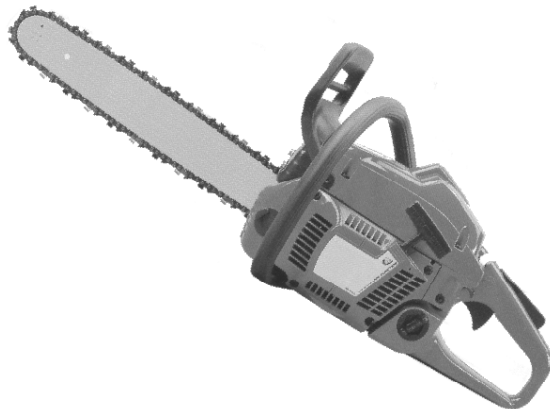




Outdoor Power Equipment Technician

Study Guide



Power Equipment

Final Period and Qualification

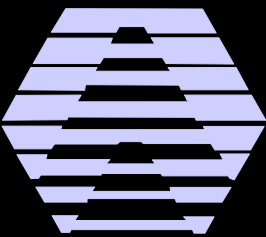


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SECTION ONE: TOPIC FLOW CHARTS

MECHANICAL TRANSMISSIONS

Transmissions	Types of Construction	Shifting Mechanisms	Theory of Operation
	Parts Nomenclature	Gear Ratio	
Transaxles	Types of Construction	Shift Mechanisms	Clutches
	PTO Drive		
Differentials	Operation	Backlash	Tooth Contact
Final Drives	Worm Gears	Disc Drive	Chain & Sprocket
Trouble shooter	Gear Failure	Bearing Failure	Roller chain Inspection
Assembly Techniques	Bearing Preload	Shaft Shimming	Retaining Rings
	Seal & Bearing Installation	Lubrication Requirements	Retaining Rings

Hydrostatic Drives

Hydraulic Principle	Fluid Characteristics	Laws & formulas	Flow Principles
	Pressure Relationships		
Basic System Operation	Piston Type	Gear Type	Vane Type
	Theory of Operation	Parts Nomenclature	Inspection & Repair
Valves	Directional Control Types	Flow Characteristics	Pressure Types
	Sequence Operation & Placement	Priority Operation	
Actuators	Motor	Cylinders	Accumulators
	Theory of Operation	Parts Nomenclature	Inspection & Repair
Problem Diagnostics	Test Equipment	Hydraulic Fittings	Safety Precautions

Electrical/Electronics

Electrical Basics	OHMS law	Power Formula	Series Circuit
	Parallel Circuit	Meter Usage	
Batteries	Wet Cell Maintenance Free Dry Cell	Chemical Action	Activate Procedure
	Charging and Installing	Testing	Safety Precautions
Charging System	Different Types	Stators	Rectifiers
	Regulators	Static Tests	Dynamic Tests
Starting Systems	Manual Recoil	Electric Start	Starter Motor
	Solenoids	Voltage Drop & Current Measurement	Relays & Safety Interlock
Magneto Points Ignition	Condenser Operation	Points & Timing	Component Testing
	Kill Switches		

Battery Points Ignition	Spark Polarity	Ignition Switches	
Magneto CDI	Theory of Operation	Charge Coils	Trigger Coils
	Semi-conductor Characteristics	System & component Testing	
Magneto Transistorized Ignition	Theory of Operation	Components Identification	Components Testing
Computer Controlled Ignition	Theory of Operation	Advance Retard	Sensor Input
Safety Interlock Circuits	Electric Start	Seat Switches	PTO Switches
	Trouble shoot Procedures	Safety Procedures	

Advanced Fuel Systems

Electronic Fuel Injection	Operating Principles	Fuel Components	Sensor Components
	Electronic Control Unit		
Fuel Components	High Pressure Pump	Fuel Pressure Regulator	Fuel Injectors Fuel Rails
	Fuel Lines Fuel Fittings Fuel Tanks		
Sensor Components	Throttle Position Indicator	Engine Speed Sensor	Oil Temperature Sensor
	Oxygen Sensor		
Electronic Control Unit	Malfunction Indicator Light	Closed Loop Operation	Open Loop Operation
	Limp Home Operation		
Fuel Testing System	Measure Fuel Pressure	Inspect and Test Injectors	Fuel System Bleeding
Sensor Testing	Connectors and Grounding Inspection	Resistance Measurements	Voltage Measurements
	MIL Operation		

System Wiring	Battery Connect and Disconnect	Battery Charging and Boosting	Relays Inspection
	Multi Connectors and Grounding		
Alternate Fuels	Liquid Propane Gas	Kerosene	Components of each
	Operating Principles		
LPG	Problem Diagnosis	Adjustment Procedures	Safety Concerns
Kerosene	Mixture Re-adjustment	Modifications required if converting from Gasoline	
Diesel Low-pressure System	Fuel Tanks	Filters	Fuel Tank Fittings
	Primer Pumps	Electric Pumps	Diaphragm Pumps
Diesel High-pressure System	Pump Types	Pump Timing	Delivery Valves
	Fuel Lines and Fittings	Injector Types and Construction	Injector Testings
Diesel Fuel system Troubleshooting	Bleeding Procedures	Under Fueling	Over Fueling

Sensor Testing	Cylinder Cancellation Testing	Resistance Measurements	Voltage Measurements
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Generators

Electromagnetic Induction	RPM	Magnetic Strength	Number of Windings
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Proximity Air Gap	Polarity
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Generator Types	Standard	Bobbin	Condenser
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Inverter

Electrical Components	Exciter Winding	Sensor Winding	Sub Winding
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Field Winding Rotor	AVR	Back up Coil
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Capacitor

Components Testing Static	Continuity of Windings	Open Circuits	Short to Ground
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Rectifier Testing

Component Testing Dynamic

AC Output

DC Output

Full Field Test

Engine Features

Low Oil Shut Down

Electric Fuel solenoid

Governor Adjustment

Loaded Engine RPM

Cutting Equipment/ Handheld Power Accessories

Two Cycle Engines	Operating Theory	Exhaust Scavenging	Diaphragm Carburetors
	Failure Analysis		
Chain Saws	Cutting Chain Repair	Chain Maintenance	Chain Troubleshooting
	Quick Bar Maintenance		
Clutching	Chain Saw and String Trimmer	Operational Theory	Basic Troubleshooting
Water Pumps Low Pressure	Parts Nomenclature	Disassembly Procedures	Reassembly Procedures and Adjustment
Clutching PTO	Electric	Mechanical	
Water Pump High Pressure	Parts Nomenclature	Theory of Operation	Adjustment
	Troubleshooting		
Rotary Mowers	Blade Tip Speed	Levelling	Belt Installation
	Drive Shafts		

SECTION TWO TOPIC OBJECTIVES**General Knowledge** (from years 1, 2, 3)

1. Understand the basic laws of electricity and be able to wire, diagnose and calculate values for the various circuits used in a marine application.
2. Know the types and proper use of precision measuring tools.
3. Describe and troubleshoot the various cooling systems used in power equipment engines.
4. Know the various four stroke and two stroke engine designs, their advantages, disadvantages and the applications where they may be used.
5. Compare the operation of the two and four stroke engine, compare their relative volumetric efficiency.
6. Describe all the functions of exhaust systems.
7. Know the typical service procedures for both two and four stroke engines.
8. Diagnose and describe failures to bearings and seals as well as understand the operation and placement of the various bearings and seals.
9. Describe the operation of a lead acid battery and the methods used to safely service and maintain the battery.
10. Describe the various starting and charging systems in use and the problems that may arise as a result of failures to any of the systems components.
11. Know P.D.I. procedures for power equipment.
12. Describe and troubleshoot hydraulic systems.

Practice Questions

13. What is Ohm's law?
14. What are the three measurements that a vernier calliper can measure?
15. Why does an overhead cam engine have a higher maximum R.P.M. than a push rod engine?
16. engine?
17. How is L head valve clearance adjusted on an engine that does not have adjustable lifters?
18. What is valve float?
19. How would you trouble shooting a hydraulic system that won't hold pressure?
20. What is the difference between a loop charged engine and a cross scavenged engine?
21. What determines when the engine achieves the best volumetric efficiency on a four stroke? Two stroke?
22. What are the electronic and mechanical engine management systems found in power equipment?

23. What three things are required to produce electrical energy mechanically?
24. What is the diode trio and what function does it serve in an alternator?
25. How does an automatic decompression system work?
26. What will the voltage drop test tell you about the starting circuit of an engine?
27. How does the commutator and brushes of a starter motor change the direction of current flow in the armature of the starter motor?
28. How can you change the volumetric efficiency (power output) of a two stroke engine?
29. What is actually measured with a dwell meter?

Mechanical Transmissions

1. Be familiar with various transmissions and transaxle assemblies as used in both consumer and individual equipment including design consideration and parts nomenclature.
2. Know proper nomenclature for all types of gears and their parts.
3. Be able to calculate gear ratio and shaft speed and direction.
4. Identify transmission gear failures, including operator error, lack of lubrication, improper assembly and shifting problems.
5. Be familiar with the lubrication requirements of various transmissions and transaxles.
6. Know proper names of all parts of all bearing types that may be found in a transmission or transaxle.
7. Be able to identify and diagnose different types of bearing failures.
8. Be able to properly assemble a transmission or transaxle ensuring correct gear backlash, shaft end float, retainer and lip installation, seal and bearing installation.

Practice Questions

1. Name the type of gear that has its teeth machined at an angle.
2. Name 4 materials that transmission gears might be made of.
3. What might be the cause(s) of excessive backlash in a level gear set and what would be the results?
4. Choose a transmission and calculate gear ratios for all forward and reverse speeds.

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5. What is the recommended lubricant for both popular brands of in-line shift gear transmissions?
 6. What would be the result of installing a bearing in a housing by driving on the inner race?
 7. Which direction is a typical double lip seal installed?
 8. Which way does an external retaining ring face when installed correctly?
 9. How is excessive transmission shaft endplay corrected?
 10. What holds an H-shift transmission in gear?
 11. How is preload on a tapered roller bearing set?

Hydrostatic Drive

1. Be able to understand and apply principles of flow and pressure; hydraulic formulas.
2. Be familiar with the use of hydraulic measuring tools and their connection as used for diagnostic purposes.
3. Be able to describe the operation of open and closed loop systems.
4. Be able to identify the different directional control valves and how they are actuated.
5. Understand how different relief valves operate in various hydraulic circuits.
6. Troubleshoot hydrostatic drive problems including hydraulic pumps and motor disassembly and inspection.
7. Be able to explain the operation of swash plates as used in hydro drives.
8. Be familiar with various hydraulic fittings and hoses as used on lawn/garden and commercial equipment.
9. Be familiar with different types of hydraulic seals as well as any special installation techniques.

Practice Questions

1. Explain the purpose of an accumulator in a hydraulic system.
2. How would a weak pressure relief valve affect hydraulic system performance?
3. How would you clean/repair a sticky directional control valve?
4. Explain the operation of an electric over hydraulic directional control valve and also how much power/amps the electrical circuit would carry.
5. How are the various hydraulic actuators cushioned?

6. What would be a good symptom of hydrostatic charge pump inlet restriction?
7. Would a restriction on the inlet line to the actuator affect its performance? If so, how?
8. Explain how hydraulic motor torque can be varied.
9. Explain how the swash plate controls ground speed and direction.
10. Describe how the implement drive motor is powered by the hydraulic system.

Electrical/Electronics

1. Be able to perform calculations involving Ohm's Law and finding power (Watts).
2. Be familiar with properties and characteristics of series and parallel circuits.
3. Know how to use a multi-meter correctly to measure resistance, voltage, current and continuity.
4. Understand the significance of voltage drop measurements in an operating circuit.
5. Be able to correctly and fully P.D.I., service and test storage batteries of all types used in this industry.
6. Be able to troubleshoot, maintain and adjust magneto points ignition system.
7. Know the operation theory of a battery points ignition system.
8. Realize the difference between magneto and battery powered C.D.I. and how to troubleshoot and test each.
9. Understand the operational theory of magneto powered transistorized ignition.
10. Be able to explain the operation of computer controlled ignition and testing precautions involved.
11. Be familiar with the properties and operating characteristics of semi-conductors as may be used in ignition, charging and fuel systems.
12. Be familiar with the operation and components of battery charging systems as found on lawn and garden equipment.
13. Be able to test and troubleshoot various types of charging systems.
14. Understand how the electric start system operates, including both high and low current sides.
15. Be able to test all electric start system components as well as the systems as a whole.
16. Be familiar with safety interlock devices and circuitry and how they interface with ignition kill and electric start circuits.

Practice Questions

1. Why are diodes used in the ignition shut-off circuit on some V-twin engines?
2. What is the significance of performing a voltage drop measurement across a starter solenoid?
3. List, in order, the steps for putting a new standard wet cell battery into service, as well as how to choose the appropriate charges.
4. Describe all the tests that can be performed on a battery and the significance of each.
5. Explain how the seat safety switch shuts off engine ignition under certain circumstances.
6. Does a half wave charging system include a regulator?
7. With the engine running, would a voltage reading of 14.8 V.O.C. across the battery indicate an overcharge problem?
8. Calculate the fuse required for a circuit to operate 3 of 35w, 12v light bulbs.
9. Describe the operation of both types of magneto powered C.D. ignition systems.
10. Explain the operation of the capacitor in the magneto points ignition system.
11. With a battery points ignition system, is coil polarity a concern and when does ignition occur?
12. If a switch is "open", what would be the ohmmeter reading across it and which range would you select on the meter?
13. On a full wave charging system, an ohmmeter reading between one A.C. lead and ground indicates continuity. Is this okay?
14. Describe how to test a single phase, full wave rectifier using an ohmmeter.
15. List the tests that can be performed on a charging system stator both statically and dynamically.
16. Explain the relationship between point gap, ignition timing and dwell.
17. What might cause a magneto points type ignition coil to be cracked (other than impact)?
18. In order for the electric start to work, a neutral safety switch must be open or closed?
19. Explain the basic function of semi-conductors used in equipment, including diode, S.C.R., transistor, Thermistor, capacitor, resistor, and where each might be used.
20. How much resistance would there be in a 12 volt circuit with 7 amps flowing?
21. As engine speed is increased, some ignition systems provide timing advance. How is this done on the electronic systems (transistorized and C.D.I.)?

NOTES

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22. What is the source of power for the ignition system used on E.F.I. engines?
 23. What is the maximum voltage drop allowed across a switch, length of conductor, or a connection as specified by most manufacturers?

Advanced Fuel Systems

1. Be familiar with E.F.I. operating principles, components and function of each including precautionary measures with battery, connections and cleaning.
2. Be able to identify, remove and replace all E.F.I components and sensors.
3. Understand how malfunctioning E.F.I. sensors will affect running characteristics of the engine.
4. Be familiar with testing procedures pertaining to all E.F.I. sensors.
5. Know how to test fuel pressure on E.F.I. systems.
6. Be familiar with fuel injector testing procedures.
7. Be familiar with operating principles, components and adjustment of L.P.G. fuel systems and related engine components.
8. Be aware of safety concerns when working on or adjusting L.P.G. systems.
9. Be able to connect test equipment required for L.P.G. systems.
10. Be aware of running characteristics and any engine/ignition modifications required when using kerosene as a fuel.
11. Know the differences between wet and dry liners as used on multi-cylinder diesel engines.
12. Be familiar with the different fuel governor types and how each functions.
13. Understand how basic high pressure fuel circuits and where/how to bleed them.
14. Be able to identify the different high pressure fuel pumps and know how each works.
15. Be able to identify the different diesel injector types and how to test them.
16. Be familiar with different pre-combustion chamber designs.
17. Be familiar with diesel fuels, storage and machinery filter systems and components.
18. Be aware of engine pre-heat system and be able to troubleshoot problems with it.
19. Be able to demonstrate different injector pump timing procedures.
20. Be able to perform diesel cylinder compression tests and cylinder leak down test.
21. Be familiar with turbo charges used on diesel engines as to their function, lubrication requirements and different types.

Practice Questions

1. Explain how air/fuel mixture is controlled on E.F.I. engines.
2. What problems or conditions might cause a rich running condition at all speeds?
3. Explain how a fuel injector works.
4. What controls fuel pressure to the injectors on E.F.I. engines?
5. Where is the T.P.I. located?
6. Explain how the E.C.U. operates.
7. How is mixture, strength controlled/adjusted on L.P.G. equipped engines?
8. Are there any engine/ignition modifications required if switching from gasoline to L.P.G.?
9. Are there any engine/ignition modifications required if switching from gasoline to kerosene fuel?
10. Name and explain the three tests that can be performed on diesel fuel injectors.
11. Explain the purpose of the pre-combustion chamber as used in many small multi-cylinder diesels.
12. Explain the procedure that would be used to properly bleed a high pressure fuel system (diesel) that had been run out of fuel.
13. Explain the term "spill timing" as referred to in a diesel fuel system.
14. What would be the symptoms of using summer grade diesel fuel in winter?
15. How would the mechanic diagnose a loose delivery valve in a diesel fuel system?
16. Explain how the engine governor controls the high pressure fuel pump on a diesel.
17. What would be the symptom(s) of a leaking injector on a diesel engine?
18. Why is a water separator used in many diesel fuel systems and not usually on gasoline systems?
19. What could be a serious problem if water gets into diesel fuel system components (i.e. the pump)?

Generators

1. Know and understand principles of electro magnetic current induction.
2. Be aware of the different types of portable generators (standard, bobbin, condenser, inverter).
3. Be familiar with the operation of each type of generator/engine.
4. Know the names and function of all electrical components/windings as found in the various portable generator designs.
5. Be able to explain how to test all electrical components of all types of portable generators.
6. With the aid of a service manual be able to identify and test the various windings of a generator.
7. Know how to test a rectifier using an ohmmeter.
8. Be able to explain how to set up engine controls/governor to ensure proper generator operation under load.
9. Be familiar with the test equipment used to dynamically test generator output.
10. Be familiar with special features of the engine with respect to its fuel and lubrication systems.
11. Describe operation and service of automatic voltage regulators (AVR).

Practice Questions

1. List the four factors that affect the amount of power magnetically included in a coil or winding.
2. List the four types of portable generators and the engine operating characteristics of each.
3. On a standard type generator, list the two resistance checks for the rotor and the significance of each.
4. Where do the ends of the main winding(s) connect to?
5. What circuit(s) does the sub winding power?
6. How many ohmmeter readings are required to test a single phase full wave rectifier?
7. Explain how the A.V.R. controls A.C. voltage output.
8. On a bobbin type generator, what supplies the initial current to excite the rotor during start up?
9. How does power (voltage) get from the A.V.R. to the to the rotor windings in a standard type generator?

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10. What frequency should the generator A.C. output be set to and what ways can we measure it?

Cutting Equipment/Handheld/Power Accessories

1. Be familiar with the operational theory of single cylinder, air cooled, two cycle engines.
2. Be able to troubleshoot and adjust diaphragm carburetors as used on multi-position 2 cycle engines.
3. Be familiar with maintenance of chain saw chain and guide bars.
4. Be knowledgeable of failure analysis of 2 cycle engines as used with chain saws and string trimmers.
5. Be familiar with disassembly and reassembly of portable water pumps.
6. Be able to explain the operation of centrifugal clutches as used on saws, trimmers, etc. and list common failures.
7. Be familiar with electric clutches as used on garden tractor P.T.O. and the power required to operate them.
8. Describe set up procedures for mower deck height, levelling, and blade timing.
9. For rotary mowers know the maximum recommended blade tip speed and how to calculate for different blade lengths.
10. Describe proper chain saw sharpening technique.
11. Describe chain saw assembly procedure, include, bar pad, sprocket and chain matching, diagnose set up problems.

Practice Questions

1. How is the correct diameter of file determined for sharpening a chain.
2. What items/conditions indicate that a saw chain has been joined/riveted correctly?
3. List what would cause a chain saw to not cut straight?
4. List service/inspection items related to a chain saw guide bar.
5. Is it required to "time" the blades of a tractor mounted mowing deck?
6. List the angle and dimension specifications usually referred to when sharpening a chain saw chain.
7. What would cause a string trimmer to run rich at all engine speeds?
8. Explain the term "exhaust scavenging" as it applies to two cycle engines.
9. How would a two cycle engine be pressure tested?

Additional Information -

It will be assumed that the applicant will have a thorough understanding of such topics as:

- four stroke engine
 - design
 - overhaul techniques
 - tuning and maintenance
 - testing and troubleshooting
- engine failure analysis
- basic carburetion
- precision measurement
- metric/standard conversion

Reference Material

John Deere F.O.S. Diesel

John Deere F.O.S. Hydraulics

John Deere F.O.S. Electrical Systems Compact Equipment

Small Gas Engines Fundamentals (Alfred C. Roth)

Briggs & Stratton Service Manual for Out of Production Engines

Kohler V-Twin E.F.I. Service Update

Oregon Maintenance and Safety Manual

http://www.oregonchain.com/tech/manual_maint.htm



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