficient for equipment operation and provides energy for the feedback circuit.

5. What is the function of the feedback circuit?

   a. The feedback circuit maintains oscillations in the tank.
   b. The feedback circuit provides a means for changing the oscillator's frequency.
   c. The feedback circuit amplifies the oscillator output.
   d. The feedback circuit feeds the oscillator output to the power supply.

PROGRESS CHECK
LESSON I

Functional Analysis -- Basic Oscillators

1. The function of a basic oscillator circuit is to

   a. convert AC to DC.

   b. convert DC to a desired AC frequency.

   c. supply the Audio Amplifier with the proper DC voltage levels.

   d. filter the DC variations from the power supply.

2. The tank circuit establishes the __________ of the basic oscillator circuit.

   a. voltage

   b. current

   c. frequency

   d. power

3. State the two functions of the amplifier in a basic oscillator circuit:

   a. ____

   b. ____

4. The feedback loop in a basic oscillator circuit will:

   a. sustain oscillations.

   b. feed energy back to the power supply.

   c. provide proper bias.

   d. establish oscillator frequency.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON II.

AUDIO-VISUAL RESPONSE SHEET
LESSON II

Parallel Resonant Circuits

ANSWER ALL QUESTIONS ON STATIC/MOTION PROGRAM TWENTY TWO-II ON THIS RESPONSE SHEET.

1. Select the most correct definition of the flywheel effect.

   a. The reduced amplitude of the oscillations due to internal losses in the tank.
   b. The transfer of energy between the capacitor and inductor at resonance.
   c. The ratio of inductance to capacitance.
   d. The actions of a tank circuit with an AC input.

2. What causes damped oscillations?

   a. Changing frequency of the tank.
   b. The flywheel effect.
   c. Energy losses in the circuit.
   d. Improper input.

3. What would adding parallel inductance to a tank do to its frequency?

   ANS. ______________________________

EXPERIMENT
LESSON II

Damped Oscillations

IN THIS EXPERIMENT YOU WILL ASSEMBLE A TANK CIRCUIT, CAUSE IT TO OSCILLATE, AND OBSERVE THE DAMPED WAVEFORM.

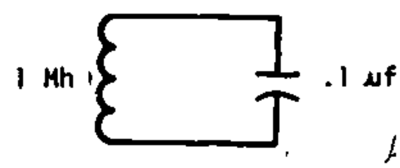
Equipment Required

Device 6F16
Template - C
Oscilloscope
1X Probe (2)

Procedure

This oscillator (template "C") is the one you will use for experiment Twenty Two-IV. For this experiment we will only need to use the tank circuit. (L1, C3)

Insert the 1 mh choke in L1.
Insert the .10 μf capacitor for C3.



The CALIBRATOR OUTPUT of the oscilloscope can be used as a switch. It first puts out a positive voltage then switches to a negative voltage at a 1 KHz rate.

Using this signal to start oscillations we should be able to see the damped oscillations.

Oscilloscope Set Up

a. CALIBRATOR switch to 5
b. Channel A SENSITIVITY (volts/cm) to .2
c. SWEEP TIME to 0.1 millisecond/cm

Connect a 1X probe to the CALIBRATOR 1 KC VOLTS OUTPUT JACK. Connect the probe tip to the top of the tank circuit (top of L1). Connect the probe ground clip to the bottom of the tank circuit (bottom of L1).

Connect a 1X probe to the Channel "A" INPUT jack. Connect the probe tip to the top of the tank circuit (top of C3).

Observe the waveform and note the damped oscillations each time the input signal switches.

IF YOU DO NOT SEE THE DAMPED WAVEFORM, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

WHEN YOU HAVE OBSERVED THE DAMPED WAVEFORM, PROCEED TO LESSON II PROGRESS CHECKS.

PROGRESS CHECK
LESSON II

Parallel Resonant Circuits

1. Identify the type of waveform generated by a tank circuit:

a. 

c. 

b. 

d. 

2. What is meant by the term damped oscillations?

____

____

3. If the value of capacitance is increased in a tank circuit, the resonant frequency will (increase/decrease).

4. If the value of inductance is increased in a tank circuit, the resonant frequency will (increase/decrease).

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONES AGREE WITH THE ANSWERS, PROCEED TO LESSON III.

EXPERIMENT
LESSON III

Frequency Measurement Using An Oscilloscope

Equipment Required

1. Oscilloscope
2. Test signal box - Model 124 multigenerator
3. Coaxial cable with BNC connectors

SAFETY PRECAUTIONS: OBSERVE ALL APPLICABLE SAFETY PRECAUTIONS

Procedure

1. Obtain a line trace.
2. Connect one end of the BNC coxial cable to Channel A of the oscilloscope and the other end to Output #1 of the test signal box.
3. Adjust the SWEEP TIME control to obtain the fewest complete cycles on the oscilloscope.

   SWEEP TIME setting ______________

4. Move the TRIGGER LEVEL control in the negative direction. What happens to the starting point of the waveform? ________

   ____.

5. Adjust the TRIGGER LEVEL control so that the length of one cycle of the waveform can be easily measured. Count the number of centimeters that one complete cycle covers.

   ______________ cm.

NOTE: At times, it may be helpful to use the HORIZONTAL and/or VERTICAL positioning controls to more easily "sight" the dimensions of the waveform.

6. To obtain the period of the waveform, multiply the number of centimeters by the setting of the sweeptime control.

   __________ cm X __________ /cm = ______________

7. Using the equation $F = 1/t$, substitute the time of the period into the equation and carry out the indicated operations.

   F = ______________

8. Disconnect the coaxial cable from output # 1 and connect it to output #3 of the test signal box.

9. Obtain the fewest cycles on the oscilloscope.

   SWEEP TIME setting ______________

10. Calculate the period of one cycle.

   period = ______________

11. What is the frequency of this waveform?

   F = ______________

12. Connect the coaxial cable to output # 5. What is the frequency of this waveform?

   F = ______________

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO THE PROGRESS CHECKS. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

PROGRESS CHECK
LESSON III

Frequency Measurement Using An Oscilloscope

1. The complete sequence of events in a waveform is called a ________________.

2. A ________________ is the time required to complete one cycle.

3. A waveform's cycle can be measured from which points?

   a. trough to trough
   b. crest to crest
   c. leading edge to leading edge
   d. All of the above

4. Calculate the frequency in the below examples.

   a. Period = 50 msec ________________ Hz

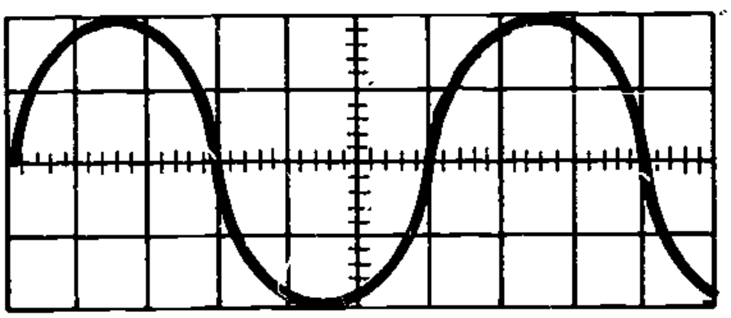
   b. Period = 200 μsec ________________ Hz

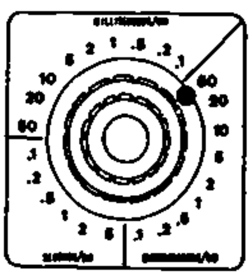
   c. Period = 17.5 μsec ________________ Hz

5. The ________________ ________________ ________________ allows you to select the number of cycles displayed on the oscilloscope.

6. The ________________ ________________ ________________ allows you to move the starting point in either a positive or negative direction.

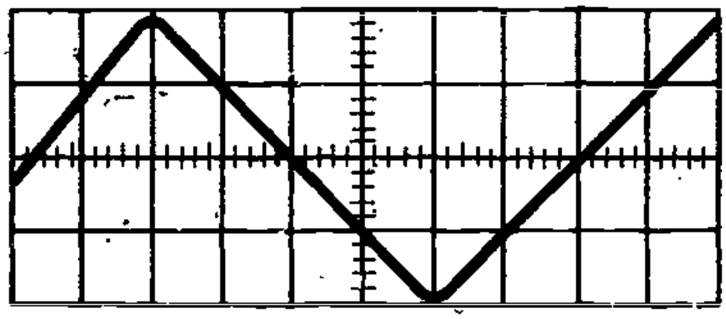
7. What is the frequency of the below waveform?

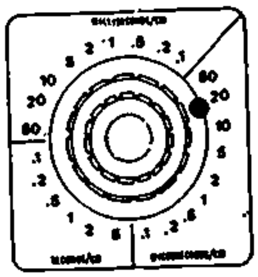




F = ________________________

8. What is the frequency of the this waveform?





F = ______________________

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON IV.

AUDIO VISUAL RESPONSE SHEET
LESSON IV PART 1

BASIC OSCILLATOR OPERATION

ANSWER ALL QUESTIONS IN STATIC/MOTION PROGRAM TWENTY TWO-IV-1 ON THIS RESPONSE SHEET

1. A B C D (Circle One)

2. A B C D (Circle One)

3. A B C D (Circle One)

4. List the components that make up each of the functional part of the Colpitts oscillator.

ANSWER

Tank	________
Amplifier	________
Stabilization/Bias Network	________
Feedback	________

5. List the components that determine the frequency of oscillations in the circuit shown. (Clapp Oscillator)

ANSWER ____________________

EXPERIMENT
LESSON IV
PART 1

Oscillator Operation

The operation of an oscillator circuit will be investigated in this section of the experiment. You will build an actual oscillator circuit and make appropriate measurements to verify that the circuit operates according to theory.

Equipment Req

Device 6F16
Oscilloscope
10X Probe

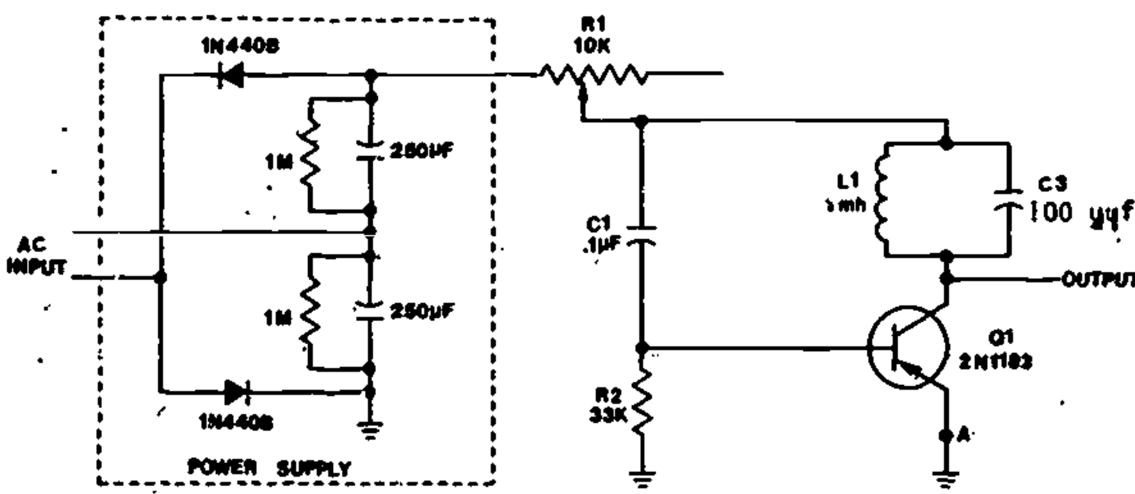
Procedure

1. Using all applicable safety precautions, energize the oscilloscope.

   a. Obtain a line trace.
   b. Set the SENSITIVITY control to 1 volt/centimeter.
   c. Set the SWEEP TIME control to 1 microsecond/centimeter.
   d. Connect a 10X probe to the Channel A INPUT jack.

2. Set up the 6F16 transistor trainer as follows:

   a. Using template C, Transistor Oscillator, assemble the circuit illustrated below.



b. Looking at the potentiometer from the knob side rotate the potentiometer, R1, to the fully counter-clockwise position.

c. Connect the 10X probe to the output of the oscillator. Connect the ground lead to point A on the oscillator.

d. Energize the oscillator by connecting the power cord of Device 6F16 to a 117 volt, 60 Hz source.

e. Rotate the potentiometer R1 clockwise to obtain the least distorted sine wave on the oscilloscope screen. (Note: If the pot is turned too far, oscillations will stop.)

3. Calculate the frequency of the waveform displayed on the oscilloscope screen.

Ans. ______________________________

4. The feedback path for this oscillator is provided through Capacitor C1. Remove C1 from the circuit and observe what happens to the waveform displayed on the oscilloscope screen. Notice that the waveform dies out too quickly to observe the damping effect. (Replace capacitor C1 into the circuit before continuing.)

5. Replace the 100 μμf tank capicitor, C3, with a 500 μμf capacitor. Re-adjust potentiometer R1 to obtain the best sine wave on the oscilloscope screen. Calculate the frequency of the waveform now displayed on the oscilloscope screen.

Ans. ______________________________

a. You increased the value of the tank capacitor, C3. Did the frequency of oscillations increase or decrease? Is this consistent with theory?

Ans. ______________________________

(Insure that tank capacitor, C3, is replaced with the 100 μμf capacitor before continuing).

6. Replace the 1 mh tank inductor, L1, with a 2.5 mh inductor. Again re-adjust potentiometer R1 to obtain the best sine wave on the oscilloscope screen. Calculate the frequency of the waveform displayed.

   Ans. ______________________________

   a. You increased the value of the tank inductance. Did the frequency of oscillation increase or decrease? Is this consistent with theory?

      Ans. ______________________________

7. Return the 1 mh tank inductor to the circuit.

CHECK YOUR REPSONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO EXPERIMENT TWENTY TWO-IV-2. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

EXPERIMENT
LESSON IV
PART 2

Loading Effect of Meters

This section of the experiment will compare the loading effect of a VOM to that of an Electronic Voltmeter (EVM) on an oscillator circuit.

Audio Visual: At this time you should view the audiovisual "Using the AN/USM-116." There is also an instruction manual that you may read to help you understand the operation of this particular piece of test equipment.

Plug in the EVM and turn it on. This EVM is turned on by use of the function (top) switch which has an OFF position. When the meter is ON the Power On indicator should be lit.

For stable operation the EVM requires about twenty minutes warm-up.

While waiting for the EVM to warm up continue with the first part of the Procedure.

Equipment Required

VOM AN/PSM-4 ( )/or Simpson 260
EVM (Electronic Voltmeter)
Oscilloscope
Device 6F16:Template C

Procedure

1. a. Connect the oscilloscope to the output of the oscillator. Leave it connected throughout the remainder of the Job Sheet.

   b. Adjust the oscillator for maximum undistorted output.

   c. Use the oscilloscope to measure the RMS value of the output sine wave (RMS is 0.707 times peak)

   Ans. ______________ VAC

2. Use the VOM to measure the output of the oscillator.

   a. Set the function switch of the VOM to the OUTPUT position.

b. Start with the 5D volt scale and record the AC volts in the space provided for each setting of the meter.

50 V Scale ________________ VAC
25 V Scale ________________ VAC
10 V Scale ________________ VAC
5 V Scale ________________ VAC

3. With the VOM set on the 5 V scale adjust the oscillator for maximum output. Notice how much the meter loads the circuit.

4. When you connected the VDM to the output of the oscillator what happened to the frequency of oscillations?

The frequency ______________________________.

5. Now measure the AC voltage at the output of the oscillator with the EVM. See Notes below.

a. Ans ________________ VAC

How does this value compare with the value measured by the oscilloscope?

b. ______________________________________.

c. Did the EVM change the frequency appreciably? __________

Note: It is suggested that this measurement be made with the meter set for 30 VAC. The 30 VAC scale is read on the black 3.D volt graduations. Remember to zero the meter with the ZERO ADJUST before taking the measurement.

Note: The ground clip on the AC probe should be connected to circuit common. (ground).

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWER, PROCEED TO EXPERIMENT TWENTY TWO-IV-3. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

EXPERIMENT
LESSON IV
Part 3

Troubleshooting Oscillators

This experiment will demonstrate the principles of operation of two basic oscillator circuits -

1. Colpitts Oscillator
2. Armstrong Oscillator

SAFETY PRECAUTIONS:

Beware of all open and bare connections on the NIOA 203 Oscillator. Remember, even low voltages can KILL!

Equipment Required:

1. NIOA 203 Audio Oscillator
   PC203-2 Printed Circuit Card
   PC203-5 Printed Circuit Card
2. Oscilloscope
3. 1X Probe
4. BNC - BNC Cables (2)
5. BNC "TEE" Connector (1)
6. NIOA 203 Audio Oscillator Instruction Manual

Procedure:

1. Energize and set up the oscilloscope for dual trace operation with an EXTERNAL TRIGGER input.
2. Using the two BNC cables and the BNC "TEE" connector, connect the NIOA 203 Oscillator output (BNC Jack on the front panel) to the EXTERNAL INPUT and CHANNEL A of the oscilloscope.
3. Connect the 1X Probe to CHANNEL B of the oscilloscope. Ensure the CHANNEL "B" POLARITY SWITCH is in the "+UP" position. This probe will be used later in the job sheet.
4. Place the CHANNEL "A" POLARITY SWITCH to the "-UP" position. This will enable you to see the proper phase of the oscillator output signal.

NOTE: The output signal of the oscillator is inverted 180° by an output amplifier in the NIOA 203 Oscillator. The CHANNEL "A" POLARITY SWITCH on the oscilloscope in the "-UP" position allows you to invert the Oscillator's output another 180°, displaying the true output phase of the Oscillator.

5. Remove the top cover of the Oscillator.

   NOTE: Perform the following procedures for the Colpitts Oscillator (PC 203-2), then, after step 14, come back to step 6 and repeat the procedure using the Armstrong Oscillator (PC 203-5).

6. Insert PC Board 203-2 (203-5) into the NIDA 203 Oscillator chassis.

7. Plug in and energize the oscillator.

8. Rotate the amplitude control on the front panel of the Oscillator fully "clockwise." Disregard the multiplier and frequency controls. These controls have no effect when using the PC 203-2 and PC 203-5 boards.

   Refer to Figure 5-9 in the NIOA 203 Instruction Manual during this experiment.

9. Measure and record the period of the output signal.

   PC 203-2 ________________ seconds.
   PC 203-5 ________________ seconds.

10. What is the output frequency?

    PC 203-2 ________________ Hz
    PC 203-5 ________________ Hz

11. What type of amplifier is used in this circuit (common base, common collector, common emitter)

    PC 203-2 ________________
    PC 203-5 ________________

12. Measure the phase relationship between the output signal and the feedback signal to the base of Q1. (Connect channel "B" to the amplifier input. Channel "A" is measuring the oscillator's output.)

    PC 203-2 (in phase/90° out of phase/180° out of phase/270° out of phase)

    PC 203-5 (in phase/90° out of phase/180° out of phase/270° out of phase)

13. What components of the circuit determine the oscillator frequency?

PC 203-2 ____, ____, ____
PC 203-5 ____, ____

14. Deenergize and unplug the Oscillator and remove the PC card.

15. Go back to step # 6 and repeat the procedure using PC Board 203-5.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.

PROGRESS CHECK
LESSON IV

Oscillator Operation

1. The purpose of L1 in Figure 1 is to

a. establish the oscillator frequency.

b. couple feedback energy to the resonant tank.

c. couple energy out of the resonant tank.

d. provide a DC path to ground.

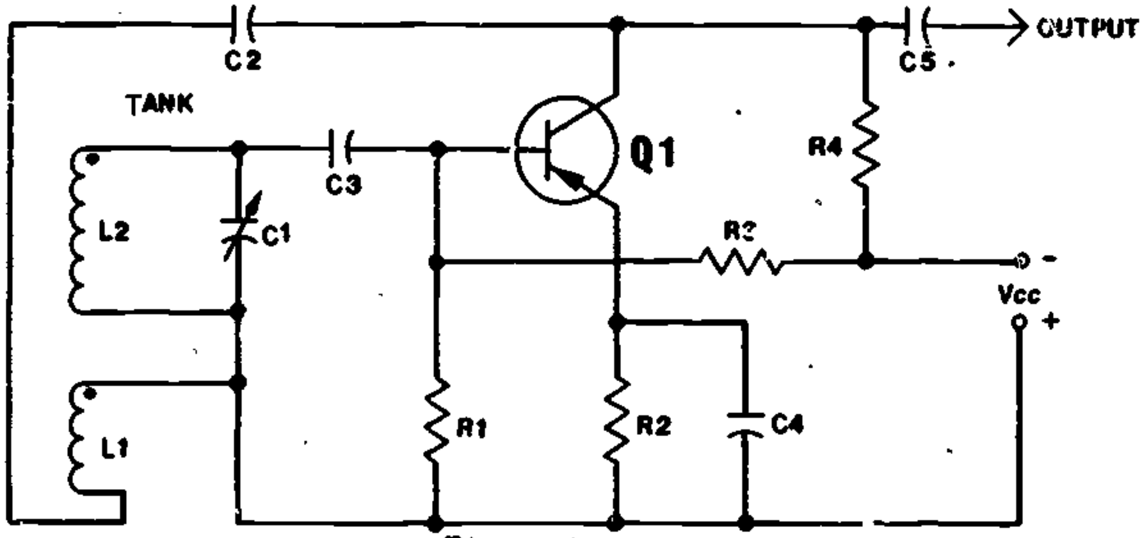


Figure 1

2. In figure 1, which component can be used to change the frequency of oscillation?

a. C4

b. L2

c. Q1

d. C1

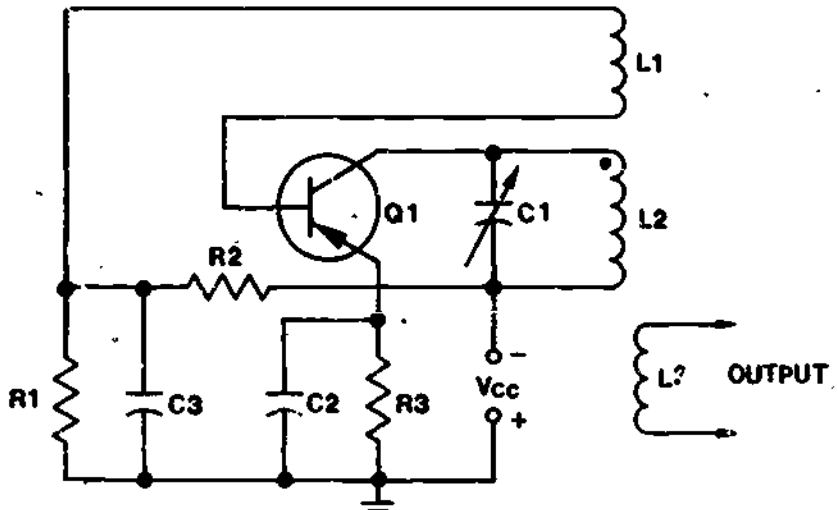


Figure 2

3. In figure 2, which inductor determines the frequency of oscillation?

   a. L1

   b. L2

   c. L3

4. In figure 2, the purpose of transistor Q1 is to

   a. feed amplified energy to the tank circuit.

   b. feed amplified energy to tickler coil L1.

   c. increase the energy of the DC supply voltage.

   d. establish the frequency of oscillation.

5. The amplifier and feedback path for the oscillator in figure 3 is from point

   a. C, through Q1, through C2, to point A.

   b. B, through C1, through Q1, through C2, to point A.

   c. A, through C2, through Q1, to point C.

   d. A, through C2, through Q1, through C1, to point B.

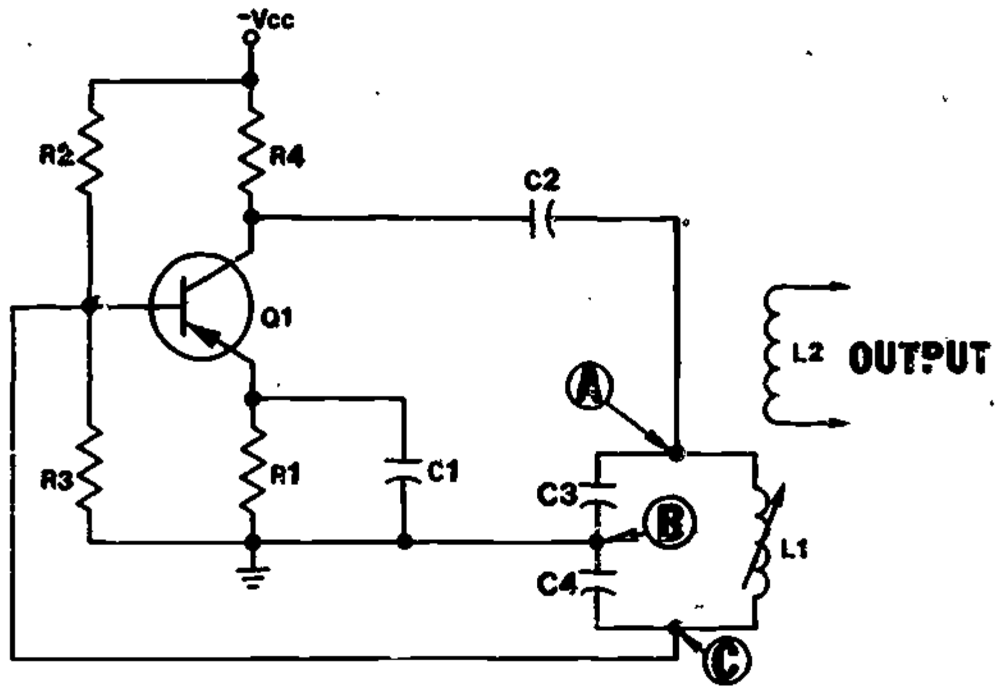


Figure 3

6. In figure 3, which components establish the frequency of oscillation?

   a. C1, C2, C3, Q1

   b. L1, L2, C1

   c. R1, C1, C3, L1

   d. C3, C4, L1

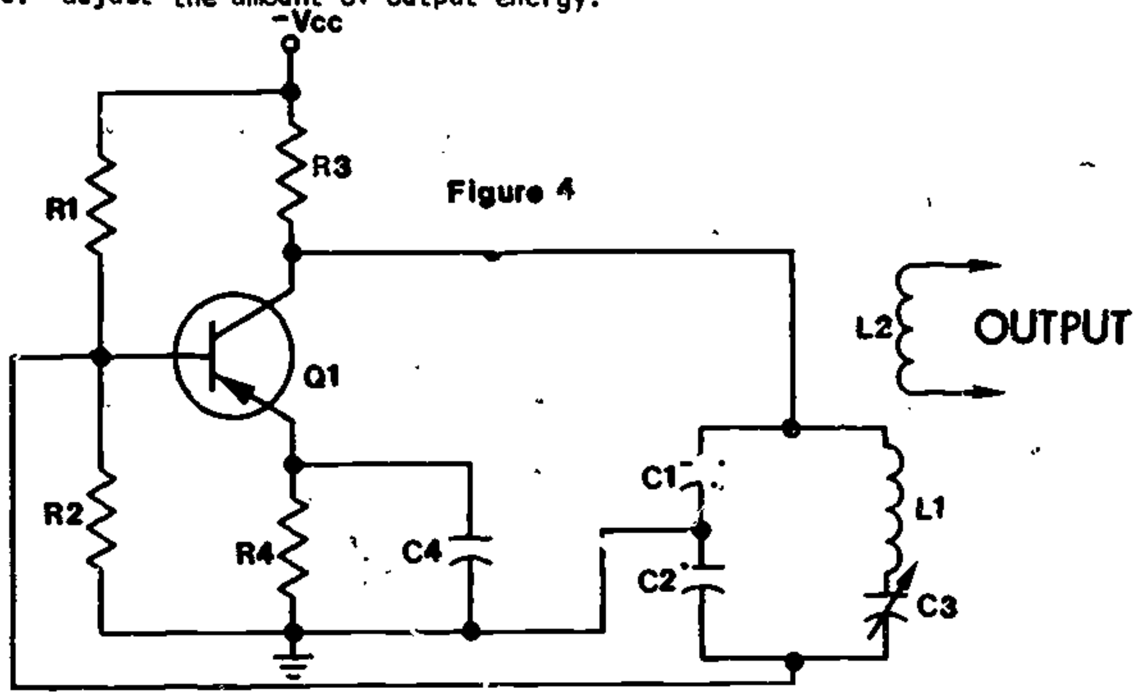
7. The purpose of capacitor C2 in figure 4 is to

   a. vary the frequency of oscillation.

   b. adjust the bias on transistor Q1.

   c. provide the correct amount of feedback energy.

   d. adjust the amount of output energy.



8. What test equipment should be used when measuring voltage in an oscillator circuit?

   a. ______________________

   b. ______________________

   Why?

   c. ______________________

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO THE MODULE TEST.

YOU HAVE NOW COMPLETED THIS MODULE. IF YOU FEEL THAT YOUR PROGRESS CHECK RESULTS INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE TESTS, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE END OF MODULE TESTS, YOU MAY REVIEW ANY PART OF THIS MODULE.

ANSWER SHEETS

FOR

MODULES

TWENTY

TWENTY-T

TWENTY ONE

TWENTY ONE-T

TWENTY TWO

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON 1

Basic Power Supplies

1. Voltage, current (either order)
2. d
3. Step the input up or down
4. AC, DC
5. h
6. a. Regulates the output (maintains constant output voltage).
   b. Couple output to electronic equipment (load).

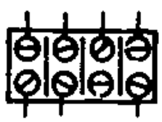
ANSWER SHEET FOR EXPERIMENT LESSON 11

Input Stage

1.

1. g
2. e
3. c
5. d
6. f
8. i
10. b
11. a
12. h
13. b (new model parts ID board)
    c (older model parts ID board)
15. i
16. a
17. b
19. c
20. b
21. h
22. e
23. i
25. h

2. a.



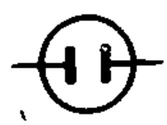
e.

b.

f.

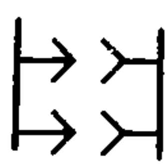
c.

g.



d.

h.



ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON II

Input Stage

1. Connect ship's supply into power supply

2. a, d, e

3. Provide overload protection

4. a. Circuit breaker
   b. Indicator lamp
   c. Fuse
   d. Switch

5. Turn power supply on or off

6. Indicate power on condition

ANSWER SHEET
FOR
EXPERIMENT
LESSON III

Input and Transformer Secondary Stages

3a. 340 Vp-p ± 10%

3b. 170 V ± 10%

3c. 120 VRMS ± 10% (Remember: RMS voltages is 0.7 times peak voltage.)

3d. 120 VAC ± 10%

4a. 340 Vp-p

4b. No

5. Yes

6a. 340 Vp-p ± 10%

6b. (2) The primary winding of transformer T-1.

6c. Yes

6d. No

8a. No

8b. Yes

10a. 100 Vp-p ± 10%

10b. Yes

11. No

12a. Approximately 3.4 - 1

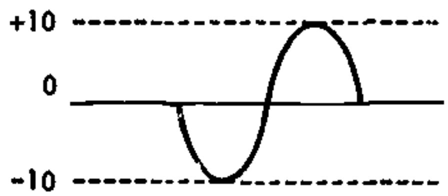
12b. Step-down transformer.

ANSWER SHEET
FOR
PROGRESS CHECK
LESSON III

Power Supply Transformer Secondary Stage

1. b

2. b

3. 

ANSWER SHEET
FOR
EXPERIMENT
LESSON IV
PART 1

Power Supply Rectifiers

#26	Low	610Ω	High ∞
#27	Low	200Ω	High ∞
#28	Low	0Ω	High 0Ω
#29	Low	280Ω	High ∞

#26, 1: ∞ #27, 1: ∞ #28, 1: 1 #29, 1: ∞

no

ANSWER SHEET
FOR
PROGRESS CHECK
LESSON IV

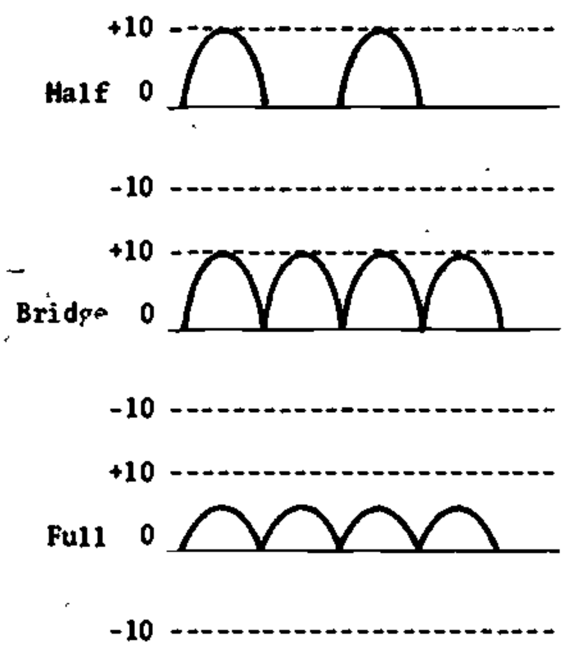
Power Supply Rectifiers

1. Half wave
   Bridge
   Full wave

2. b

3. a

4.

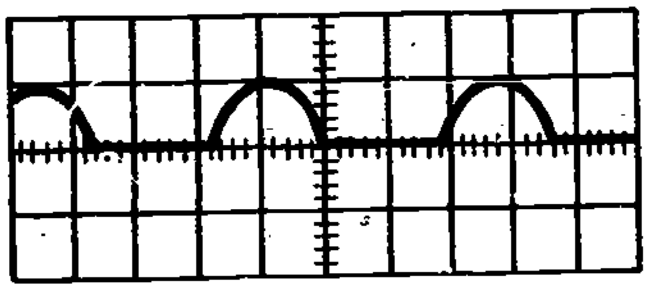


ANSWER SHEET
FOR
EXPERIMENT
LESSON V

Power Supply Rectifiers and Filters

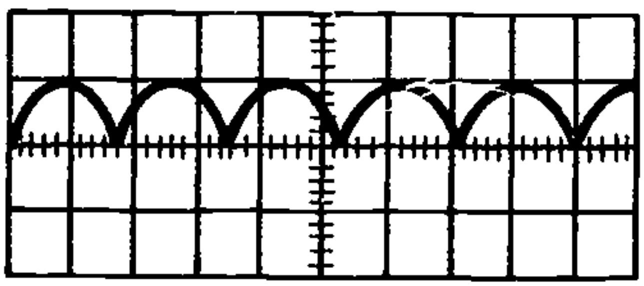
5. (1) CR1 only

6.



45 Vp-p ± 10%

7a.



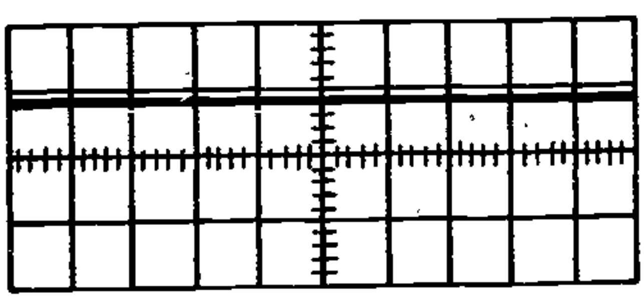
45 Vp-p ± 10%

7b. (3) both the positive and negative alternations of the AC input

7c. twice as many

8. 27 VDC ± 10%, .05 DC AMPS ± 10%

11.



45 VDC ± 10%

12. 43 VDC ± 10% .075 DC AMPS ± 10%
    decrease; increase (in that order)

14. <u>Positive</u> side of the C1 must be jumpered to ground to discharge C1.

ANSWER SHEET FOR PROGRESS CHECKS LESSON V

Power Supply Filters

1. b
2. Choke
3. c

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON VI

Power Supply Regulators

1. Maintain constant voltage out regardless of current load

2. Increase

3. Increase

4. d

ANSWER SHEET
FOR
EXPERIMENT
LESSON VII

Power Supply Output Stage

4. 25.5 VDC ± 10% ; .06 DC AMPS ± 10%

6a. 28 VDC ±10%

8a. 40VDC ±10%

8b. 27 VDC ±10%

8c. 13 VDC ±10%

8d. .13 DC AMPS ±10%

8e. .06 DC AMPS ±10%

9a. .07 DC AMPS ±10%

11a. 27 VDC ±10% ; .08 DC AMPS ±10%

11b. No

13. Decreased

12. ER1 13 VDC IR1 .13 DC AMPS ICR1 .05 DC AMPS

14a. 21.5 VDC ±10%; .185 DC AMPS ±10%

14b. yes

14c. yes

15. ER1 18.5 DCV ±10% IR1 .185 DC AMPS ±10% ICR1 0 DC AMPS

NOTE: Tolerance of the DC AMPERES meter may give an erroneous reading of as much as 50 milliamps. If on step 15 ICR1 has up to 50 milliamps through it, it can be attributed to "slop" in the DC AMPERES meter.

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON VII

Power Supply Systems Concept

1. Loading effect (or just "loading")

2. Interloading

3. Increase or decrease

4. a. Current in fixed branch will change
   b. Loading effect

5. Add a regulator or a zener diode

ANSWER SHEET FOR PROGRESS CHECKS LESSON I

Vacuum Tube Power Supplies

LESSON I

1. a
2. b
3. c
4. c
5. d
6. b
7. b
8. a
9. b

ANSWER SHEET FOR EXPERIMENT LESSON 1

Transistor Identification

1. a. 32
   b. 30
   c. 31
   d. 34
   e. 33

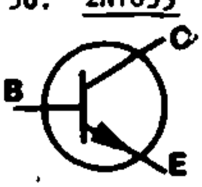
2.

COMPONENT NUMBER	TRANSISTOR NUMBER	E-B	B-C	E-C	EBC
30.	2N1893	30.PN HIGH NP LOW	NP HIGH PN LOW	NP LOW PN HIGH	NPN
31.	2N1183	31.PN LOW NP HIGH	NP LOW PN HIGH	NP HIGH PN LOW	PNP
32.	2N3055	32.PN HIGH NP LOW	NP HIGH PN LOW	NP LOW PN HIGH	NPN
33.	2N2222A	33.PN HIGH NP LOW	NP HIGH PN LOW	NP LOW PN HIGH	NPN
34.	ECG105	34.PN LOW NP HIGH	NP LOW PN HIGH	NP HIGH PN LOW	PNP

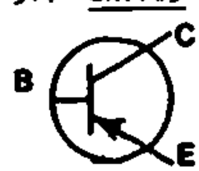
* NOTE - Directions must be followed exactly to obtain readings as given.

Your resistance readings may not be exactly like those above, due to difference in interpretation of meter readings and manufacturing tolerances; however, they should be fairly close. If not, recheck your readings.

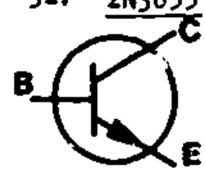
3. 30. 2N1893



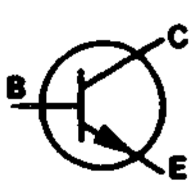
31. 2N1183



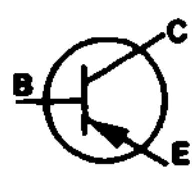
32. 2N3055



33. 2N2222A



34. ECG105



135

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON 1

Basic Transistor Theory

1. c

2. The voltage across Rv increases. The current through Rv decreases.

3. b

4. 1-b; 2-c; 3-a

5. c

6. 2-NPN
   5-PNP

7. b

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON 11

Transistor Biasing

1. c
2. c; f
3. b
4. 0.15v
5. c
6. b
7. b
8. c

ANSWER SHEET
FOR
EXPERIMENT
LESSON III

Transistor Amplifier Functional Analysis

1. (-) negative
2. yes
3. PNP
4. 0ma
5. 0ma
6. .04 ma
7. 3.7 ma
8. 92.5
9. increase
10. 5 volts
11. 8 volts p-p

Reading may not be exact, because of differences in training devices. However your readings should be fairly close to those above.

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON III

Functional Transistor Amplifier Functional Analysis

1. To control a large current with a small input signal (or words to that effect).

2. 1-b, c
   2-a
   3-b, c

3. a. Resistive-capacitive;
   b. Transformer

4. b

5. a

ANSWER SHEET
FOR
EXPERIMENT
LESSON IV

Transistorized Amplifier Circuits

7a. Common emitter amplifier, will invert the input signal.

7b. Common collector amplifier, will not invert the input signal.

7c. Common base amplifier, will not invert the input signal.

16a.	PC206-6 gain	PC206-7 loss	PC206-8 gain
16b.	yes	no	no
16c.	1:100	1:1	1:6

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON IV

Basic Transistor Amplifier Configurations

1. a. common-emitter
   b. common-base
   c. common-collector

2. 1-b
   2-c
   3-b

ANSWER SHEET
FOR
EXPERIMENT
LESSON V
PART 1

Transistor Amplifier Analysis

1. -8.0 volts

2. cut off

3. -.1 volts

4. -.16 volts

5. -.1 volts

6. saturation

7. Positive portion flattened out, the potentiometer raised the bias to where the input signal drove the transistor into saturation (or words to that effect).

8. all

9. 180°

10. Negative

11. Positive

12. "B"

Your answers may not be exact due to component tolerances, power supply variationns, and aging of components. You should find, however, that the voltage relationships clearly indicate the circuit conditions.

ANSWER SHEET
FOR
EXPERIMENT
LESSON V
PART 2

Transistor Amplifier Analysis

4. (c) common emitter amplifier.

5. (b) phase splitter.

6. (d) push-pull amplifier.

7. (c) output transformer.

9a. 1,000 ± 10%

9b. .5 V(p-p), 180° out of phase.

9c. 10 V(p-p), 180° out of phase.

9d. 2.2 V(p-p) ± 10%

10a. No

10b. (c) When Q3 cuts off, Q4 does not start conducting immediately.

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON V

Basic Transistor Amplifier Circuit Analysis

1. c
2. Cutoff
3. Saturated
4. a
5. b
6. b
7. c
8. a
9. d
10. c
11. c
12. c

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON I

Multi Element Vacuum Tubes

1. control grid

2. (b)

3. NPN

4. Negative

5. (b)

6. a. - Plate
   b. - Screen Grid
   c. - Control Grid
   d. - Cathode

7. screen grid

8. a - Plate
   b - Suppressor grid
   c - Screen grid
   d - Control grid
   e - Cathode

9. (c)

10. (b)

ANSWER SHEET
FOR
EXPERIMENT
LESSON II
PART I

Vacuum Tube Circuit Configurations

7a.

PC	GAIN
206-1	8
206-2	.6
206-3	4

7b.

PC 206-1	Yes	Signal is 180° Out of Phase.
PC 206-2	No	Phase Shift 0°.
PC 206-3	No	Phase Shift 0°.

7c. 206-1 common emitter
206-2 common collector
206-3 common base

10a. (4) pentode.

10b. (3) cathode.

10c. (2) control

10d. (3) suppressor, (1) screen. (in that order)

12. 4 VAC input; 80 VAC output; Gain 20; 180° out of phase.

13. a. 220 VDC
b. 100 VDC
c. 0 V
d. -1.4 VDC
e. 0 V
f. 56 VDC

14. conducting

ANSWER SHEET
FOR
EXPERIMENT
LESSON T-11
Part 2

<u>Operation of the TV-7D/U or TV-10D/U Tube Tester</u>

THE ANSWER SHEET FOR THIS EXERCISE IS IN THE BOX OF TUBES TO BE TESTED.

ANSWER SHEET FOR PROGRESS CHECKS LESSON 11

Vacuum Tube Circuit Configurations

1. common emitter
2. larger
3. (d)
4. common base
5. larger
6. common collector
7. (a)
8. (d)
9. a - Grounded-Cathode
   b - Grounded Grid
   c - Cathode Follower (Grounded Plate)
   d - Push - Pull
   e - Phase - Splitter
10. (b)
11. (a)

ANSWER SHEET FOR PROGRESS CHECKS LESSON I

Functional Analysis -- Oscillators

1. b

2. c

3. a. Amplify oscillations,
   b. Provide power to sustain oscillations.

4. a

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON II

Parallel Resonant Circuits

1. a

2. Gradual loss of amplitude in that tank due to circuit losses.

3. Decrease

4. Decrease

ANSWER SHEET FOR EXPERIMENT LESSON III

Frequency Measurement with an Oscilloscope

3. .1 millisec/cm

4. The starting point moves in a negative direction (or words to this effect)

5. 10 cm

6.

   10 cm X.1 millisec/cm = 1 millisec

   Period = 1 millisec = t

7.

   $F = 1/t$

   $F = \frac{1}{1 \text{ millisec}}$

   $F = \frac{1}{1X10^{-3}}$

   F = 1000 HZ or 1 KHZ

9. 20 or 50 μ sec/cm

10. period = 470 μsec

11. F = 2.1 KHZ

12. F = 700 HZ

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON III

Measuring Frequency With An Oscilloscope

1. cycle
2. period
3. d
4. a. 20 HZ
   b. 5000 HZ or 5 KHZ
   c. 57.14 KHZ
5. Sweeptime control
6. Trigger Level control
7. 3.33 KHZ
8. 6.25 KHZ

ANSWER SHEET
FOR
LESSON IV
EXPERIMENTS

PART I **Oscillator Operation**

3. 500KHZ --- 333 KHZ

5. Frequency = 200KHZ-250KHZ
   a. Frequency decreased, Yes

6. Frequency - 200 KHZ-25-KHZ
   a. Frequency decreased, Yes

PART II **Loading Effects**

1. c 12V-15VAC

2. b. 50V scale 10-15 VAC
   Note: Meter should be on Output function
   25v scale 5-10 VAC
   10v scale 2-5 VAC
   5v scale .2v - 5VAC

4. Decreased.

5. a. 11V-14VAC
   b. Close
   c. No

PART III **Oscillators**

9. PC 203-2 - 225μsec ± 10%

   PC 203-5 - 40usec ± 10%

10. PC 203-2 - 4.5KHz ± 10%

    PC 203-5 - 25KHz ± 10%

11. PC 203-2 - common emitter amplifier.

    PC 203-5 - common emitter amplifier.

12. PC 203-2 - 180° out of phase.

    PC 203-5 - 180° out of phase.

13. PC 203-2 - C3-2, C4-2, L1-2

    PC 203-5 - C3-5, T1-5

ANSWER SHEET FOR PROGRESS CHECKS LESSON IV

Oscillator Operation

1. b
2. d
3. b
4. a
5. a
6. d
7. c
8. a. VTVM
   b. Oscilloscope (Either order)
   c. Standard VOM will load the circuit.