



**General Plant Operator/
Operations Technician
Test**

Study Guide

May 2007

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Section 1: Introduction

Overview

This study guide is designed to familiarize you with the basic knowledge and skills required by Southern Company's General Plant Operator (GPO) and Operations Technician (Op Tech) and covered by the General Plant Operator/Operations Technician (GPO/Op Tech) Test. The guide will familiarize you with the test, assist in your preparation to take the test, and offer suggestions or strategies to use in taking the test.

GPO/Op Tech Test Description

What does the GPO/Op Tech Test cover?

The GPO Test covers topics in these areas:

- Electrical
- Operations
- Mechanical
- Safety

The content of the test includes questions related to specific subjects relevant to the three topics above. The subjects covered in each topic are listed below. Detailed descriptions of the knowledge areas and skills covered by the test follow in the next section of this guide.

What are the major knowledge areas included in the GPO/Op Tech Test?

Here is a list of subjects covering the four knowledge areas:

Electrical

- Electrical Theory
- Electrical Troubleshooting
- Electrical Test Equipment
- Hydraulics and Pneumatics
- Print Reading
- Electrical Applications
- Electrical Mechanical Procedures

Operations

- Plant Auxiliaries
- Electrical/ Mechanical Clearances
- General Power Plant Operation
- Boiler Operation
- Turbine Operation
- Generator Operation
- Plant Electrical

Mechanical

- Basic Hand and Power Tools
- Rigging and Hoisting
- Precision Measurement
- Millwright Work
- Equipment Lubrication
- Mechanical Prints and Drawings

Safety

- General Plant Safety
- Fire Prevention

What is the purpose of the GPO/Op Tech test?

The purpose of the GPO/Op Tech Test is to measure a person's knowledge and ability to apply concepts, terms and principles related to the electrical, operations, and mechanical tasks and safety requirements performed by a GPO/Op Tech. The test contains questions that emphasize the understanding of the subjects, along with the ability to apply the knowledge.

Who has to take the GPO/Op Tech Test?

Candidates-both internal and external-for GPO/Op Tech positions at Southern Company are required to take the test.

What kind of test is it?

The GPO/Operations Technician Test is a multiple-choice test in which questions have four (4) possible answers but only one that is correct. Some questions refer to figures containing diagrams, schematics, drawings and charts. Examples of the types of diagrams or drawings included in the test are provided in the next section of this guide. The test has a total of 264 questions, and is presented in 3 timed parts.

Part I: 75 questions

Part II: 95 questions

Part III: 94 questions

Each part is timed with the following maximum time limits:

Part I: 2 hrs. 15 mins. (followed by a 15-minute break)

Part II: 1 hr. 30 mins. (followed by a 15-minute break)

Part III: 1 hr. 45 mins.

Calculations and Formulas

Some questions require calculations. However, calculators are permitted so you should bring one to the testing session. The calculator should be quiet, handheld and battery operated.

Some questions also require the use of formulas. A list of formulas that might be used is provided during the test so it is not necessary to have them memorized. You will be expected to identify and select the proper formula from the list so it is critical that you be familiar with various formulas prior to the testing session. The list of formulas provided is included in this guide.

How are results determined?

Test results are determined based on the number of questions answered correctly with no penalty for guessing. So, it is to your benefit to try to answer every question. Success on the test is based on the total number of questions answered correctly across all test parts.

What happens if a person is unsuccessful on the test?

People who do not score well enough to qualify will have an opportunity to take the test again according to Southern Company's retest policy (provided in Section 4).

What kinds of questions are on the test?

The GPO/Op Tech Test includes a number of different types of test questions. The types of questions include the following:

Terms and definitions – These questions ask for the definition of a term, the name for a concept or device, or characteristics of a component.

Example: A device used to convert direct currents to alternating current is called:

Relationships and Principles – These questions ask how two concepts or measurements relate to each other.

Example: Holding currents constant, increasing resistance affects voltage by:

Interpreting Facts – For these questions, a situation or problem will be described and the answer that describes what is happening or what is wrong must be selected.

Example: When measuring voltage across a circuit with a multimeter, the meter reads 0 volts. A possible explanation for this reading would be:

Calculating Values – These questions require the calculation of amounts, measurements, or electrical values given specific information.

Example: If three 20-ohm resistors are placed in series, the total resistance in the circuit is:

How-To– These questions ask how to perform a task or specific activity.

Example: When using a volt-ohm meter to measure voltage, the lead should be connected in the following manner:

How should the study guide be used?

You should use this study guide to help you determine whether or not you are ready to take the GPO/Op Tech Test. If you find that you are not ready to take the GPO/Op Tech Test, this guide will help you identify the areas in which you might want to focus your development efforts.

First, thoroughly review the knowledge and skills included in the GPO/Op Tech Test. These will be covered in the next section of this guide. Identify those areas that you know or are familiar with and those that you might need to review or learn. Make a list of those developmental areas that you will need to work on.

Next, answer the sample questions included in the guide to help further determine areas you know or do not know. This will also help familiarize you with the type of questions you will see on the test.

Finally, use the resources suggested to identify materials or courses that you can use to help review areas you already know or learn those you need to learn.

Also, review the general tips for taking tests. This information will help you prepare to take the GPO/Op Tech Test once you feel you have the technical knowledge or skills to do so. This study guide was designed to assist in your preparation for the GPO/Op Tech Test. However, there is no guarantee that you will pass the test by simply following the guide. It is up to you to learn, study, and review the topic areas until you feel you are prepared to take the test.

Section 2: Skill and Knowledge Areas

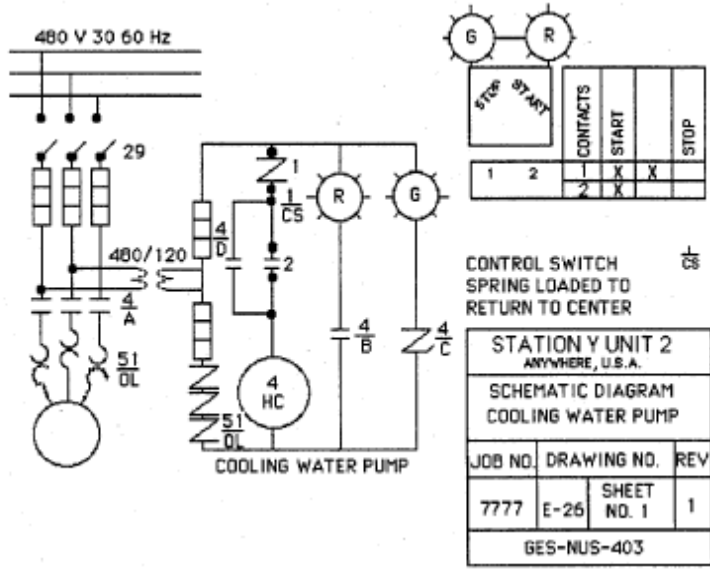
Electrical Knowledge Areas

1. **Electrical Theory:** Knowledge of all concepts, principles, symbols and calculations related to electricity; definitions, theories, formulas, and different types of circuits (e.g., series, parallel and series-parallel)
 - a) Definitions of electrical concepts (e.g., capacitance, inductance, resistance, and parallel circuits); includes conversion of units of measurement
 - b) Identification and interpretation of basic symbols; theory of operation of circuits, types of circuits and determination of electrical values (e.g., resistance, capacitance, and inductance); includes knowledge of electrical components (resistors, capacitors and inductors)
 - c) Ability to read and interpret electrical diagrams; calculation of electrical values based on various “laws” or principles; includes Ohm’s Law, Kirshchoff’s Law, peak to peak and RMS conversions; knowledge of various formulas associated with calculations
 - d) Characteristics measured by various pieces of electrical test equipment (e.g., ammeter, voltmeter, ohmmeter and multimeter)
 - e) Ability to calculate voltage drops and electrical values from or between specific points (e.g., total resistance, current) in series, parallel and series-parallel circuits
 - f) Units of measure for all electrical terms (e.g., resistance, current, voltage, inductance, and capacitance)
 - g) Basic theory of operations of transformers (e.g., potential transformers); calculation of line voltage on potential transformers based on ratios; types of transformers and windings (e.g., delta, wye); transformer protection devices; includes knowledge of power factors and reasons for/effects of grounding
 - h) Principles and operations of DC power supplies; includes the operation of voltage regulators and load resistors, calculation of voltage based on diagrams, and symbols
2. **Electrical Troubleshooting:** Knowledge of methods of diagnosing problems and analyzing symptoms of problems with electrical equipment
 - a) Proper operation and maintenance of AC and DC generators; includes knowledge of visual and operational symptoms of equipment problems (e.g., brushes)
 - b) Ability to troubleshoot electrical circuits (e.g., pump, motor, motor control) using elementary diagrams; includes knowledge of symbols and their use
3. **Electrical Test Equipment:** Knowledge of types and operation of electrical test equipment
 - a) Proper connections and procedures for determining electrical values (e.g., voltage, resistance, current) and using test equipment (e.g., voltmeter, ammeter)

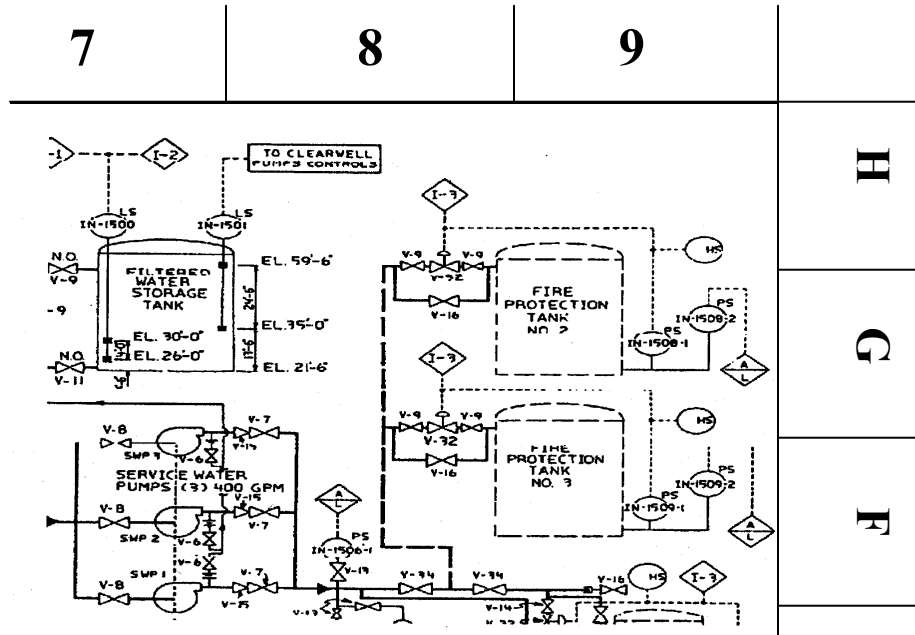
- b) Purpose and proper operation of electronic test equipment (e.g., megohmmeter/megger, multimeter)
4. **Hydraulics and Pneumatics:** Knowledge of basic principles of hydraulics and pneumatics
- a) Ability to calculate hydraulic pressure and factors that affect pressure
 - b) Knowledge of purpose and functions of hydraulic and pneumatic devices
5. **Print Reading:** Knowledge of and ability to read various types of schematics and diagrams (e.g., circuit diagrams, P & ID, relay logic); includes equipment components, equipment operation and electrical values (e.g., current) based on drawings [See sample provided]
6. **Electrical Applications:** Knowledge of various types of electrical applications, their principles and their operation; includes batteries, protective devices, solenoids, diodes, transformers, and motors
- a) Principles of operation, use and maintenance of batteries; includes charging process and procedures for checking condition (e.g., specific gravity readings)
 - b) Knowledge of different types of protective devices (e.g., relays, fuses, breakers); includes their purpose or use, operation, coding, and troubleshooting
 - c) Definition, operation and components of solenoids
 - d) Knowledge of different types of motors (e.g., three-phase), motor components, maintenance procedures (e.g., cleaning); includes knowledge of load current charts
7. **Electrical/Mechanical Procedures:** Knowledge of all lock out/tag out or clearance and isolation procedures for safely removing and/or returning equipment from or to service; includes procedures for working with electrical equipment
- a) Procedures for implementing, releasing, or transferring clearances and switching orders; includes knowledge of and purposes for lock out/tag out or clearances
 - b) Procedures for isolating breakers (e.g., racking out or in) and switches; includes knowledge of all steps and check points to ensure process has been performed properly
 - c) Procedures for safely working with energized equipment; includes isolation procedures and protective equipment and its use (e.g., rubber blankets)
 - d) Purpose of and proper procedures for grounding sensitive electronic devices

Sample Drawings and Charts

Ability to troubleshoot electrical systems using elementary diagrams like the one below.



Ability to read and interpret P & ID drawings like the one below.



Operations Knowledge Areas

1. **Plant Auxiliaries:** Knowledge of plant equipment (e.g., pumps, motors) that runs, controls, or operates different systems (e.g., boiler, turbine)
 - a) Design and definition of a boiler feed pump and how it operates; different types (e.g., those associated with drum type boilers); pressure and temperature standards/limits; means to protect boiler feed pumps during their operation; symptoms of pump problems and how to troubleshoot (e.g., excess vibration, increase/decrease in pressure)
 - b) Different types of motors (e.g., three-phase, variable speed); includes operating temperatures and factors that affect it

2. **Electrical/Mechanical Clearances:** Knowledge of procedures for safely issuing and executing lock-out/tag-out or clearances (e.g., step-by-step procedure for electrical or mechanical isolation of a piece of equipment); terms used to describe isolation of equipment (e.g., breakers)

3. **General Power Plant Operation:** Knowledge of various power plant equipment and components (e.g., valves); characteristics of substances used in the generation of electricity (e.g., steam, gases); unit start-up and shut-down procedures
 - a) Characteristics and types of steam, fluids, and gases (e.g., superheated steam) and how they are used; includes how to measure density, temperature-related characteristics and factors that affect their temperature
 - b) Different types of valves and traps (e.g., steam); includes how and why they are used, their function/operation and their purpose
 - c) Different types of gases (e.g., nitrogen, hydrogen); includes their characteristics, their safety hazards and safety precautions
 - d) Different types of heat transfer (e.g., conduction, convection), conversion of fluids to gas, terminology for the conversion, and measurement characteristics of heat (e.g., BTU)
 - e) Ability to read and convert information to monitor heat transfer and plant operating conditions (e.g., barometric readings, temperature readings); conversion of Celsius and Fahrenheit temperature readings; units of measure; different types of pressure (e.g., gauge, absolute), and how to convert pressure from one unit of measurement to another
 - f) Condensate/feedwater cycles and related components (e.g., deaerator, surge/storage tank); purpose and operation of components and cycles; temperature and pressure settings for cycle and components

4. **Boiler Operation:** Knowledge of the characteristics and types of boilers; includes boiler operation and components in the system
 - a) Characteristics of combustion and factors that affect it; includes methods for detecting proper combustion
 - b) Purpose and operation of drum-type boilers; temperature and pressure settings and factors that affect them; safety procedures for operation of boiler; procedures for testing boiler tube integrity; factors that impact the efficient operation of the boiler (e.g., valve or drain operation)

5. **Turbine Operation:** Knowledge of the characteristics and types of steam and gas turbines; includes turbine operation and components in the system
 - a) Different sections of the turbine and their purpose (e.g., high pressure, intermediate pressure, low pressure, compressor, combustion); types of turbines and/or turbine parts (e.g., blades, rotor, valves, turning gear) and their purpose; proper operating procedures (e.g., hot and cold starts); factors that impact the efficient operation of the turbine (e.g., drains or valve operation, ambient conditions); temperature control; methods to detect turbine problems
 - b) Proper operation of turbine auxiliaries and components (e.g., valve operation)
 - c) Proper procedures for turbine operations (e.g., speed control)
 - d) Various lubrication or oil systems (e.g., back up oil supply, hydraulic oil supply); their operation and their purpose; includes proper pressures and results if not maintained
 - e) Turbine protective devices and their proper operation (e.g., turbine trips); includes purpose for protective devices in the system

6. **Generator Operation:** Knowledge of the characteristics and types of generators; includes generator operation and components in the system
 - a) Different sections of a generator and their purpose (e.g., stator, field, exciter); types of generators (e.g., AC, DC, number of poles); proper operating procedures (e.g., speed control, temperature control); factors that impact the efficient operation of a generator (e.g., temperature, voltage); includes methods to detect generator problems and determine proper operation
 - b) Methods for regulating generator operation; includes methods to detect improper operation and results of improper operation
 - c) Knowledge of process to synchronize a generator and purpose for synchronizing

7. **Plant Electrical**: Knowledge of basic functions and electrical operations of plant equipment such as relay protection equipment, electric motors, and transformers
 - a) Types, purpose, and function of relays
 - b) Components of electric motors and their purpose
 - c) Methods to determine proper operation of transformers and transformer standards

Mechanical Knowledge Areas

1. **Basic Hand and Power Tools:** Knowledge of types of basic hand tools, power tools, and their proper use
 - a) Basic hand tools that a power plant mechanic uses (e.g., saws, wrenches, pliers); includes how to select the appropriate tool
 - b) Basic power tools used in a power plant (e.g., grinders, drills); includes how select proper tools and components (e.g., drill bits)

2. **Rigging and Hoisting:** Knowledge of materials, procedures, and safety procedures involved in lifting or transporting equipment and/or materials; includes selection of proper materials and technique based on material size and weight
 - a) Various types of knots and uses of each (e.g., square, bowline); includes how to determine proper lifting configurations based on equipment or material
 - b) Rigging materials (e.g., shackles, eye-bolts), equipment, and configurations (e.g., choke, basket); impact different configurations have on load capacity (e.g., sling angle); safety and inspection procedures (e.g., wear detection); how to select materials (e.g., wire rope); includes ability to read and interpret load charts
 - c) Hand signals used in lifting and transporting materials and equipment with cranes and hoists (e.g., lift, lower, back)
 - d) Ability to determine load weight based on item dimensions (e.g., height, weight, thickness)

3. **Precision Measurement:** Knowledge of precision measurement tools (e.g., inside and outside micrometers); includes their function and how to read them
 - a) All types of precision measurement tools, including micrometers, inside calipers, feeler (i.e., thickness) gauge, radius gauge, dial indicators, layout tools (e.g., dividers, squares), and torque wrench; includes knowing their uses
 - b) Definitions for different aspects of fit (e.g., tolerance, clearance)
 - c) Proper layout of work and ability to make calculations and measurements (e.g., hole positioning, overall size of fabricated piece, how to maximize material)

4. **Millwright Work:** Knowledge of millwright procedures for equipment repair and fabrication; includes pumps, belt drives, bearings, couplings, and valves
 - a) Procedures for repairing pump and pump components (e.g., shafts); includes method to determine shaft run out
 - b) Bearing types and uses (e.g., journal, thrust)

- c) Ability to calculate gear turning rate based on characteristics of gear (e.g., speed, number of teeth) when a formula is provided
 - d) Different types of valves and uses for each; includes valve components and valve operation (e.g., check, needle)
 - e) Different types of seals and purpose of each, how to install sealing mechanisms (e.g., pump packing), and how to determine problems with seals
 - f) Procedures involved in installing and aligning couplings (e.g., motor and pump coupling); includes how to calculate the amount of shim required
5. **Equipment Lubrication:** Knowledge of various types of lubricants (e.g., grease, oil); includes uses and purposes for lubrication
- a) Characteristics and principles of lubrication; includes troubleshooting lubrication problems; purpose for and use of lubricants, factors that affect lubricants, and how to select proper lubricants
 - b) Types and characteristics of lubrication systems and how they are used
 - c) Various types and applications of filters; includes determining and selecting filter with proper micron rating and knowledge of purpose of micron rating
6. **Mechanical Prints and Drawings:** Knowledge of types of prints and drawings (e.g., schematics, diagrams, mechanical drawings); includes ability to read and interpret specifications and calculate dimensions

Safety Knowledge Areas

1. **General Plant Safety**: Knowledge of all aspects of general plant safety; knowledge of proper tool use and personal protection equipment
 - a) Safety procedures for using power tools (e.g., grinders, cutters, drills); how to select proper tool or equipment for purpose
 - b) Personal protective equipment (e.g., types of eye protection to protect against various hazards) and its proper use
 - c) Procedures for working in confined spaces and use of respirators; includes safe oxygen levels for entry into confined space
 - d) Safety or proper procedures for using ladders; how to set up safely (e.g., distance of base from wall)

2. **Fire Prevention**: Knowledge of the different classes of fires, how they differ, and what type of extinguisher is used for each class (e.g., water, carbon dioxide); includes proper procedures for use of extinguishers and knowledge of different extinguishing systems

Electrical Formulas

While you may have memorized basic resistance, Ohm's Law, and Kirchoff's Law formulas, here are these formulas, as well as some others, which may not be as familiar but would be available on the job in a reference book or manual. Some of these will apply to some of the items on the test. Wherever required, you are expected to determine which formula to use for a given application. Note: Formulas are not labeled on the actual test.

Capacitance – Parallel:

$$C_T = C_1 + C_2 + C_3 + \dots$$

Capacitance – Series:

$$C_T = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots}$$

Inductance – Series:

$$L_T = L_1 + L_2 + L_3 + \dots$$

Inductance – Parallel:

$$L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \dots}$$

Resonance:

$$f = \frac{1}{2\pi \sqrt{LC}}$$

Capacitive Reactance:

$$X_C = \frac{1}{2\pi f C}$$

Inductive Reactance:

$$X_L = 2\pi f L$$

Total Impedance:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Pi:

$$\Pi = 3.1416$$

Ohm's Law

Current $I = E/R$

Resistance $R = E/I$

Voltage $E = IR$

Power $P = IE$

Power $P = RI^2$

Current $I = P/E$

Average Voltage:

$$V_{\text{avg}} = V_{\text{peak}} \times .637$$

RMS Voltage:

$$V_{\text{rms}} = V_{\text{peak}} \times .707$$

Resistance – Series:

$$R_T = R_1 + R_2 + R_3 + \dots$$

Resistance – Parallel:

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots}$$

Resistance – Parallel: (all resistors same value)

$$R_T = R/N$$

Resistance – Parallel: (2 resistors, different values)

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$

Current – Series:

$$I_T = I_1 + I_2 + I_3 + \dots$$

Current – Parallel:

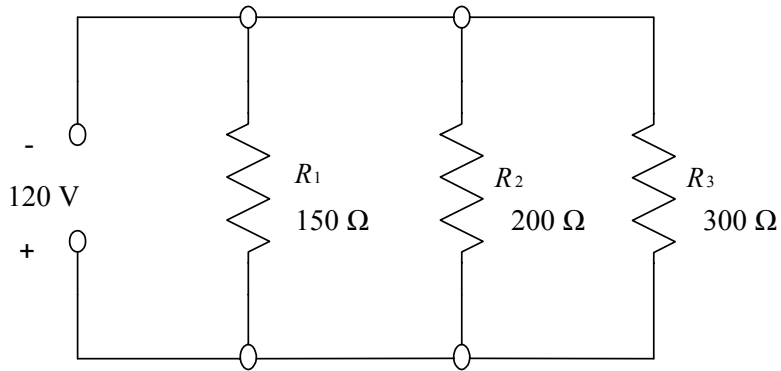
$$I_T = I_1 + I_2 + I_3 + \dots$$

NOTE: Because there are different methods or sequences of operations for calculating some problems, answers may vary slightly because of rounding. In those cases, you will have to choose the answer closest to your calculations.

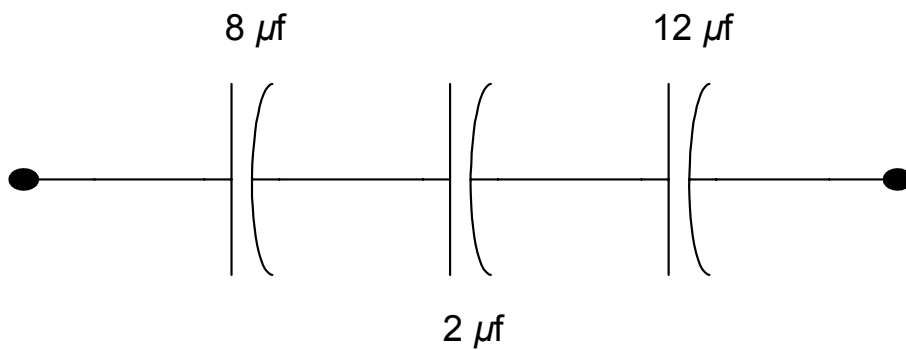
Section 3: Sample Test Items and Answers

Sample Test Items

1. In the diagram below, the equivalent resistance of the circuit is:



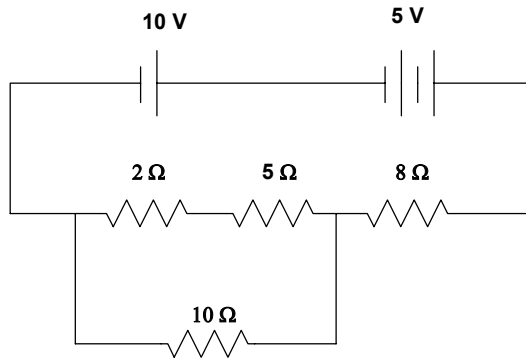
- A. 66.67 ohms
B. 120 ohms
C. 650 ohms
D. 666.7 ohms
2. If capacitors of $8 \mu\text{f}$, $2 \mu\text{f}$, and $12 \mu\text{f}$ are connected in series, the total capacitance is:



- A. $1.41 \mu\text{f}$
B. $7.33 \mu\text{f}$
C. $11.00 \mu\text{f}$
D. $22.00 \mu\text{f}$

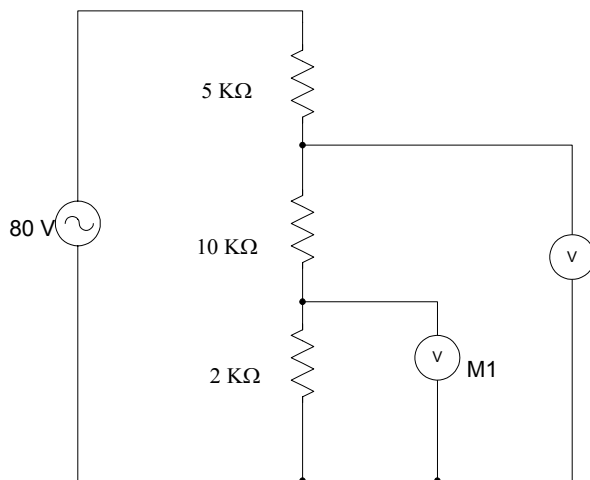
3. For the diagram below, compute:

- a) total resistance (R_T)
- b) total voltage (V_T)
- c) total current (I_T)



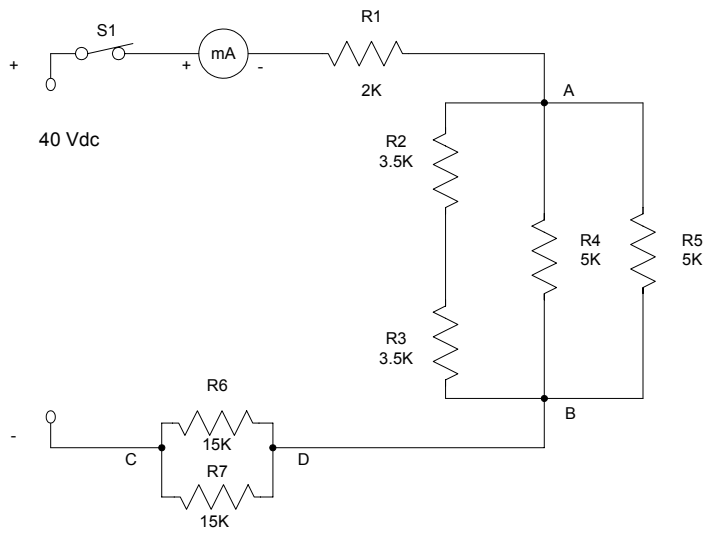
- | | | |
|--------------|--------------|-------------|
| a) $R_T =$ | b) $V_T =$ | c) $I_T =$ |
| A. 4.5 ohms | A. 4.5 volts | A. 0.5 amps |
| B. 9 ohms | B. 5 volts | B. 1.5 amps |
| C. 12.5 ohms | C. 7.5 volts | C. 3.0 amps |
| D. 25 ohms | D. 15 volts | D. 6.0 amps |

4. In the circuit diagram below, the voltage indicated by voltmeter M1 is:



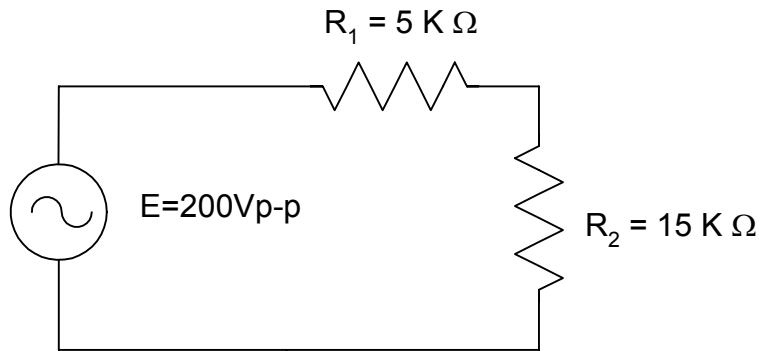
- A. 9.4 volts
- B. 20 volts
- C. 47 volts
- D. 80 volts

5. The ammeter in the circuit diagram below will indicate:



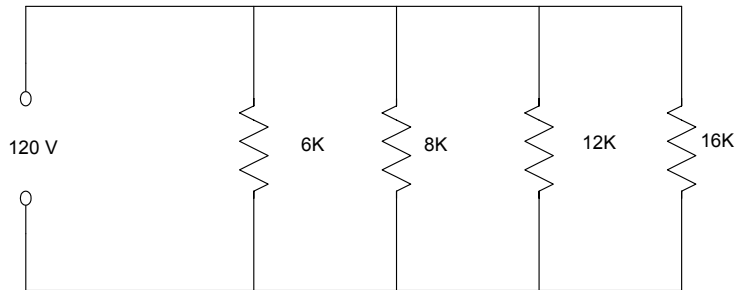
- A. 1.9 milliamps
- B. 2.6 milliamps
- C. 3.5 milliamps
- D. 7.0 milliamps

6. The RMS current flow in the circuit diagram below is:

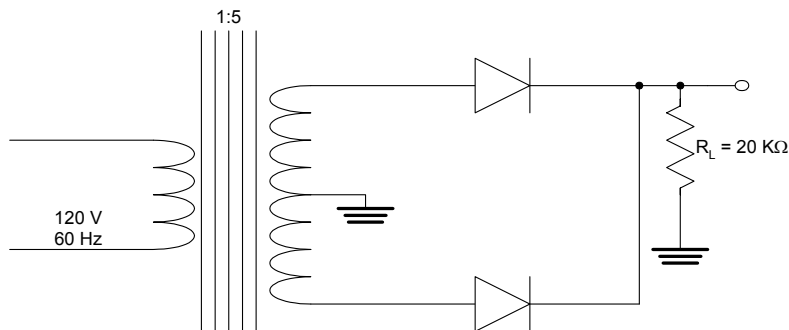


- A. 1.8 milliamps
- B. 3.5 milliamps
- C. 7.1 milliamps
- D. 10.0 milliamps

7. A 6 k-ohm, an 8 k-ohm, a 12 k-ohm, and a 16 k-ohm resistor are connected in parallel to a 120 volt power source. The resistor which dissipates the highest watts is the:

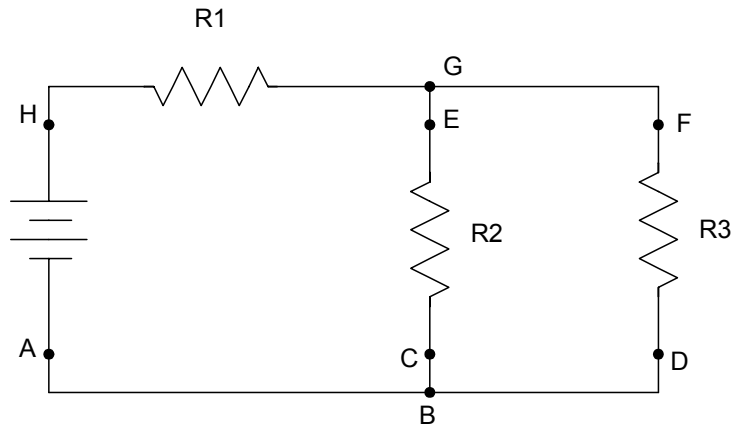


- A. 6 k-ohm
 B. 8 k-ohm
 C. 12 k-ohm
 D. 16 k-ohm
8. A 5:1 potential transformer is used to monitor a high voltage line. If a voltmeter on the secondary of the transformer indicates 120 volts, the line voltage is:
- A. 120 volts
 B. 240 volts
 C. 600 volts
 D. 1200 volts
9. In the circuit diagram below, the voltage measured across the load resistor (R_L) with a DC voltmeter is:



- A. 120 volts
 B. 150 volts
 C. 300 volts
 D. 600 volts

10. To measure voltage across R_1 and R_2 in the diagram below, a voltmeter could be connected between points:



- A. A and B
 - B. F and A
 - C. H and C
 - D. H and F
11. Using the information given below, the pressure at the bottom of a 300 ft. tank that is $\frac{1}{2}$ full of water is calculated to be:

$$P = 0.43 \times H$$

Where:

P=Pressure

H=Height of water in the tank

- A. 32.25 psi
 - B. 64.5 psi
 - C. 129 psi
 - D. 150 psi
12. Four identical electrical fan coils, each rated at 120 volts AC, are connected in parallel with one another. If one fan coil develops an open circuit, then:
- A. None of the fans will run.
 - B. Three of the fans will run.
 - C. The remaining fans will run, but at a slow speed.
 - D. The remaining fans will run, but at a higher than normal speed.

13. The following is not a protection device for a generator:
- A. Sudden-pressure relay.
 - B. Under-frequency relay.
 - C. Volts per hertz relay.
 - D. Directional over-current relay.
14. Excessively high temperature on a boiler feed pump could be caused by:
- A. Vibration
 - B. No or low cooling water flow
 - C. High surge tank water level
 - D. Low drum level
15. To ensure that it is safe to work on a piece of electrical equipment, the equipment must be:
- A. Disconnected and tagged from its electrical source
 - B. Tagged on its control switch
 - C. Isolated from its electrical source
 - D. Tagged in control room
16. The following is a major safety concern when working with superheated steam:
- A. it's invisible
 - B. it's noisy
 - C. it's combustible
 - D. it's moisture level is high
17. A type of valve that rotates on a pin and is used with low flow pressure is a:
- A. Stem valve
 - B. Stop valve
 - C. Solenoid valve
 - D. Butterfly valve

18. Two factors involved in turning water into steam are temperature and:

- A. Flow
- B. Pressure
- C. Water chemistry
- D. Water level

19. The purpose of a condensate pump is to pump water to the:

- A. Deaerator
- B. Boiler feed pump
- C. Hotwell
- D. Coldwell

20. A reason to maintain proper drum level is to:

- A. Prevent water hammer in the deaerator
- B. Prevent water carryover into superheater
- C. Reduce hotwell makeup
- D. Reduce flow to the reheat

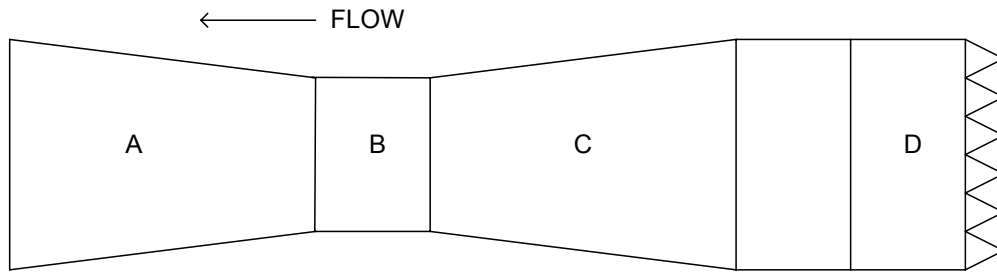
21. The relief safety valve lift setting is greatest on:

- A. LP feedwater header
- B. LP drum
- C. HP drum
- D. HP superheater

22. Turbine speed is controlled by:

- A. Line voltage
- B. Generator voltage
- C. Stop valve
- D. Control valves

23. In the gas turbine diagram provided, the inlet section is:



Gas Turbine

- A. A
 - B. B
 - C. C
 - D. D
24. If the field excitation is decreased on an AC generator:
- A. Vars will increase.
 - B. Vars will decrease.
 - C. Watts will increase.
 - D. Watts will decrease.
25. The purpose of the exciter in a generator is to:
- A. Convert DC voltage to AC voltage
 - B. Convert AC voltage to DC voltage
 - C. Maintain field voltage
 - D. Maintain stator winding temperature

26. The estimated weight of steel is 500-lb/cu ft. The weight of the box (including the four sides and the bottom) in the figure below is:

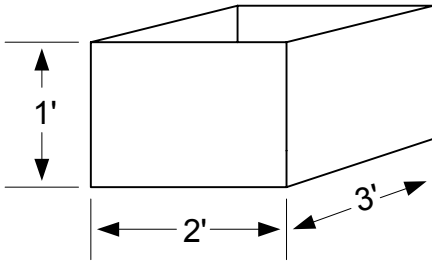
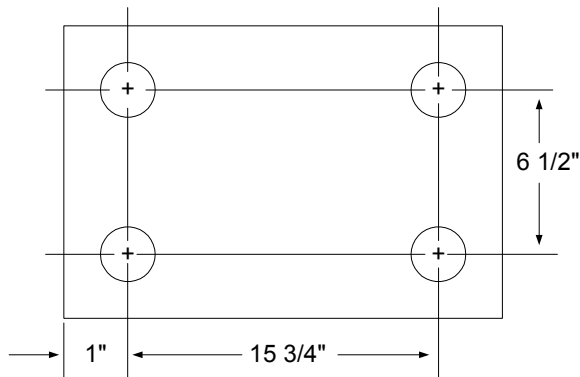


Plate thickness = 3 inch
 Width = 2 ft.
 Height = 1 ft.
 Length = 3 ft.

- A. 1000 lb.
 B. 1500 lb.
 C. 2000 lb.
 D. 3000 lb.
27. The weight of the piece of metal described below is approximately:
- * METAL PLATE 3' X 6' X 3" WITH A 9" SQUARE HOLE CUT IN THE CENTER
 - * WEIGHT OF THE METAL = 490 LBS/FT³
- A. 1163 lb.
 B. 1838 lb.
 C. 2136 lb.
 D. 2205 lb.
28. To fabricate the base plate shown below from a 1/2" plate, the overall size would be:



- A. 1/2" x 6 1/2" x 16 3/4"
 B. 1/2" x 8 1/2" x 16 3/4"
 C. 1/2" x 6 1/2" x 17 3/4"
 D. 1/2" x 8 1/2" x 17 3/4"

29. Using the information below, determine the turning rate of gear B.

Speed of gear A= 110 rpm

Number of teeth on gear A=24

Number of teeth on gear B=64

Number of teeth on gear C=16

To determine turning rate of gear B, use

$$S_B = \frac{N_A \times S_A}{N_B}$$

Where:

S_A = Speed of gear A

S_B = Speed of gear B

S_C = Speed of gear C

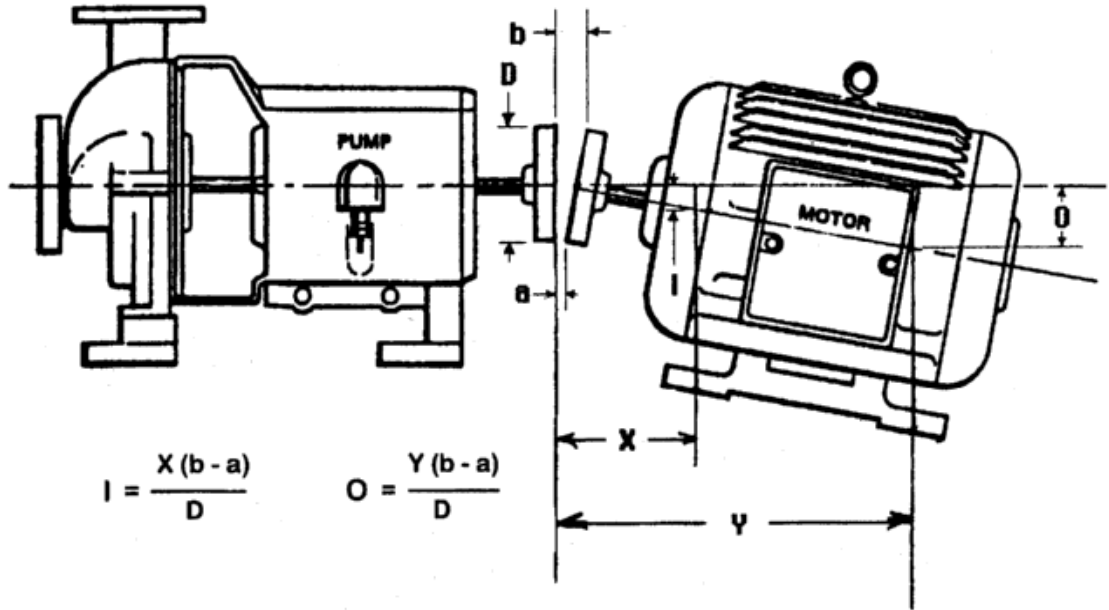
N_A = Number of teeth on gear A

N_B = Number of teeth on gear B

N_C = Number of teeth on gear C

- A. 22.6 rpm
- B. 41.25 rpm
- C. 57.5 rpm
- D. 110.0 rpm

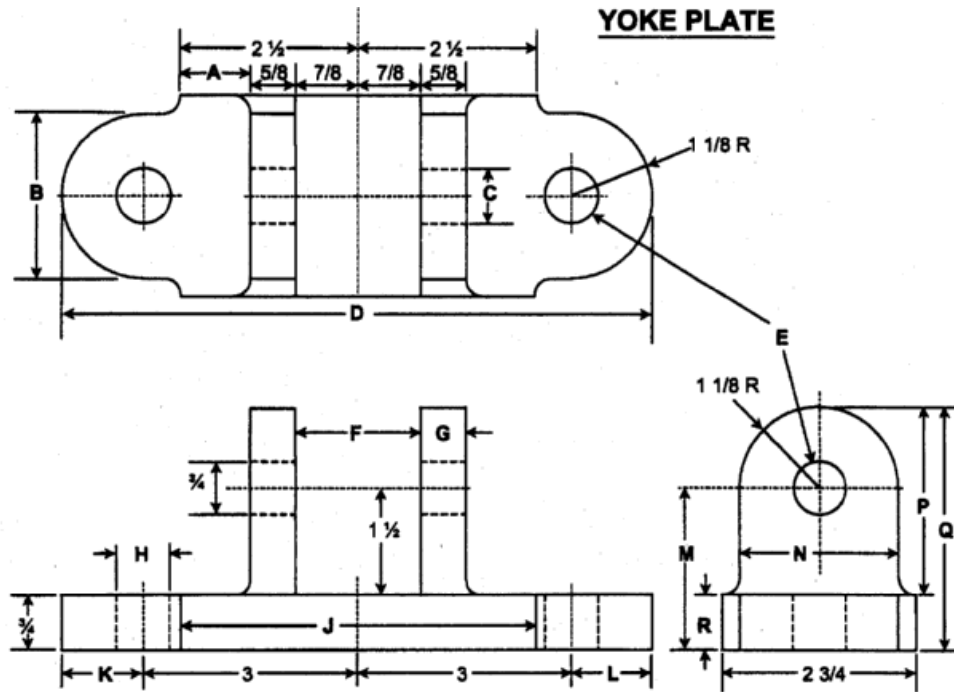
30. Using the information provided below, the amount of shim to be added to the inboard "I" and the outboard "O" feet of the motor are:



$a = 0.003''$, $b = 0.010''$, $D = 2''$, $X = 2''$, $Y = 10''$

- A. .007 for the inboard .035 for the outboard
- B. .007 for the inboard .045 for the outboard
- C. .009 for the inboard .035 for the outboard
- D. .009 for the inboard .045 for the outboard

31. Refer to the Yoke Plate drawing. Dimension "A" is:



- A. 1/2
- B. 1
- C. 1 1/2
- D. 2 3/4

32. What type of valve would be used to regulate flow?

- A. Globe valve
- B. Check valve
- C. Diaphragm valve
- D. Relief valve

33. The following bearing would not normally be lubricated with oil:

- A. Ring bearings
- B. Babbitt bearings
- C. Low speed roller bearings
- D. Kingsbury thrust bearings

34. When handling a caustic chemical, the following hand protection should be used:

- A. Leather gloves
- B. Fabric gloves
- C. Welding gloves
- D. Rubber gloves

35. The following represents a “Class A” fire:

- A. Paper fire
- B. Metal fire
- C. Oil fire
- D. Electrical fire

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Answer Key

1. A	11. B	23. D
2. A	12. B	24. B
3a. C	13. A	25. C
3b. D	14. B	26. C
3c. B	15. A	27. C
4. A	16. A	28. D
5. C	17. D	29. B
6. C	18. B	30. A
7. A	19. A	31. B
8. C	20. B	32. A
9. C	21. C	33. C
10. C	22. D	34. D
		35. A

Explanation of Correct Answers

Note: For some questions, there may be alternative ways to arrive at the correct answer.

1. A

Total resistance for a circuit connected in parallel ($R_1 = 150$, $R_2 = 200$, $R_3 = 300$):

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$R_T = \frac{1}{\frac{1}{150} + \frac{1}{200} + \frac{1}{300}}$$

$$R_T = 66.67 \text{ ohms}$$

2. A

Total capacitance in a circuit connected in a series ($C_1 = 8$, $C_2 = 2$, $C_3 = 12$):

$$C_T = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

$$C_T = \frac{1}{\frac{1}{8} + \frac{1}{2} + \frac{1}{12}}$$

$$C_T = 1.41 \mu\text{f}$$

3a. C

Break down the problem into steps:

- First, add the first 2 resistors ($R_1 = 2$, $R_2 = 5$) (connected in series) using $R_T = R_1 + R_2$:

$$R_T = 2 + 5 = 7$$

- Then, use the resulting value as R_1 in the formula for 2 resistors of different values connected in parallel ($R_1 = 7$; $R_2 = 10$):

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{7 \times 10}{7 + 10} = 4.12$$

- Finally, use the above value as R_1 in the formula for resistors connected in series ($R_1 = 4.12$, $R_2 = 8$):

$$R_T = R_1 + R_2 \quad R_T = 4.12 + 8 \quad R_T = 12.12 \text{ ohms}$$

3b. D

Total Voltage ($V_1 = 10$, $V_2 = 5$): $V_T = V_1 + V_2$

$$V_T = 10 + 5$$

$$V_T = 15 \text{ volts}$$

3c. B

Ohm's Law for calculating current where ($E = 15$, $R = 12.5$):

$I = E/R$ where $E =$ voltage, $R =$ resistance

$$I = 15/12.5$$

$$I = 1.2 \text{ amps}$$

4. A

Ohm's Law for calculating voltage: $E = IR$ where $I =$ current, $R =$ resistance

- First, calculate total resistance for resistors connected in series ($R_1 = 5$, $R_2 = 10$, $R_3 = 2$):

$$R_T = R_1 + R_2 + R_3 \quad R_T = 5 + 10 + 2 = 17k$$

- Then, determine the current using Ohm's Law ($E = 80$; $R = 17k$):
 $I = E/R$ where $E =$ voltage, $R =$ resistance

$$I = 80/17 \quad I = 4.7$$

- Finally, calculate voltage for M_1 (note that M_1 is only related to the $2\text{ k}\Omega$ resistor):

$$E = IR \quad E = 4.7 \times 2000 \quad E = 9.4 \text{ volts}$$

5. C

The first step is to simplify the circuitry by calculating intermediate values (total resistance) when possible ($R_1 = 2$, $R_2 = 3.5$, $R_3 = 3.5$, $R_4 = 5$, $R_5 = 5$, $R_6 = 15$, $R_7 = 15$):

- Add $R_2 + R_3 = 3.5 + 3.5 = 7$
- Next, calculate the total resistance for the circuits connected in parallel with R_2 and R_3 :

$$R_T = \frac{1}{\frac{1}{R_{2+3}} + \frac{1}{R_4} + \frac{1}{R_5}} \quad R_T = \frac{1}{\frac{1}{7} + \frac{1}{5} + \frac{1}{5}} \quad R_T = 1.84$$

- Then, calculate the total resistance for R_6 and R_7 connected in parallel ($N = \#$ resistors):

$$R_T = R/N \quad R_T = 15/2 \quad R_T = 7.5$$

- Now calculate the total resistance for circuits connected in series using the R_T values from the 2 parallel circuits (R_2 includes R_2, R_3, R_4, R_5 ; R_3 includes R_6, R_7):

$$R_T = R_1 + R_2 + R_3 \quad R_T = 2 + 1.84 + 7.5 \quad R_T = 11.34$$

- Finally, calculate the current using Ohm's Law:

$$I = E/R \quad I = 40/11.34 \quad I = 3.5$$

6. C

This problem can be solved in three steps:

- First, calculate the RMS current flow:

$$V_{\text{rms}} = V_{\text{peak}} \times .707 \quad V_{\text{rms}} = 200 \times .707 \quad V_{\text{rms}} = 141.4 \text{ volts}$$

- Then, calculate total resistance for currents connected in series ($R_1 = 5$, $R_2 = 15$):

$$R_T = R_1 + R_2 \quad R_T = 5 + 15 \quad R_T = 20 \text{ K}$$

- Finally, divide RMS voltage by the total resistance:

$$V_{\text{rms}} / R_T = 141.4 / 20\text{K} = 7.1 \text{ milliamps}$$

7. A

Calculate the watts for each resistor and compare results:

$$\text{Ohm's Law } \text{Watts} = \frac{\text{Volts}^2}{\text{Ohms}}$$

$$W_1 = 120^2 / 6 = 2400$$

$$W_2 = 120^2 / 8 = 1800$$

$$W_3 = 120^2 / 12 = 1200$$

$$W_4 = 120^2 / 16 = 900$$

The 6 k-ohm resistor dissipates the highest watts.

8. C

A 5:1 potential transformer indicates a 5:1 turn ratio. Line voltage can be calculated by multiplying voltage from the secondary on the transformer by the value indicated by the transformer. Here, the line voltage will be 5 times the voltage from the secondary on the transformer:

$$5 \times 120 = 600 \text{ volts}$$

9. C

The circuit in the diagram is center tapped. Therefore, only half of the voltage will be measured across the load resistor. The 1:5 transformer indicates that the secondary of the transformer will be 5 times the line voltage:

$$120 \times 5 = 600 \qquad 600/2 = 300$$

10. C

Look for common points in the circuit:

A voltmeter connected between A and B does not include any resistors.

A voltmeter connected between F and A includes R_2 and R_3 only.

A voltmeter connected between H and F includes R_1 only.

A voltmeter connected between H and C includes both R_1 and R_2 .

11. B

Calculate pressure using the formula provided:

$$P = 0.43 \times H \text{ where } P = \text{pressure, } H = \text{height of water in tank}$$

The height of water in a 300 ft tank that is $\frac{1}{2}$ full = 150 ft.

$$P = 0.43 \times 150 \qquad P = 64.5 \text{ psi}$$

12. B

When connected in parallel, the three remaining coils are not affected by the open circuit created by the failed coil. Therefore, the remaining three fan coils will still operate at normal speed.

13. A

A sudden-pressure relay is specifically used to protect a transformer.

The remaining relays may all be used to protect a generator.

14. B

Water is the cooling medium. If no water is getting in or through the pump coolers, oil temperature will be high due to lack of a cooling mechanism.

15. A

Without disconnecting equipment from its electrical source, it could be energized and operated.

16. A

Superheated steam is above the saturation point, so it has no moisture to create a visible indication.

17. D

The use of a butterfly valve allows the valve to be opened and is usually not used for throttling or controlling flow.

18. B

In order to turn water into steam, the molecules must spread out. While temperature influences the velocity of molecules (higher temperatures cause an increase in velocity), pressure influences the ability of the molecules to spread out (high pressure keeps molecules compact, low pressure allows molecules to spread freely). Therefore, as pressure increases, so does the temperature required to turn water into steam.

19. A

The condensate pump supplies the water to the deaerator, where condensable gases are removed and water is preheated for use in the boiler.

20. B

An improper drum level can cause water to carry over into the superheater, which may cause damage to the steam turbine and cracking in the superheated tubes.

21. C

HP drum maintains the highest pressure in the steam cycle – and therefore has the highest setting. In order to maintain flow through the superheater section for protection of the boiler, the HP superheater safety must vent first – and therefore has a lower setting. By definition, the LP feedwater header and LP drum are at lower pressure.

22. D

Control valves allow for fine-tuning or control of the steam required to maintain constant or proper turbine speed.

23. D

A is the turbine section.
B is the combustion section.
C is the compressor section.
D is the inlet section.

24. B

Watts are not dependent on the field excitation of an AC generator. Reducing the field excitation lowers the generator voltage, which in turn will decrease the Vars output.

25. C

The exciter system generates electricity for the main generator field winding.

26. C

Calculate the weight of each plate (4 sides and a bottom), then add them together:

3 inches = .25 ft

L x W x H for each plate

$2(3 \times 1 \times .25) = 1.5$ (2 long sides)	$1.5 \times 500 = 750$ lbs.
$2(3 \times 1 \times .25) = 1.0$ (2 short sides)	$1.0 \times 500 = 500$ lbs.
$2 \times 3 \times .25 = 1.5$ (bottom)	<u>$1.5 \times 500 = 750$ lbs.</u>

2000 lbs.

27. C

This problem requires 3 steps:

- Calculate the total weight of the metal plate:

3 inches = .25 ft; 9 inches = .75 ft

L x W x H

$$3 \times 6 \times .25 = 4.5 \text{ ft}^3$$

$$4.5 (490) = 2205 \text{ lbs.}$$

- Calculate the weight of the 9" square of metal:

$$L \times W \times H$$

$$.75 \times .75 \times .25 = .141 \text{ ft}^3$$

$$.141(490) = 69 \text{ lbs.}$$

- Subtract the weight of the 9" square from the total weight of the metal:

2205 lbs.

$$\begin{array}{r} - 69 \text{ lbs.} \\ \hline \end{array}$$

2136 lbs.

28. D

The diagram indicates a 1" square at each corner of the plate. Therefore, the length of each side of the plate is 2" (1" on each corner) longer than the values provided in the diagram:

$$15.75'' + 1'' + 1'' = 17.75''$$

$$6.5'' + 1'' + 1'' = 8.5''$$

The dimensions of the plate are $\frac{1}{2}'' \times 8 \frac{1}{2}'' \times 17 \frac{3}{4}''$

29. B

Using the formula provided: $S_B = \frac{N_A \times S_A}{N_B}$

$$S_B = \frac{24 \times 110}{64} \quad S_B = 41.25 \text{ rpm}$$

30. A

Using the formulas provided:

$$I = \frac{x(b-a)}{D} \quad I = \frac{2(.010 - .003)}{2} \quad I = .007$$

$$O = \frac{y(b-a)}{D} \quad O = \frac{10(.010 - .003)}{2} \quad O = .035$$

31. B

Based on the drawing, we know that Dimension A + 5/8 + 7/8 will equal 2 1/2.

- Convert 2 1/2 to eighths:

$$A + 5/8 + 7/8 = 20/8$$

$$A + 12/8 = 20/8$$

$$A = 20/8 - 12/8$$

$$A = 8/8 = 1$$

32. A

A check valve is either open or shut.

A diaphragm valve is used to stop flow.

A relief valve opens under pressure.

Of the options listed, a globe valve is the only one that is used to regulate flow.

33. C

Low speed roller bearings are normally lubricated with grease.

34. D

Although additional types of hand protection may be worn, rubber is the only type of hand protection listed that will protect against caustic chemicals. The leather, fabric, and welding gloves would allow the chemical to soak through and touch the skin.

35. A

Paper fires are class A.

Oil fires are class B.

Electrical fires are class C.

Metal fires are class D.

Section 4: Test Results, Feedback, and Retest Policy

Test Results

Test results will be generated based on the total number of questions you answer correctly. There is no penalty for guessing, so you should do your best to answer every question that you can during the time allotted. Test results are provided in terms of “Qualified” or “Not Qualified”, so your total test score will never be seen. If you receive a test result of “Qualified”, then you have passed the test.

The results of your test will become part of Southern Company Human Resource’s records. Your test responses and feedback report (described in the following section) will be strictly confidential, and will not be available to the hiring manager, selection committee, current or potential supervisors or co-workers. Southern Company Human Resources will provide you and the hiring manager with a “Qualified” or “Not Qualified” decision.

Test Feedback

In addition to a “Qualified” or “Not Qualified” test result, you will receive feedback regarding your performance on the 22 content areas listed in Section 2 of this Study Guide. You will be assigned a skill level (“Strength”, “Acceptable”, or “Developmental Need”), and provided with a worksheet that you can use to guide your own professional development in each of the content areas. A sample worksheet is provided below:

General Plant Operator/Operations Technician Feedback					
Candidate Information					
Candidate Name:	Sample Test				
SSN:	123-45-6789				
Test Date:	2/23/2007				
Test Result:	Qualified				
Content Areas	Skill Level	Development Priority	Development Activities	Target Date(s)	Status
Electrical Theory	Strength				
Electrical Troubleshooting	Strength				
Electrical Test Equipment	Strength				
Hydraulics and Pneumatics	Acceptable				
Print Reading	Acceptable				
Electrical Applications	Acceptable				
Electrical/Mechanical Procedures	Acceptable				
Plant Auxiliaries	Acceptable				
Electrical/Mechanical Clearances	Acceptable				
General Power Plant Operation	Acceptable				
Boiler Operation	Strength				
Turbine Operation	Strength				
Generator Operation	Acceptable				
Plant Electrical	Acceptable				
Basic Hand & Power Tools	Developmental Need				
Rigging & Hoisting	Developmental Need				
Precision Measurement	Acceptable				
Millwright Work	Developmental Need				
Equipment Lubrication	Acceptable				
Mechanical Prints & Drawings	Acceptable				
General Plant Safety	Strength				
Fire Prevention	Strength				

As stated above, your feedback report will be kept confidential. You may, however, choose to show your report to your supervisor or other members of management so that they may assist you with developmental planning. However, should you be hired into a GPO/Op Tech position, your new manager/supervisor will receive a copy of your feedback report for training and development purposes.

Retest Policy

Unsuccessful candidates may opt to retake the test in accordance with Southern Company's retest policy. Candidates must be actively in consideration for an open position and may be invited to take the test for a second time no sooner than 90 days after their 1st attempt. If unsuccessful, they may be invited to take the test for a third time no sooner than 90 days after their 2nd attempt. Candidates who wish to take the test for a fourth time must wait 18 months following their 3rd attempt. The retest policy is summarized in the table below:

<i>Attempt</i>	<i>Waiting Period</i>
2 nd attempt	90 days following 1 st attempt
3 rd attempt	90 days following 2 nd attempt
4 th attempt	18 months following 3 rd attempt

Additional Resources

Classes and Correspondence Courses

An additional option for training is a classroom-based course at a local technical school or college. Compare the course curriculum to the list of skills and knowledge areas outlined in Section 2 of this study guide to determine if a course covers what you need. It may also be helpful to review the list with the instructor. Call your local technical school or college and ask about their registration requirements. This information should also be available at the institution's website.

If you are unable to complete a classroom-based course, another option would be to check online for any correspondence or self-directed courses that cover the skills and knowledge areas targeted by the test.

Reference Books and Other Publications

Useful reference books may be found at your public library, your local bookstore, or online. Reference books may cost between \$20 and \$50, or sometimes more. However, some websites may sell them used, and they can usually be checked out of the library at no charge. In addition, industry/trade magazines or journals may be a good resource for the latest information and trends in the field.

On the Web

New books, courses, and websites are being developed all the time. A final recommendation would be to search online to see what other resources might be available to you.

Section 5: Testing Tips

General Testing Tips

Introduction

This section will introduce a number of tips and strategies for taking tests. It will remind you of important behaviors prior to the test as well as certain strategies you may use during the test session. As you read these strategies, try to determine which suggestions would be most helpful to you. Different people may find some of the suggestions more helpful than others.



Preparation over a period of time will increase recall.

Advance Preparation for the Testing Session

There are some things you may do in advance in order to best prepare for the testing session. Reading and studying this guide is part of a good preparation strategy. Studies have shown that memory works best when a subject or topic is studied over multiple occasions during a long period of time. Utilizing this strategy, it may be best to start studying the material contained in this guide and other resources well ahead of attending the testing session.

Become familiar with the nature of the questions that will be asked in the test session by completing the sample questions in this guide. You will feel more comfortable during the testing session if you are familiar with the types of questions you will see prior to the session.



The average adult requires about 8 hours of sleep a night in order to feel rested.

Take care of your well-being before the test session. For about a week prior to the test session, be sure to get enough sleep. You should also take steps to increase your *quality* of sleep. Your body repairs itself primarily during sleep. Disrupted sleep affects memory, mood and general well being. Alcohol inhibits the body's natural rhythm, which in turn will interrupt sleep. You should avoid alcohol near the test date. Caffeine in the evening, or excessive caffeine at any time, will make it more difficult to fall asleep and will also affect the quality of sleep.

A good diet may also affect problem solving and your ability to perform well in the testing session. Make sure that you get enough nutritional foods in the weeks before the testing session.

Sleep deprivation leads to memory function decrease.

Relax, if you've prepared well by utilizing this guide and using good study skills, you are more likely to perform well.

The test administrator has the authority to not allow any items he or she feels are unnecessary or violate test guidelines.

On the Day of the Test

Below are the specific actions that you can take to start the testing session relaxed and ready to do your best:

- Eat enough to not be hungry, but not so much that you are stuffed.
- Do not drink a lot of liquids prior to the testing session.
- Avoid any medication that may make you drowsy.
- Arrive early.
- Settle in and try to relax.
- Realize that even if you prepared well, you may be nervous or stressed.

Below is a list of items that will **not** be allowed into the testing session:

- Laptop computers
- Study guides
- Notes
- Beepers
- Cellular phones
- MP3 players/portable CD players

Note: Only basic scientific calculators will be permitted.

During the Test Session

During the test session, it is important to stay relaxed and focused on the test. To perform your best, you need to be positive and confident. Work quickly but accurately. You may find it helpful to wear a watch to the testing session. This will help you monitor the time. You should try to complete all the questions in the test, but if you find yourself working a little slowly, do not sacrifice accuracy for speed.

Listen to and read the instructions carefully

The test administrator will read the instructions aloud. Be sure to follow along in the test booklet. Each test may have different instructions. If so, the instructions will clarify any items that are specific to the test you are taking. Be sure that you understand what to do for each test. If you have any questions be sure to ask them at this time. Once the test begins, the test administrator will not be able to answer any questions.

Know the time limits

If the test is timed, the test administrator will read aloud the time limit for each test during the instructions. Make a note of the start time. **Do NOT set your watch alarm.** It is important to use the time limits to pace yourself. Occasionally, check your testing progress against the time limit.

Do not spend too much time on any one question

If you are having difficulty answering a question, go on to the next question. If you have time left when you get to the end, you may go back and answer any skipped questions. If you do skip a question, be sure to skip the corresponding answer space on the answer sheet.



Bring a watch to the testing session to monitor the time limits.



The tests are timed. It is important to pace yourself.

Try to provide an answer for every question

Answering Questions

During the test, it is important to stay relaxed and focused. Your score is determined by the number of questions answered correctly. It is important to try to answer all the questions. Next, we will discuss some strategies that will assist you when you encounter a question that you have a hard time answering.

Eliminating Incorrect Responses

If you are unsure of the correct response, try to eliminate the responses that you know are wrong. It is generally better to eliminate the responses and take an *educated* guess than to leave an item blank. Below is a sample:

Which of the following would most likely be found in a bedroom?

- A. Pillow
- B. Spoon
- C. Book
- D. Refrigerator

“Refrigerator” would obviously be found in a kitchen. You now have “Pillow”, “Spoon”, and “Book” remaining. You know that spoons and books may be found in a bedroom **if** someone was eating or reading in bed. However, the question asks which one would “most likely” be found in a bedroom; you know that generally a bed with pillows is found in a bedroom, so the best answer is “A”, “Pillow.” In this question, the key words “most likely” helped you eliminate some choices

Difficult Questions

Were there any other questions in the test that are similar in subject matter? It is possible that other questions in the test may contain a clue to the correct response to a difficult question.

Matching Response to Question

There may be a phrase in the question that matches, or closely resembles, a portion of the response. An example is provided below:

Which magazine would you consult first to locate articles on the use of yeast in baking?

- A. Restaurant Today
- B. Home Baking
- C. Home Improvements
- D. Psychology Today

The correct response is “B”. The word “baking” appears in the question and in the correct response.



Try to eliminate responses to give you a better idea of the correct response.



Studying is the best way to know the answers to the test items. However, difficult questions may require educated guessing.



Check your local library for additional resources on effective test taking strategies.



You may find additional resources online.

Additional Resources on Test Taking Strategies

It is up to you to be well prepared for the testing session. This guide introduced some basic steps which will help you feel more positive and confident about test taking. We have also provided some training on answering difficult questions. There are numerous books that have been written on test taking and strategies for test taking. If this is a subject that interests you, check your library or the internet for additional resources.

If you have any additional questions about the GPO/Op Tech test, or the use of this Study Guide, please contact **Southern Company Human Resources**.