Automotive Chassis Systems 7e
Chapter 35 ALIGNMENT DIAGNOSIS & SERVICE
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Chassis Systems.** It correlates material to task lists specified by ASE and NATEF
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain learning objectives to students as listed on SLIDE. 1. List the various checks that should be performed before aligning a vehicle. 2. Explain the diagnosis of lead, memory steer, and torque steer. 3. Discuss how to measure camber, caster, SAI, toe, and toot. 4. List the types of alignments. 5. Explain how to adjust the rear camber, front camber, SAI, and included angle. 6. Explain the method of aligning electronic-suspension vehicles and modified vehicles **This chapter will help prepare for ASE Suspension and Steering (A4) certification test content area "D" (Wheel Alignment Diagnosis, Adjustment, and Repair).**
Establish the Mood or Climate	Provide a ***WELCOME,*** Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: This lesson plan is based on Automotive Chassis Systems 7th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 35: Chapter Images

ICONS	Chapter 35 Alignment Diagnosis & SVC
	1. SLIDE 1 CH35 ALIGNMENT DIAGNOSIS & SERVICE
	Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED **Alignment (31 Links)**
	
	At the beginning of this class, you can download the crossword puzzle & Word Search from the links below to familiarize your class with the terms in this chapter & then discuss them
	Crossword Puzzle (Microsoft Word) (PDF) Word Search Puzzle (Microsoft Word) (PDF)
	**DISCUSSION:** Ask the students to discuss the benefits of correct wheel alignment. What problems may result from improper wheel alignment?
	**DISCUSSION:** Ask the students to talk about the four basic steps for correcting any automotive problem. How do they relate to wheel alignment problems? Remind the students that a careful inspection of the steering, suspension, and tires should take place prior to aligning a vehicle.
	2. SLIDE 2 EXPLAIN FIGURE 35-1 owner of this Honda thought that all it needed was an alignment. Obviously, something more serious than an alignment caused this left rear wheel to angle inward at the top. 3. SLIDE 3 EXPLAIN FIGURE 35–2 Magnetic bubble-type camber/caster gauge. To help it keep its strong magnetism, it is best to keep it stored stuck to a metal plate or metal tool box
	**DEMONSTRATION:** Show how to use a magnetic bubble-type camber/caster gauge for setting alignment: **FIGURE 35-2**

ICONS	Chapter 35 Alignment Diagnosis & SVC
	**Part of prealignment check on truck should include finding out if it carries load. Changing ride height will change alignment.**
	**HANDS-ON TASK: perform all necessary prealignment checks on vehicle FIGURES 35-4 & 5**
	4. **SLIDE 4 EXPLAIN FIGURE 35–3** Typical tire wear chart as found in a service manual. Abnormal tire wear usually indicates a fault in a steering or suspension component that should be corrected or replaced before an alignment is performed. 5. **SLIDE 5 EXPLAIN FIGURE 35–4** Measuring points for ride (trim) height vary by manufacturer. 6. **SLIDE 6 EXPLAIN FIGURE 35–5** Measuring to be sure the left and right sides of the vehicle are of equal height. If this measurement is not equal side-to-side by as little as 1/8 in. (3 mm), it can affect handling of vehicle 7. **SLIDE 7 EXPLAIN Figure 35-6** bulge in this tire was not noticed until it was removed from the vehicle as part of a routine brake inspection. After replacing this tire, the vehicle stopped pulling and vibrating
	**DEMONSTRATION: Show the students tires with shifted belts that could cause a pull**
	**HANDS-ON TASK: Have students perform steps to diagnose a lead or pull condition. Select a student to report the results of the test to the class.**
	**DISCUSSION: Ask the students to discuss memory steer & its causes**
	8. **SLIDE 8 EXPLAIN Figure 35-7** Equal outer CV joint angles produce equal steer torque (toe-in). If one side receives more engine torque, that side creates more toe-in and the result is a pull toward one side, especially during acceleration. 9. **SLIDE 9 EXPLAIN Figure 35-8** Broken or defective engine or transaxle mounts can cause the powertrain to sag, causing unequal drive axle shaft CV joint angles.
	

ICONS	Chapter 35 Alignment Diagnosis & SVC
	**HANDS-ON TASK:** Have the students perform the steps to test for memory steer.
	**DISCUSSION:** Ask the students to talk about the problem of torque steer. What causes torque steer? How do manufacturers attempt to reduce torque steer when designing their vehicles? **FIGURE 35-8**
	**HANDS-ON TASK:** Have the students perform the necessary steps to diagnose a torque steer problem & then suggest ways to correct it **FIGURE 35-8**
	**ON-VEHICLE NATEF TASK:** Perform prealignment inspection and measure vehicle ride height; perform necessary action
	**ON-VEHICLE NATEF TASK:** Prepare vehicle for wheel alignment on the alignment machine; perform four-wheel alignment by checking and adjusting wheel caster.
	**ON-VEHICLE NATEF TASK:** Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer; determine necessary action
	10. **SLIDE 10 EXPLAIN FIGURE 35–9** This alignment chart indicates the preferred setting with a plus or minus tolerance
	**HANDS-ON TASK:** Have the students perform the alignment specifications steps of the Halderman text before beginning wheel alignment.
	**DISCUSSION:** Ask students to compare the two methods used by vehicle and alignment equipment manufacturers to specify alignment angles.
	11. **SLIDE 11 EXPLAIN Figure 35-10** Using the alignment rack hydraulic jacks, raise the tires off the rack so that they can be rotated as part of the compensating process 12. **SLIDE 12 EXPLAIN Figure 35-11** This wheel sensor has a safety wire that screws to the valve stem to keep the sensor from falling onto the ground if the clamps slip on the wheel lip

ICONS	Chapter 35 Alignment Diagnosis & SVC
	**DISCUSSION:** Ask the students to talk about the **units of measure** used in alignment specs & how to convert from minutes to degrees
	**DEMONSTRATION:** Show the students how to determine the midpoint of a manufacturer's alignment specification, **FIGURE 35-9**
	13. **SLIDE 13 EXPLAIN Figure 35-12** If toe for an oversize tire is set by distance, the toe angle will be too small. Toe angle is the same regardless of tire size.
	**Wheel Alignment, Adjust Toe** **Wheel Alignment, Toe**
	**DISCUSSION:** Ask the students to talk about how to determine **toe**. Why is toe angle more accurate than center-to-center distance? **FIGURE 35-12**
	14. **SLIDE 14 EXPLAIN Figure 35-13** protractor scale on the front turn plates allows the technician to test the turning radius by turning one wheel to an angle specified by the manufacturer and observing the angle of the other front wheel. Most newer alignment machines can display turning angle based on sensor readings, and therefore the protractor scale on the turn plate is not needed or used.
	**DISCUSSION:** Ask the students to discuss the meaning of term "**camber**" and how to measure it. Ask the students to talk about how **caster** is measured & discuss meaning of "caster sweep." **FIGURE 35-13**
	**Be sure to check for clearance on front of alignment when doing a caster sweep. Sometimes the sensors will collide. Check this while doing setup to save time later.**
	**HANDS-ON TASK:** Have the students perform the procedures to set up an alignment
	**DISCUSSION:** Ask the students to discuss how to measure toe-out on turns (TOOT). Why is this diagnostic procedure recommended as part of a total alignment check? If the TOOT is not correct, what are symptoms and likely causes?

ICONS	Chapter 35 Alignment Diagnosis & SVC
	**DISCUSSION:** **Ask the students to talk about how to check frame alignment of FWD vehicles. How do FWD designs affect SAI, included angle, & camber?**
	15. **SLIDE 15 EXPLAIN FIGURE 35–14** By checking the SAI, camber, and included angle, a damaged suspension component can be determined by using this chart. 16. **SLIDE 16 EXPLAIN Figure 35-15** In this example, both SAI and camber are far from being equal side-to-side. However, both sides have the same included angle, indicating that the frame may be out of alignment. An attempt to align this vehicle by adjusting the camber on both sides with either factory or aftermarket kits would result in a totally incorrect alignment. 17. **SLIDE 17 EXPLAIN Figure 35-16** This is the same vehicle as shown in **Figure 35–15** , except now the frame (cradle) has been shifted over and correctly positioned. Notice how both the SAI and camber become equal without any other adjustments necessary.
	**HANDS-ON TASK: FIGURE 35-14** **to make a card for each angle (correct, < specs, > specs). Put all SAI cards in one box and make a similar box for camber & included angle. Have students draw a card from each box and match card they drew to the diagnosis. You may want to place the diagnosis choices on a board visible to the whole class**
	**DISCUSSION:** **Ask the students to discuss the steps involved in performing a four-wheel alignment. Why is four-wheel alignment the most accurate alignment method?**
	18. **SLIDE 19 EXPLAIN Figure 35-17** Geometric-centerline-type alignment sets the front toe readings based on the geometric centerline of the vehicle and does not consider the thrust line of the rear wheel toe angles 19. **SLIDE 19 EXPLAIN Figure 35-18** Thrust line alignment sets front toe parallel with the rear-wheel toe 20. **SLIDE 20 EXPLAIN Figure 35-19** Four-wheel alignment corrects for any rear-wheel toe to make the thrust line and the geometric centerline of the vehicle both the same
	SEARCH INTERNET: **Have students search the Internet to research wheel alignment services. Ask them to prepare to DISCUSS the types of wheel alignment available, their advantages & disadvantages,**

ICONS	Chapter 35 Alignment Diagnosis & SVC
	and their prices. Ask students to indicate, based on their research, which service they would recommend and why.
	**DISCUSSION:** Ask students to discuss why camber has a greater pull effect than caster.
	21. **SLIDE 21 EXPLAIN Figure 35-20** rear camber is adjustable on this vehicle by rotating the eccentric cam and watching the alignment machine display. 22. **SLIDE 22 EXPLAIN Figure 35-21** Some vehicles use a threaded fastener similar to a tie rod to adjust camber on the rear suspension. 23. **SLIDE 23 EXPLAIN Figure 35-22** Aftermarket alignment parts or kits are available to change the rear camber.
	**DISCUSSION:** Ask the students to talk about the procedures for adjusting rear toe on a vehicle. Does the vehicle on which they are working require an aftermarket kit to adjust rear toe? **FIGURE 35-21**
	**HANDS-ON TASK:** Have students first check a vehicle for accident damage & then perform the necessary steps to check the rear camber.
	24. **SLIDE 24 EXPLAIN Figure 35-23** rear toe was easily set on this vehicle. Adjusting nuts were easy to get to and turn. Adjusting rear toe is not this easy on every vehicle.
	25. **SLIDE 25 EXPLAIN Figure 35-24** By moving various rear suspension members, the rear toe can be changed 26. **SLIDE 26 EXPLAIN Figure 35-25** The use of these plastic or metal shims requires that the rear wheel as well as the hub assembly and/or backing plate be removed. Proper torque during reassembly is critical to avoid damage to the shims.
	**Wheel Alignment, Camber Adjust, SLA** **Wheel Alignment, Camber Adjust, Strut**
	27. **SLIDE 27 EXPLAIN FIGURE 35–26** The use of these plastic or metal shims requires that the rear wheel as well as the hub assembly and/or backing plate be removed. Proper torque during reassembly is critical to avoid damage to the shims. 28. **SLIDE 28 EXPLAIN Figure 35-27** Many struts allow camber adjustment at the strut-to-knuckle fasteners. Here a special tool

is being used to hold and move the strut into alignment with the fasteners loosened. Once the desired camber angle is achieved, the strut nuts are tightened and the tool is removed.

29. **SLIDE 29 EXPLAIN Figure 35-28** Some struts require modification of the upper mount for camber adjustment.

Include a check point for removal of all tools in your alignment routine. Tool in Figure 35–27 is easy to forget if an effort to remove it has not been made.

30. **SLIDE 30 EXPLAIN Figure 35-29** example of the many methods that are commonly used to adjust front caster and camber

DISCUSSION: Have the students review and comment on the caster and camber adjustment methods

Wheel Alignment, Caster Adjust, SLA

Wheel Alignment, Caster

31. **SLIDE 31 EXPLAIN Figure 35-30** If there is a nut on both sides of the strut rod bushing, then the length of the rod can be adjusted to change caster.

32. **SLIDE 32 EXPLAIN Figure 35-31** Placing shims between frame and the upper control arm pivot shaft is a popular method of alignment for many SLA suspensions. Both camber and caster can be easily changed by adding or removing shims.

DISCUSSION: Ask the students to talk about the procedures for adjusting caster & camber by using shims. Why should they adjust caster & camber before adjusting toe?

33. **SLIDE 33 EXPLAIN Figure 35-32** The general rule of thumb is that a 1/8-in. shim added or removed from both shim locations changes the camber angle about 1/2 degree. Adding or removing a 1/8-in. shim from one shim location changes the caster by about 1/4 degree

34. **SLIDE 34 EXPLAIN Figure 35-33** Some SLA-type suspensions use slotted holes for alignment angle adjustments. When the pivot shaft bolts are loosened, the pivot shaft is free to move unless held by special clamps as shown. By turning the threaded portion of the clamps, the camber and caster can be set and checked before tightening the pivot shaft bolts.

ICONS	Chapter 35 Alignment Diagnosis & SVC

35. **SLIDE 35 EXPLAIN Figure 35-34** When the nut is loosened and the bolt on the eccentric cam is rotated, the upper control arm moves in and out. By adjusting both eccentric cams, both camber and caster can be adjusted.

1 or 2 shims will stay in place better than a stack same thickness. Magnet (taken from a bad wheel speed sensor) will hold shim stack in place until the nut is tightened.

36. **SLIDE 36 EXPLAIN Figure 35-35** Many procedures for setting toe specify that steering wheel be held in straight-ahead position using a steering wheel lock, as shown. One method recommended by Hunter Engineering sets toe without using steering wheel lock.
37. **SLIDE 37 EXPLAIN Figure 35-36** Adjusting toe by rotating the tie rod on a vehicle equipped with rack-and-pinion steering.
38. **SLIDE 38 EXPLAIN Figure 35-37** Toe is adjusted on a parallelogram-type steering linkage by turning adjustable tie rod sleeves. Special tie rod sleeve adjusting tools should be used that grip the slot in the sleeve and will not crush the sleeve while it is being rotated.
39. **SLIDE 39 EXPLAIN Figure 35-38** Special tie rod adjusting tools should be used to rotate the tie rod adjusting sleeves. The tool grips the slot in the sleeve and allows the service technician to rotate the sleeve without squeezing or damaging the sleeve.

Wheel Alignment, Align Steering Wheel 1
Wheel Alignment, Align Steering Wheel 2

40. **SLIDE 40 EXPLAIN Figure 35-39** Most vehicles have alignment marks made at the factory on the steering shaft and steering wheel to help the service technician keep the steering wheel in the center position.
41. **SLIDE 41 EXPLAIN Figure 35-40** puller being used to remove a steering wheel after the steering wheel retaining nut has been removed.
42. **SLIDE 42 EXPLAIN Figure 35-41** toe-in on the right wheel creates a turning force toward the right.
43. **SLIDE 43 EXPLAIN Figure 35-42** An aftermarket camber shim can be added to change the front camber on this Honda.
44. **SLIDE 44 EXPLAIN Figure 35-43** aftermarket kit for this Ford is installed at the top of strut tower and allows more camber and caster adjustment than is possible with factory adjustment

ICONS	Chapter 35 Alignment Diagnosis & SVC
	**45. SLIDE 45 EXPLAIN Figure 35-44** A typical tire temperature pyrometer. The probe used is a needle that penetrates about 1/4 inch (7 mm) into the tread of the tire for most accurate readings **46. SLIDE 46 EXPLAIN Figure 35-45** Jig holes used at the assembly plant to locate suspension and drivetrain components. Check service information for the exact place to measure and the specified dimensions when checking for body or frame damage. **47. SLIDE 47 EXPLAIN FIGURE 35.46** A typical analog-type steering angle sensor that uses a variable voltage as the steering wheel is rotated. **48. SLIDE 48 EXPLAIN FIGURE 35.47** The output of a typical digital steering angle sensor. **49. SLIDES 49-66 OPTIONAL EXPLAIN ALIGNMENT**
	
	**ON-VEHICLE NATEF TASK: Prepare vehicle for wheel alignment on the alignment machine; perform four-wheel alignment by checking and adjusting wheel caster.**
	**ON-VEHICLE NATEF TASK: Check toe-out-on-turns (turning radius) and SAI (steering axis inclination) and included angle; determine necessary action**
	**ON-VEHICLE NATEF TASK: Check angles that can detect collision damage; determine necessary action.**