

Instructor's Manual
for

Light Vehicle Diesel Engines

1st Edition

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CHAPTER 1

Diesel Engine Operation

REVIEW QUESTIONS AND ANSWERS:

- What is the difference between an overhead-camshaft engine and a cam-in-block engine? **(Text page 6)**
When the camshaft is located in the block, the valves are operated by lifters, pushrods, and rocker arms. This type of engine is called a pushrod engine, a cam-in-block engine, or an overhead valve (OHV) engine. Some engine designs place the camshaft or shafts in the cylinder head; these are called overhead camshaft-type engines.
- What is the difference between an indirect and a direct injection diesel engine? **(Text pages 4–5)**
In an older indirect injection engine, fuel is injected into a small pre-chamber, which is connected to the cylinder by a narrow opening. In a direct injection (DI) diesel engine, fuel is injected directly into the cylinder.
- What is the displacement of a six-cylinder diesel engine with a 4-inch bore and a 4-inch stroke? **(Text page 7)**
The formula is:
Cubic inch displacement = π (pi) $\times$ R² $\times$ Stroke $\times$ Number of cylinders
 3.14×4 (2 squared) $\times 4 \times 6 = 301.4$ cubic inches

4. If an engine at sea level produces 100 HP, how many horsepower would it develop at 6,000 feet of altitude?

(Text page 9)

A non-supercharged or non-turbocharged engine loses about 3% of its power for every 1,000 feet (300 m) of altitude. Therefore, if an engine can create 100 HP at sea level, the same engine can only create about 82 HP at 6,000 feet ($3\% \times 6 = 18\%$).

5. What is the difference between torque and power? (Text page 8)

Torque is the term used to describe a rotating force that may or may not result in motion. The term power means the rate of doing work. Power equals work divided by time. Work is achieved when a certain amount of mass (weight) is moved a certain distance by a force.

CHAPTER QUIZ QUESTIONS AND ANSWERS:

1. All overhead valve engines _____. (Text page 6)
 - a. Use an overhead camshaft
 - b. Have the valves located in the cylinder head X**
 - c. Operate by the two-stroke cycle
 - d. Use the camshaft to close the valves
2. A DOHC V-6 diesel engine has how many camshafts? (Text page 6)
 - a. One
 - b. Two
 - c. Three
 - d. Four X**
3. What phase of combustion creates the knock noise in a diesel engine? (Text page 5)
 - a. Slow combustion
 - b. Rapid combustion X**
 - c. Controlled combustion
 - d. Delayed combustion
4. Torque is expressed in units of _____. (Text page 8)
 - a. Pound-feet X**
 - b. Foot-pounds
 - c. Foot-pounds per minute
 - d. Pound-feet per second
5. Horsepower is expressed in units of _____. (Text page 8)
 - a. Pound-feet
 - b. Foot-pounds
 - c. Foot-pounds per minute X**
 - d. Pound-feet per second
6. A normally aspirated automobile engine loses about _____ power per 1,000 feet of altitude. (Text page 9)
 - a. 1%
 - b. 3% X**
 - c. 5%
 - d. 6%
7. One cylinder of an automotive four-stroke cycle engine completes a cycle every _____. (Text page 3)
 - a. 90°
 - b. 180°
 - c. 360°
 - d. 720° X**

8. How many rotations of the crankshaft are required to complete each stroke of a four-stroke cycle engine? **(Text page 3)**
- a. One-fourth
 - b. One-half X**
 - c. One
 - d. Two
9. A rotating force is called _____. **(Text page 8)**
- a. Horsepower
 - b. Torque X**
 - c. Combustion pressure
 - d. Eccentric movement
10. Technician A says that a crankshaft determines the stroke of an engine. Technician B says that the length of the connecting rod determines the stroke of an engine. Which technician is correct? **(Text pages 6–7)**
- a. Technician A only X**
 - b. Technician B only
 - c. Both Technicians A and B
 - d. Neither Technician A nor B

CHAPTER 2

Diesel Engine Blocks and Rotating Assemblies

REVIEW QUESTIONS AND ANSWERS:

1. What is the difference between a girdle and a bedplate? (Text page 14)
A girdle uses a solid steel support that attaches to the main bearing caps and ties the entire lower part of the block together. A bedplate, also called a frame-ladder design, is a structural member that attaches to the bottom of the block and supports the crankshaft.
2. What is the difference between gray cast iron and compacted graphite iron (CGI)? (Text page 11)
Gray cast iron contains about 3% carbon (graphite), which makes it gray in color. Compacted graphite iron (CGI) has increased strength, ductility, toughness, and stiffness compared to gray iron. With the addition of even small amounts of magnesium, an excess of the sulfur and oxygen form in the molten solution, resulting in the shape of the graphite changing to compacted graphite forms.
3. Where is the block heater located? (Text page 13)
A block heater is normally installed in one of the core (freeze) plugs where an electrical current from a 110-volt electrical outlet is used to heat the coolant in the block.
4. What is the difference between Nitriding and Tuftriding? (Text page 16)
Nitriding is a process where the crankshaft is heated to about 1,000°F (540°C) in a furnace filled with ammonia gas, and then allowed to cool. Nitriding adds nitrogen (from the ammonia) into the surface of the metal, forming hard nitrides in the surface of the crankshaft to a depth of about 0.007 inch (0.8 mm). Tuftriding is a hardening procedure that involves heating the crankshaft in a molten cyanide salt bath. Tuftriding is a trade name of General Motors.
5. How is surface finish measured? (Text page 16)
Surface finish is measured in micro-inches, and the smaller the number is, the smoother the surface. The typical specification for main and rod crankshaft journals is between 10 and 20 roughness average (Ra). This very smooth surface finish is achieved by polishing the crank journals after the grinding operation.
6. Why should crankshafts be stored vertically? (Text page 19)
All crankshafts should be coated with oil to keep them from rusting, and stored vertically until time for engine assembly to help prevent warping due to gravity.

CHAPTER QUIZ QUESTIONS AND ANSWERS:

1. The block deck is the _____. (Text page 11)
 - a. Bottom (pan rail) of the block
 - b. Top surface of the block X**
 - c. Valley surface of a V-type engine
 - d. Area where the engine mounts are attached to the block
2. Forged crankshafts can be identified by _____. (Text page 16)
 - a. A narrow parting line
 - b. A wide parting line X**
 - c. Being magnetic
 - d. Being non magnetic

3. Cast iron has about how much carbon content? **(Text page 11)**
- a. Less than 1%
 - b. 2%
 - c. **3% X**
 - d. 4% or higher
4. Engine blocks can be manufactured using which method? **(Text page 11)**
- a. **Sand cast X**
 - b. Die cast
 - c. Extruded cylinder
 - d. Machined from a solid piece of metal
5. Typical journal-to-bearing clearance is _____. **(Text page 22)**
- a. 0.00015 to 0.00018 inch
 - b. **0.0005 to 0.0025 inch X**
 - c. 0.15 to 0.25 inch
 - d. 0.02 to 0.035 inch
6. A bearing shell has a slightly larger arc than the bearing housing. This difference is called _____. **(Text page 22)**
- a. Bearing crush
 - b. Bearing tang
 - c. **Bearing spread X**
 - d. Bearing saddle
7. Bearing _____ occurs when a bearing shell is slightly above the parting surface of the bearing cap. **(Text page 22)**
- a. Overlap
 - b. **Crush X**
 - c. Cap lock
 - d. Interference fit
8. Core plugs are also called _____. **(Text page 11)**
- a. Freeze plugs
 - b. Antifreeze plugs
 - c. Frost plugs
 - d. **Both a and c X**
9. The distance between the centerline of the connecting rod bearing journal and the centerline of the crankshaft main bearing journal determines the _____ of the engine. **(Text page 14)**
- a. Bore
 - b. **Stroke X**
 - c. Cylinder centerline
 - d. Main bearing cap bore
10. What is used to add strength to the lower engine block in a diesel engine? **(Text pages 13–14)**
- a. Cross-bolted main bearing caps
 - b. Girdle
 - c. Bedplate
 - d. **All of the above X**

CHAPTER 3

Diesel Cylinder Heads and Valve Trains

REVIEW QUESTIONS AND ANSWERS:

1. What is the purpose and function of valve bridges (crossheads)? (Text page 33)
Bridges, also called *crossheads*, are similar to rocker arms and are used in many diesel engines to span two valves from one pushrod.
2. How is a two-material valve constructed? (Text page 28)
Some exhaust valves are manufactured from two different materials when a one-piece design cannot meet the desired hardness and corrosion resistance specifications. The joint cannot be seen after valves have been used. The valve heads are made from special alloys that can operate at high temperatures, have physical strength, resist lead oxide corrosion, and have indentation resistance. These heads are welded to stems that have good wear resistance properties. These types of valves are usually welded together using a process called inertia friction welding.
3. How does a hydraulic lifter work? (Text pages 34–35)
A hydraulic lifter consists primarily of a hollow cylinder body enclosing a closely fit hollow plunger, a check valve, and a pushrod cup. Lifters that feed oil up through the pushrod have a metering disc or a restrictor valve located under the pushrod cup. Engine oil under pressure is fed through an engine passage to the exterior lifter body. An undercut portion allows the oil under pressure to surround the lifter body. Oil under pressure goes through holes in the undercut section into the center of the plunger. From there it goes down through the check valve to a clearance space between the bottom of the plunger and the interior bottom of the lifter body. It fills this space with oil at engine pressure. Slight leakage allowance is designed into the lifter so the air can bleed out, and the lifter can leak down.
4. What are the steps needed to check valve springs? (Text pages 29–30)
Valve springs are checked for the following:
 1. Free height (or length) without being compressed should be within 1/16 (0.06) inch of specifications
 2. Pressure with valve closed, and height as per specifications
 3. Pressure with valve open, and height as per specifications**Most specifications allow for variations of plus or minus 10% from the published figures.**
5. Why do exhaust valve seats operate cooler in an aluminum cylinder compared to a cast iron cylinder head? (Text page 29)
The exhaust valve seat runs as much as 180°F (100°C) cooler in aluminum heads than in cast iron heads, because aluminum conducts heat faster than cast iron. Insert seats are also used to recondition integral valve seats that have been badly damaged.

CHAPTER QUIZ QUESTIONS AND ANSWERS:

1. The camshaft makes _____ for every revolution of the crankshaft. (Text page 31)
 - a. One-quarter revolution
 - b. One-half revolution X**
 - c. One revolution
 - d. Two revolutions

2. A DOHC V-6 diesel engine has how many camshafts? **(Text page 31)**
 - a. One
 - b. Two
 - c. Four X**
 - d. Six
3. The camshaft is driven by _____. **(Text page 31)**
 - a. Timing gears
 - b. Timing chains
 - c. Timing belts
 - d. Any of the above X**
4. Many diesel engines use hollow stem exhaust valves that are partially filled with _____. **(Text page 28)**
 - a. Steel shot
 - b. Sodium X**
 - c. Carbon
 - d. Ethylene glycol
5. Aluminum cylinder heads use _____. **(Text page 36)**
 - a. Valve seat inserts
 - b. Integral valve seats
 - c. Valve guide inserts
 - d. Both a and c X**
6. _____ are used in many diesel engines to span two valves from one pushrod. **(Text page 33)**
 - a. Pedestals
 - b. Bridges X**
 - c. Rocker arms
 - d. Pushrods
7. Valve springs are checked for _____. **(Text pages 29–30)**
 - a. Free height (or length) without being compressed
 - b. Pressure with the valve closed
 - c. Pressure with the valve open
 - d. Any of the above X**
8. The cylinder head should be removed by first loosening all of the head bolts _____. **(Text page 35)**
 - a. In the reverse order of the tightening sequence X**
 - b. Loosening the longer bolts first, then the shorter bolts
 - c. In the same order as used in the tightening sequence
 - d. In any order
9. The gasket surface of a cylinder head, as measured with a precision straightedge, should have a maximum variation of _____. **(Text page 36)**
 - a. 0.002 inch in any 6 inch length, or 0.004 inch overall X**
 - b. 0.001 inch in any 6 inch length, or 0.004 inch overall
 - c. 0.020 inch in any 10 inch length, or 0.02 inch overall
 - d. 0.004 inch in any 10 inch length, or 0.008 inch overall
10. Typical valve stem-to-guide clearance is _____. **(Text page 36)**
 - a. 0.030 to 0.045 inch (0.8 to 1 mm)
 - b. 0.015 to 0.020 inch (0.4 to 0.5 mm)
 - c. 0.005 to 0.010 inch (0.13 to 0.25 mm)
 - d. 0.001 to 0.004 inch (0.025 to 0.100 mm) X**