Automotive Maintenance and Light Repair, 1ST Edition

Chapter 61 Machining Brake Drums and Rotors

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers **Automotive Maintenance and Light Repair.** 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 the chapter learning objectives to the students. • Prepare for the Brakes (A5) ASE certification test content area "E" (Miscellaneous Systems Diagnosis and Repair). • Discuss the construction of brake drums and rotors. • Explain the formation of hard spots in drums and rotors. • Describe how to measure and inspect drums and rotors before machining. • Discuss how surface finish is measured and its importance to satisfactory brake service. • Demonstrate how to machine a brake drum and rotor correctly
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.

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1. **SLIDE 1 MACHINING BRAKE DRUMS AND ROTORS**
2. **SLIDES 2-3 EXPLAIN OBJECTIVES**

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4. **SLIDES 4-5 EXPLAIN Brake Drums**
6. **SLIDE 6 EXPLAIN Figure 61-1** Types of brake drums. Regardless of the design, all types use cast iron as a friction surface.
7. **SLIDES 7-8 EXPLAIN Brake Drums**
9. **SLIDE 9 EXPLAIN Figure 61-2** The airflow through cooling vents helps brakes from overheating.
10. **SLIDE 10 EXPLAIN Figure 61-3** Scored drums and rotors often result in metal-to-metal contact.

DEMONSTRATION: SHOW STUDENTS A BRAKE DRUM THAT DISPLAYS EVIDENCE OF SCORING. ASK STUDENTS TO SPECULATE ON CAUSES OF SCORING. WHY ARE DRUM BRAKES MORE PRONE TO SCORING THAN DISC BRAKES?

DEMONSTRATION: SHOW STUDENTS A BRAKE DRUM THAT HAS CRACKS, AND DISCUSS THE POSSIBLE CAUSES OF THE CRACKING. SHOW STUDENTS HOW TO DO THE TAP TEST TO DETERMINE IF A BRAKE DRUM IS CRACKED.

11. **SLIDE 11 EXPLAIN Figure 61-4** Cracked drums or rotors must be replaced.
12. **SLIDE 12 EXPLAIN Figure 61-5** A heat-checked surface of a disc brake rotor.
13. **SLIDE 13 EXPLAIN Figure 61-6** These dark hard spots are created by heat that actually changes the metallurgy of cast-iron drum. Most experts recommend replacement of any brake drum that has these hard spots.

DISCUSSION: ASK STUDENTS TO TALK ABOUT THE ISSUE OF HEAT CHECKING IN BRAKE DRUMS. HOW IS IT DIFFERENT FROM CRACKING AND WHAT CAUSES IT?

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14. **SLIDES 14-15 EXPLAIN** Brake Drum Distortion

DEMONSTRATION: SHOW EXAMPLE OF A BRAKE DRUM THAT DISPLAYS EVIDENCE OF HARD, OR CHILL, SPOTS. HOW ARE HARD SPOTS CAUSED AND WHAT PROBLEMS DO THEY CREATE? SHOW STUDENTS AN EXAMPLE OF A BRAKE DRUM THAT DISPLAYS BELLMOUTH DISTORTION, AND DISCUSS WHAT CAUSES IT.

DEMONSTRATION: SHOW AN EXAMPLE OF A BRAKE DRUM THAT HAS GONE OUT-OF-ROUND. ASK STUDENTS TO DISCUSS THE CAUSES OF OUT-OF-ROUND BRAKE DRUM DISTORTION AND ITS SYMPTOMS. ASK STUDENTS TO TALK ABOUT ECCENTRIC DISTORTION OF BRAKE DRUMS. WHAT ARE THE SYMPTOMS OF ECCENTRIC DISTORTION & WHAT PROBLEMS DOES IT CAUSE? HOW CAN IT BE AVOIDED OR RESOLVED? SHOW STUDENTS HOW TO PERFORM THE PARKING BRAKE TRICK TO DIAGNOSE BRAKE-PEDAL PULSATION.

DISCUSSION: ASK STUDENTS TO DISCUSS ISSUE OF DRUM DISTORTION. HOW DOES EVEN MINUTEST SHIFT IN POSITION CAUSE DRUM DAMAGE?

16. **SLIDE 16 EXPLAIN Figure 61-7** Bellmouth brake drum distortion.
17. **SLIDE 17 EXPLAIN Figure 61-8** Out-of-round
18. **SLIDE 18 EXPLAIN Figure 61-9** Eccentric brake drum distortion.

DEMONSTRATION: SHOW STUDENTS HOW TO REMOVE A BRAKE DRUM, AND THEN ASK THEM TO INSPECT IT FOR DISTORTION. HAVE STUDENTS USE A MICROMETER TO MEASURE THE BRAKE DRUMS THEY REMOVED PREVIOUSLY

DISCUSSION: ASK STUDENTS TO TALK ABOUT WHY BRAKE DRUMS ON THE SAME AXLE SHOULD HAVE AS CLOSE TO THE SAME ID AS POSSIBLE. WHAT IS INDICATED WHEN THE BRAKE DRUM CHAMFER IS NOT VISIBLE?

ICONS	Ch61 Machining Brake Drums and Rotors
	HANDS-ON TASK: HAVE STUDENTS REMOVE A BRAKE DRUM THAT IS STUCK ON THE HUB MY USING THE HAMMER TAPE METHOD TO RELEASE IT FROM THE HUB.
	DEMONSTRATION: SHOW HOW TO REMOVE A BRAKE DRUM, AND THEN ASK THEM TO INSPECT IT FOR DISTORTION. HAVE STUDENTS USE A MICROMETER TO MEASURE THE BRAKE DRUMS THEY REMOVED PREVIOUSLY
QUESTION	**DISCUSSION:** DISCUSS WHY BRAKE DRUMS ON THE SAME AXLE SHOULD HAVE AS CLOSE TO THE SAME ID AS POSSIBLE. WHAT IS INDICATED WHEN THE BRAKE DRUM CHAMFER IS NOT VISIBLE?
	HANDS-ON TASK: HAVE STUDENTS REMOVE A BRAKE DRUM THAT IS STUCK ON THE HUB MY USING HAMMER TAPE METHOD TO RELEASE IT FROM HUB.
	19. **SLIDE 19 EXPLAIN Figure 61-10** A straightedge can be used to check for brake drum warpage. 20. **SLIDE 20 EXPLAIN Figure 61-11** Discard diameter & maximum diameter are brake drum machining & wear limits. 21. **SLIDE 21 EXPLAIN Figure 61-12** Most brake drums have a chamfer around edge. If chamfer is no longer visible, the drum is usually worn (or machined) to its maximum allowable ID.
	ANIMATION: MEASURING BRAKE DRUM W/DIAL INDICATOR **Brake Drum Micrometer (View) (Download)**
	22. **SLIDE 22 EXPLAIN Figure 61-13** Typical needle-dial brake drum micrometer. The left movable arm is set to the approximate drum diameter and the right arm to the more exact drum diameter. The dial indicator (gauge) reads in thousandths of an inch. 23. **SLIDE 23 EXPLAIN Figure 61-14** (a) A rotor or brake drum with a bearing hub should be installed on a brake lathe using the appropriate size collet that fit bearing cups (races). (b) A hubless rotor or brake drum requires a spring and a tapered centering cone. A faceplate should be used on

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both sides of rotor or drum to provide support. Always follow operating instructions for specified setup for brake lathe being used.

24. **SLIDE 24 EXPLAIN Figure 61-15** A self-aligning spacer (SAS) should always be used between the drum or rotor and the spindle retaining nut to help ensure an even clamping force and to prevent the adapters and cone from getting into a bind. A silence band should always be installed to prevent turning-tool chatter and to ensure a smooth surface finish.

DEMONSTRATION: SHOW HOW TO USE A SELF-ALIGNING SPACER (SAS) TO ENSURE THAT SPINDLE NUT APPLIES AN EVEN FORCE TO THE DRUM. SHOW STUDENTS THE STEPS INVOLVED IN USING LATHE TO MACHINE A DRUM BRAKE

QUESTION

DISCUSSION: DISCUSS MICROMETER INDICATOR ON FEED HANDLE OF BRAKE LATHE. HOW CAN THIS MICROMETER BE USED FOR BOTH METRIC AND STANDARD MEASUREMENTS?

25. **SLIDE 25 EXPLAIN Figure 61-16** After installing a brake drum on the lathe, turn the cutting tool outward until the tool just touches the drum. This is called a scratch cut.
26. **SLIDE 26 EXPLAIN Figure 61-17** After making a scratch cut, loosen the retaining nut, rotate the drum on the lathe, and make another scratch cut. If both cuts are in the same location, the drum is installed correctly on the lathe and drum machining can begin.
27. **SLIDE 27 EXPLAIN Figure 61-18** Set the depth of cut indicator to zero just as turning tool touches the drum
28. **SLIDE 28 EXPLAIN Figure 61-19** lathe has a dial that is "diameter graduated". This means that a reading of 0.030 in. indicates a 0.015 in. cut that increases the inside diameter of the brake drum by 0.030 in.
29. **SLIDE 29 EXPLAIN Figure 61-20** Notice chatter marks at edge of friction-area surface of brake drum. These marks were caused by vibration of drum because the technician failed to wrap dampening strap (silencer band) over friction-surface portion of brake drum.

NATEF MLR TASK A5C1: REMOVE, CLEAN, INSPECT, AND MEASURE BRAKE DRUM DIAMETER; DETERMINE NECESSARY ACTION.

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NATEF MLR TASK A5C2: REFINISH BRAKE DRUM AND MEASURE FINAL DRUM DIAMETER; COMPARE WITH SPECIFICATIONS

30. **SLIDE 30 EXPLAIN Figure 61-21** This excessively worn (thin) rotor was removed from the vehicle in this condition. It is amazing that the vehicle was able to stop with such a thin rotor.
31. **SLIDE 31 EXPLAIN Figure 61-22** Severely worn vented disc brake rotor. The braking surface has been entirely worn away exposing the cooling fins. The owner brought the vehicle to a repair shop because of a "little noise in the front." Notice the straight vane design.
32. **SLIDE 32 EXPLAIN Figure 61-23** Directional vane vented disc brake rotors. Note that the fins angle toward the rear of the vehicle. It is important that this type of rotor be reinstalled on correct side of vehicle.
33. **SLIDE 33 EXPLAIN Figure 61-24** Typical composite rotor that uses cast iron friction surfaces and a steel center section
34. **SLIDE 34 EXPLAIN Figure 61–25** A show vehicle equipped with high-performance brakes including cross-drilled brake rotors.

DEMONSTRATION: SHOW SOLID AND VENTED DISC ROTORS, AND DISCUSS THEIR CONSTRUCTION, WHERE THEY ARE USED, AND HOW THEY WORK TO DISSIPATE HEAT.

DISCUSSION: DISCUSS DIFFERENCES BETWEEN CROSS-DRILLED & SLOTTED ROTORS. HOW DOES EACH AID IN DISPERSING GAS AND DUST PARTICLES? ASK STUDENTS TO DISCUSS ALUMINUM METAL MATRIX COMPOSITE ROTORS. WHAT ARE THE ADVANTAGES OF THIS TYPE OF ROTOR CONSTRUCTION? HOW CAN THEY BE DISTINGUISHED FROM CONVENTIONAL CAST IRON ROTORS? WHAT ARE THE SPECIAL SERVICING REQUIREMENTS FOR ALUMINUM METAL MATRIX COMPOSITE ROTORS?

ANIMATION: ROTOR LATERAL RUNOUT

Rotor Runout (View) (Download)

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Rotor Thickness Measurements (View)(Download)

Rotor Thickness Variation & Brake Pedal Pulsation (View) (Download)

ROTOR RUNOUT

ROTOR MEASURING

35. **SLIDES 35-36 EXPLAIN Causes of Rotor Distortion**
37. **SLIDE 37 EXPLAIN Figure 61–26** Brake rotor lateral-runout distortion
38. **SLIDE 38 EXPLAIN Figure 61-27** Before measuring lateral runout with dial indicator (gauge), remove any wheel bearing end play by tightening spindle nut to 10 to 20 ft-lb with torque wrench. This step helps prevent an inaccurate reading. If vehicle is to be returned to service, be sure to loosen spindle nut and retighten to specifications to restore proper bearing clearance
39. **SLIDE 39 EXPLAIN Figure 61-28** (a) Rotate the disc brake rotor one complete revolution while observing the dial indicator (gauge). (b) Most vehicle manufacturers specify a maximum runout of about 0.003 in. (0.08 mm).
40. **SLIDE 40 EXPLAIN Figure 61-29** Brake rotor lack-of-parallelism distortion.
41. **SLIDE 41 EXPLAIN Figure 61-30** (a) Disc brake rotor thickness variation (parallelism). (b) The rotor should be measured with a micrometer at four or more equally spaced locations around the rotor.

DEMONSTRATION: SHOW DISC ROTOR THAT EXHIBITS LACK OF PARALLELISM. ASK THEM TO TALK ABOUT WHAT CAUSES LACK OF PARALLELISM AND WHAT PROBLEMS CAN RESULT.

DEMO

DISCUSSION: ASK STUDENTS TO DISCUSS PROBLEM OF LATERAL RUNOUT (LRO) OF DISC ROTOR. WHAT CAUSES LRO? WHAT PROBLEMS RESULT FROM LRO? ASK STUDENTS TO TALK ABOUT HOW DISTORTION CAN OCCUR IN A DISC BRAKE ROTOR. WHY ARE EFFECTS OF DISTORTION MORE PRONOUNCED ON DISC BRAKE ROTOR THAN ON A DRUM BRAKE?

QUESTION

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	DISCUSSION: HAVE STUDENTS TALK ABOUT HOW A TIRE THAT IS NOT TRUE CAN CAUSE A VIBRATION THAT COULD BE CONFUSED WITH A BRAKE PROBLEM. HAVE STUDENTS TALK ABOUT HOW THEY WOULD DETERMINE IF THE VIBRATION BEING FELT IS FROM THE TIRES OR FROM BRAKES
	42. **SLIDE 42 EXPLAIN FIGURE 61–31** A carbon-ceramic brake (CCB) rotor on a Ferrari.
	DEMONSTRATION: SHOW WHERE MINIMUM RECOMMENDED THICKNESS IS ON ROTOR, & DISCUSS SIGNIFICANCE OF THIS MEASUREMENT.
	43. **SLIDE 43 EXPLAIN** Disc Brake Rotor Thickness 44. **SLIDE 44 EXPLAIN Figure 61-32** digital readout rotor micrometer is an accurate tool to use when measuring a rotor. Both fractional inches & metric millimeters used. 45. **SLIDES 45-46 EXPLAIN** When Rotors Should Be Machined 47. **SLIDE 47 EXPLAIN Figure 61-33** If fingernail catches on a groove in rotor, rotor should be machined. 48. **SLIDE 48 EXPLAIN Figure 61-34** This rusted rotor should be machined. 49. **SLIDE 49 EXPLAIN Figure 61-35** Rotors that have deep rust pockets usually cannot be machined.
	RUST IS VERY HARD ON CUTTING BITS. REMOVE AS MUCH AS YOU CAN BEFORE RUNNING CUTTER OVER ROTOR.
	50. **SLIDES 50-52 EXPLAIN Rotor Finish**
	53. **SLIDE 53 EXPLAIN Figure 61-36** Electronic surface finish machine. Reading shows about 140 μ in. This is much too rough for use but typical for rough cut surface
	DEMONSTRATION: SHOW HOW TO DO THE BALLPOINT PEN TEST TO DETERMINE IF THE FRICTION SURFACE OF A BRAKE DRUM OR DISC ROTOR IS SMOOTH ENOUGH.

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	**DEMONSTRATION: SHOW CORRECT PROCEDURE FOR MACHINING DISC BRAKE ROTOR.**

54. **SLIDES 54-55 EXPLAIN** Machining Brake Rotor
56. **SLIDE 56 EXPLAIN Figure 61-37** Most positive rake brake lathes can cut any depth in one pass, thereby saving time. Typical negative rake lathe uses a 3-sided turning tool that can be flipped over, giving 6 edges.
57. **SLIDE 57 EXPLAIN** Machining Brake Rotor
58. **SLIDE 58 EXPLAIN Figure 61-38** Recommended adapters & location for machining hubbed & hubless rotors.
59. **SLIDE 59 EXPLAIN Figure 61-39 (a)** Composite adapter fitted to a rotor. **(b)** Composite rotor properly mounted on a lathe.
60. **SLIDE 60 EXPLAIN Figure 61-40** damper is necessary to reduce cutting-tool vibrations that can cause a rough surface finish.
61. **SLIDE 61 EXPLAIN Figure 61-41** After installing the rotor on the brake lathe, turn the cutting tool in just enough to make a scratch cut.

62. **SLIDE 62 EXPLAIN Figure 61-42** After making a scratch cut, loosen the retaining nut and rotate the rotor on the spindle of the lathe one-half turn. Tighten the nut and make a second scratch cut. The second scratch cut should be side-by-side with the first scratch if the rotor is installed correctly on the brake lathe

63. **SLIDE 63 EXPLAIN Figure 61-43 (a)** This technician uses two sanding blocks each equipped with 150-grit aluminum-oxide sandpaper. **(b)** With the lathe turned on, the technician presses the two sanding blocks against the surface of the rotor after the rotor has been machined, to achieve a smooth microinch surface finish.
64. **SLIDE 64 EXPLAIN CHART 61-1**

65. **SLIDE 65 EXPLAIN Figure 61-44 (a)** After machining and sanding the rotor, it should be cleaned. In this case brake cleaner from an air pressurized spray can is used. **(b)** With the lathe turning, the technician stands back away from the rotor and sprays both sides of the rotor to clean it of any remaining grit from the sanding process. This last step ensures a clean, smooth surface for the disc brake pads and a quality brake repair. Sanding

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each side of the rotor surface for one minute using a sanding block and 150-grit aluminum-oxide sandpaper after a finish cut gives rotor proper smoothness and finish.

66. **SLIDE 66 EXPLAIN Figure 61-45** grinder with sandpaper can be used to give a smooth non-directional surface finish to the disc brake rotor.
67. **SLIDE 67 EXPLAIN Figure 61-46** correct final surface finish should be smooth and non-directional.
68. **SLIDE 68 EXPLAIN Figure 61-47** Rust should always be cleaned from both the rotor and hub whenever rotors are machined or replaced. An air-powered die grinder with a sanding disc makes quick work of cleaning this hub.

ROTOR MACHINING

ROTOR/DRUM MACHINING AMMCO

DISCUSSION: ASK STUDENTS TO TALK ABOUT DIFFERENCES BETWEEN A ROUGH AND FINISH CUT ON LATHE. ASK STUDENTS TO DISCUSS DIFFERENCE BETWEEN POSITIVE & NEGATIVE RAKE LATHES. WHICH IS PREFERABLE FOR MACHINING BRAKE ROTORS AND WHY? ASK STUDENTS TO DISCUSS PRECONDITIONS FOR MACHINING ROTOR

HANDS-ON TASK: MACHINE DISC ROTOR. GRADE STUDENTS ON THEIR ABILITY TO COMPLETE THE TASK CORRECTLY AND FOLLOW SAFETY PROCEDURES. USING A MICROMETER, HAVE STUDENTS MEASURE THICKNESS OF ROTOR AFTER THEY HAVE PERFORMED FINISH CUT TO DETERMINE IF IT COMPLIES WITH OEM SPECS

NATEF MLR TASK A5D5: CLEAN AND INSPECT ROTOR; MEASURE ROTOR THICKNESS, THICKNESS VARIATION, AND LATERAL RUNOUT; DETERMINE NECESSARY ACTION

NATEF MLR TASK A5D6: REMOVE AND REINSTALL ROTOR.

NATEF MLR TASK A5D8: REFINISH ROTOR OFF VEHICLE; MEASURE FINAL ROTOR THICKNESS AND COMPARE WITH SPECIFICATIONS.

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	69. **SLIDE 69 EXPLAIN Figure 61-48** A typical hub-mount on-the-vehicle lathe. This particular lathe oscillates while machining the rotor, thereby providing a smooth and non-directional finish at the same time 70. **SLIDE 70 EXPLAIN Figure 61–49** A wheel stud was replaced on the rotor hub assembly when it was discovered to be stripped.
	DEMONSTRATION: SHOW STUDENTS THE CORRECT PROCEDURE FOR ON-THE-VEHICLE ROTOR MACHINING
	ON-CAR BRAKE LATHE VIDEO
	NATEF MLR TASK A5D7: REFINISH ROTOR ON VEHICLE; MEASURE FINAL ROTOR THICKNESS AND COMPARE WITH SPECIFICATIONS.
	71. SLIDES 71-106 EXPLAIN DRUM MACHINING
	107. SLIDES 107-154 EXPLAIN OFF-CAR ROTOR MACHINING
	155. SLIDES 155-184 EXPLAIN ON-CAR MACHINING
	SEARCH INTERNET: HAVE STUDENTS RESEARCH THE PROCESS OF CONVECTION AND HOW IT PLAYS A ROLE IN THE ABSORPTION OF HEAT WITHIN A DRUM OR DISC BRAKE SYSTEM. ASK THEM TO REPORT THEIR FINDINGS TO THE CLASS.