AUTO-1400: AUTOMOTIVE ALIGNMENT, STEERING AND SUSPENSION

Cuyahoga Community College

Viewing: AUTO-1400 : Automotive Alignment, Steering and Suspension

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Subject Code
AUTO - Automotive Technology

Course Number:
1400

Title:
Automotive Alignment, Steering and Suspension

Catalog Description:
Theory and principles of automotive alignment geometry and automotive steering and suspension systems. Laboratory competencies integrate diagnosis and repair of these systems through use of special tools and alignment equipment.

Credit Hour(s):
3

Lecture Hour(s):
2

Lab Hour(s):
3

Other Hour(s):
0

Requisites

Prerequisite and Corequisite
None.

Outcomes

Course Outcome(s):
Applying the terminology and engineering principles of the subject matter in Automotive Alignment, Steering and Suspension, and using the correct tools, equipment and service information; students can evaluate, diagnose and maintain vehicle alignment, steering and suspension systems taking into account safety, work ethics and behaviors, proper repair techniques and customer needs.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
1. Research vehicle service information including fluid type, vehicle service history, service precautions, and technical service bulletins.
2. Diagnose, maintain and repair automotive suspension and steering systems.
3. Diagnose wheel alignment angle measurements and make appropriate adjustments using alignment equipment.
4. Diagnose and repair wheel and tire assemblies and tire and wheel related issues.

5. Identify, select, and use appropriate tools and equipment.
6. Prepare the vehicle for service.

Course Outcome(s):

Shop and personal safety is a primary and ongoing concern while in the repair environment for automotive alignment, steering and suspension systems; including using tools and equipment, working around supplemental restraint (SRS) or high voltage circuits, wearing personal protection equipment, awareness of personal clothing, adornments and body, and knowledge of fire safety and evacuation routes.

Objective(s):

1. Wear personal protective equipment in the automotive lab.
2. Identify and select appropriate personal protective items for working in the automotive lab.

Course Outcome(s):

Diagnose and repair steering systems.

Objective(s):

1. Inspect steering shaft universal-joint(s), flexible coupling(s), collapsible column, lock cylinder mechanism, and steering wheel; perform necessary action.
2. Remove and replace rack and pinion steering gear; inspect mounting bushings and brackets.
3. Inspect rack and pinion steering gear inner tie rod ends (sockets) and bellows boots; replace as needed.
4. Inspect power steering fluid level and condition.
5. Flush, fill, and bleed power steering system; use proper fluid type per manufacturer specification.
6. Inspect for power steering fluid leakage; determine necessary action.
7. Remove, inspect, replace, and adjust power steering pump drive belt.
8. Remove and reinstall power steering pump.
9. Remove and reinstall press fit power steering pump pulley; check pulley and belt alignment.
10. Inspect electric power-assisted steering.
11. Describe the function of the power steering pressure switch.
12. Disable and enable supplemental restraint system (SRS).
13. Remove and replace steering wheel; center/time supplemental restraint system (SRS) coil (clock spring).
14. Diagnose steering column noises, looseness, and binding concerns (including tilt/telescoping mechanisms); determine needed action.
15. Diagnose power steering gear (non-rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action
16. Diagnose power steering gear (rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action.
17. Test power steering system pressure; determine needed action.

Course Outcome(s):

Diagnose and repair suspension systems.

Objective(s):

1. Diagnose short and long arm suspension system noises, body sway, and uneven ride height concerns; determine necessary action.
2. Diagnose strut suspension system noises, body sway, and uneven ride height concerns; determine necessary action.
3. Inspect, remove, and/or replace upper and lower control arms, bushings, shafts, and rebound bumpers.
4. Inspect, remove and install strut rods and bushings.
5. Inspect, remove, and/or replace upper and/or lower ball joints (with or without wear indicators).
6. Inspect, remove and install steering knuckle assemblies
7. Inspect, remove and install torsion bars and mounts.
8. Inspect, remove and install front stabilizer bar (sway bar) bushings, brackets, and links.
9. Inspect, remove and install strut cartridge or assembly, strut coil spring, insulators (silencers), and upper strut bearing mount.
10. Inspect rear suspension system leaf spring(s), spring insulators (silencers), shackles, brackets, bushings, center pins/bolts, and mounts.
11. Inspect, remove and install track bar, strut rods/radius arms, and related mounts and bushings.
12. Inspect rear suspension system leaf spring(s), bushings, center pins/bolts, and mounts.

13. Inspect, remove, and replace shock absorbers; inspect mounts and bushings.
14. Remove, inspect, and service or replace front and rear wheel bearings.
15. Describe the function of suspension and steering control systems and components, (i.e. active suspension and stability control).

Course Outcome(s):

Inspect, repair, and maintain service related steering and suspension components.

Objective(s):

1. Inspect, remove and/or replace power steering hoses and fittings.
2. Inspect, remove and/or replace pitman arm, relay (centerlink/intermediate) rod, idler arm, mountings, and steering linkage damper.
3. Inspect, replace, and adjust tie rod ends (sockets), tie rod sleeves, and clamps
4. Inspect, test and diagnose electrically- assisted power steering systems (including using a scan tool); determine needed action.
5. Diagnose short and long arm suspension system noises, body sway, and uneven ride height concerns; determine necessary action.
6. Diagnose strut suspension system noises, body sway, and uneven ride height concerns; determine necessary action.
7. Inspect, remove and install upper and/or lower ball joints (with or without wear indicators).
8. Inspect, remove and install short and long arm suspension system coil springs and spring insulators.

Course Outcome(s):

Diagnose wheel alignment concerns, adjust, and repair.

Objective(s):

1. Diagnose short and long arm suspension system noises, body sway, and uneven ride height concerns; determine necessary action.
2. Diagnose strut suspension system noises, body sway, and uneven ride height concerns; determine necessary action.
3. Inspect, remove and install torsion bars and mounts.
4. Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return concerns; determine necessary action.
5. Perform prealignment inspection and measure vehicle ride height; perform necessary action.
6. Prepare vehicle for wheel alignment on alignment machine; perform four-wheel alignment by checking and adjusting front and rear wheel caster, camber; and toe as required; center steering wheel.
7. Check toe-out-on-turns (turning radius); determine necessary action.
8. Check steering axis inclination (SAI) and included angle; determine needed action.
9. Check rear wheel thrust angle; determine necessary action.
10. Check for front wheel setback; determine necessary action.
11. Check front and/or rear cradle (subframe) alignment; determine necessary action.
12. Reset steering angle sensor.

Course Outcome(s):

Diagnose and repair wheel and tire concerns.

Objective(s):

1. Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return concerns; determine necessary action.
2. Perform prealignment inspection and measure vehicle ride height; perform necessary action.
3. Inspect tire condition; identify tire wear patterns; check for correct tire size, application (load and speed ratings), and air pressure as listed on the tire information placard/label.
4. Diagnose wheel/tire vibration, shimmy, and noise; determine necessary action.
5. Rotate tires according to manufacturer's recommendation including vehicles equipped with tire pressure monitoring systems (TPMS)
6. Dismount, inspect, and remount tire on wheel; balance wheel and tire assembly (static and dynamic).
7. Dismount, inspect, and remount tire on wheel equipped with tire pressure monitoring system sensor.
8. Inspect tire and wheel assembly for air loss; perform necessary action.
9. Repair tire following vehicle manufacturer approved procedure.
10. Identify indirect and direct tire pressure monitoring system (TPMS); calibrate system; verify operation of instrument panel lamps.
10. Identify and test tire pressure monitoring system (indirect and direct) for operation; verify operation of instrument panel lamps
11. Demonstrate knowledge of steps required to remove and replace sensors in a tire pressure monitoring system.
12. Demonstrate knowledge of steps required to remove and replace sensors in a tire pressure monitoring system (TPMS) including relearn procedure

13. Diagnose tire pull problems; determine needed action.

Course Outcome(s):

Prepare the vehicle for the customer.

Objective(s):

1. Reset steering angle sensor

Methods of Evaluation:

1. Participation and discussion
2. Observation
3. Written assignments
4. Exams
5. Quizzes
6. Lab tasks
7. Classroom recitations

Course Content Outline:

1. Fluids, oils, and greases
    a. Power steering fluid
    b. Gear oil
    c. Chassis and wheel bearing grease
2. Seals
    a. Rubber seals
        i. o-rings
        ii. square-cut seals
        iii. lip seals
        iv. dust covers
    b. Other seal materials
    c. Boots
3. Bushings and bearings
    a. Bushings
    b. Bearings
        i. bearing surface
        ii. ball bearings and roller bearings
4. Basics of handling
    a. Dimensions
        i. sprung and unsprung weight
        ii. center of gravity
5. Axes of movement
    a. Roll
        i. body roll
            1. roll center, independent suspension
            2. roll center, solid axle
        ii. overturning moment
    b. Pitch
    c. Yaw
6. Aerodynamics
7. Weight transfer and traction
    a. Oversteer and understeer
8. Steering wheels
    a. Steering wheel buildup
    b. Horn operation
    c. Air bags
        i. steering wheel buildup with air bag
    d. Steering wheel freeplay
    e. Steering ratio
9. Steering columns

    a. Steering shaft
        i. universal joint
        ii. flexible coupling
    b. Column jacket
    c. Column cover
    d. Collapsible column
    e. Tilt mechanisms and telescoping columns
    f. Steering column buildup
        i. column-mounted controls and switches
            1. lock housing
            2. gear selector lever housing
10. Steering gears
    a. Standard steering gear operation
        i. worm and sector operation
        ii. cam and lever operation
        iii. worm and roller operation
        iv. recirculating ball operation
    b. Standard steering gear buildup
        i. worm and roller buildup
        ii. recirculating ball buildup
    c. Standard steering gear installation
    d. Standard steering gear adjustments
        i. worm bearing preload
        ii. gear mesh preload
        iii. sector shaft endplay
    e. Rack and pinion
    f. Steering gear operation
    g. Rack and pinion buildup
    h. Rack and pinion installation
    i. Rack and pinion adjustments
        i. pinion torque
        ii. pinion bearing preload
    j. Steering gear lubrication
    k. Steering gear ratios
        i. constant ratio
        ii. variable ratio
11. Steering linkage ball joints
    a. Standard ball joints
    b. Rubber bonded socket joints
    c. Rack and pinion inner tie rod ends
12. Parallelogram linkages
    a. Parallelogram operation
    b. Parallelogram buildup
        i. pitman arm
        ii. idler arm
        iii. center link
        iv. tie rods
    c. Parallelogram linkage variants
    d. Parallelism
13. Rack and pinion linkages
    a. Rack and pinion linkage tie rods
        i. boots
14. Other steering linkages
    a. Single-tie-rod
    b. Center point
    c. Long-and-short-arm
    d. Haltenberger
15. Steering damper
16. Steering arms

17. Bump steer
18. The Ackermann angle
19. Power steering hydraulic systems
    a. Hydraulic principles
    b. System components
        i. hoses and fittings
20. Power steering pump and reservoir
    a. Pulley and belt
        i. belt tension
    b. Pump installation
    c. Pump buildup and operation
        i. power steering fluid reservoirs
        ii. vane pump
            1. pump body
            2. cam case and pump cover
            3. rotor, vanes, and cam ring
        iii. roller pump and slipper pump
        iv. gear pump
            1. pump cover
            2. pump body
            3. port housing
21. Integral power steering
    a. Integral standard steering gear
        i. rotary control valve
            1. steering limit valve
            2. pressure relief valve
            3. spool control valve
    b. Integral rack and pinion steering gear
        i. rotary control valve
        ii. spool control valve
22. Linkage power steering
23. Variable-assist power steering
    a. Hydraulically controlled systems
        i. pressure control valve and speed sensor orifice
        ii. speed sensor
            1. one-way and relief valves
        iii. gain control valve and reaction chambers
    b. Electronically controlled systems
        i. electronic sensors and control unit
        ii. solenoid
        iii. system operation
24. Four-wheel-steering operational modes
25. Mechanical four-wheel steering
26. Electronically controlled four-wheel steering
    a. modified pump
    b. rear steering gear
        i. control yoke and swing arm
        ii. main and small bevel gears
        iii. control rod and valve input rod
        iv. control valve
        v. output rod
    c. rear steering linkage
    d. fail-safe system
27. Frames
    a. Ladder frame
    b. Unit-body
28. Axles
29. Ball joints and bushings

a. Ball joints
    i. non-load-carrying
    ii. load-carrying
        1. tension-loaded
        2. compression-loaded
b. Bushings

30. Suspension links
    a. Control arms
    b. Other suspension links
31. Cushioning devices
    a. Springs
        i. spring materials
        ii. spring characteristics
            1. spring rate
            2. spring frequency
            3. sprung weight
            4. wheel rate
            5. natural frequency
        iii. types of springs
            1. leaf springs
            2. coil springs
            3. torsion bars
            4. air springs
    b. Shock absorbers
        i. shock absorber mounts
        ii. shock absorber characteristics
            1. shock absorber ratio
            2. damping force
        iii. hydraulic shocks
        iv. gas-filled shocks
            1. monotube shocks
        v. heavy-duty shocks
            1. coil-over shocks
            2. air shocks
            3. variable shocks
        vi. MacPherson struts
        vii. modified struts
        viii. pivot-base struts
32. Knuckles
33. Solid front suspensions
    a. Solid suspension characteristics
    b. Beam axle suspensions
    c. I-beam suspensions
34. Independent front suspensions
    a. Independent suspension characteristics
    b. Twin I-beam suspensions
        i. twin I-beam characteristics
    c. Short-long-arm suspensions
        i. coil springs on lower control arms
        ii. coil springs on upper control arms
        iii. longitudinal torsion bars
        iv. transverse torsion bars
        v. transverse leaf springs
        vi. short-long-arm characteristics
    d. Strut suspensions
        i. MacPherson struts
        ii. modified struts
        iii. strut characteristics
    e. Strut/short-long-arm suspensions

        i. low knuckle
        ii. long knuckle
        iii. third link
        iv. strut/short-long-arm characteristics
35. Solid rear axles
    a. Solid rear axle characteristics
        i. axle windup
            1. full-floating axle
            2. three-quarter-floating axle
            3. semi-floating axle
    b. leaf spring suspensions
        i. leaf springs with driven axle
        ii. leaf springs with non-driven axle
    c. Trailing arm suspensions
        i. trailing arms with driven axles
            1. panhard rod
            2. torque arm
        ii. trailing arms with non-driven axles
            1. coil spring
            2. strut
    d. Semi-trailing arm suspensions
36. Independent rear suspensions
    a. Independent rear suspension characteristics
    b. Short-long-arm suspensions
        i. short-long-arm characteristics
    c. Strut suspensions
        i. MacPherson strut
        ii. modified strut
            1. coil spring
            2. transverse leaf spring
        iii. strut characteristics
    d. Strut/short-long-arm suspensions
        i. strut/short-long-arm systems with driven axles
        ii. strut/short-long-arm systems with non-driven axles
        iii. strut/short-long-arm characteristics
            1. compliance steer
    e. Semi-trailing arm suspensions
        i. semi-trailing arm characteristics
    f. Multi-link suspensions
        i. multi-link characteristics
37. Semi-independent rear suspensions
    a. Semi-independent rear suspension characteristics
    b. Coil spring suspensions
    c. Strut suspensions
    d. Transverse torsion bar suspensions
38. Electronic controls
    a. Sensors
        i. ride height sensor
        ii. vehicle speed sensor
            1. pickup coil
            2. hall-effect switch
            3. optical sensors
            4. reed switch
        iii. g-force sensor
        iv. steering angle sensor
        v. throttle position sensor
        vi. other sensors
    b. Switches
    c. Electronic control module
    d. Actuators

        i. electromagnets
            1. solenoids
        ii. motors
            1. actuator motors
39. Rear load leveling
40. Variable-rate air springs
    a. System input
    b. Electronic control module operation
    c. System actuators
    d. System function indicator
41. Variable shocks
    a. System input
    b. Electronic control module operation
    c. System actuators
    d. System function indicator
42. Air springs with variable shocks
    a. System input
    b. Electronic control module operation
        i. antiroll control
        ii. antidive control
        iii. antisquat control
        iv. pitching and bouncing control
        v. speed-responsive damping
        vi. vehicle height adjustment
    c. System actuators
    d. System function indicator
43. Wheels
    a. Wheel disc
    b. Wheel rim
    c. Wheel specifications
        i. center hole diameter
        ii. bolt circle
        iii. wheel offset
        iv. wheel backspacing and dish
        v. wheel diameter and rim width
    d. Custom wheels
44. Wheel bearings
    a. Roller bearings
    b. Ball bearings
45. Brake friction assemblies
    a. Drum brakes
    b. Disc brakes
46. Tires
    a. Tire construction
        i. tire carcass
            1. ply patterns
        ii. tire casing
        iii. tire tread
            1. grooves, ribs, and sipes
        iv. tread patterns
    b. Special-purpose tires
        i. snow tires
        ii. rain tires
        iii. off-road tires
        iv. space-saver spare tires
    c. Tire specifications
        i. tire size and dimensions
        ii. tire sidewall information

1. tire size code
2. uniform tire quality grading system code
3. load range, maximum load, and maximum pressure
4. other designations

d. Tire characteristics

47. Wheel runout and balance
    a. Runout
        i. radial runout
        ii. lateral runout
        iii. runout tolerances
        iv. causes of runout
            1. causes of radial runout
            2. causes of lateral runout
    b. Balance
        i. static balance
        ii. dynamic balance
        iii. correcting imbalance
            1. wheel balancing weights
48. Steering geometry
    a. Camber
        i. effects of camber
        ii. influences on camber
    b. Caster
        i. effects of caster
            1. caster trail
            2. camber roll
        ii. influences on caster
    c. Toe
        i. effects of toe
        ii. toe change
    d. Steering axis inclination (SAI)
        i. SAI measurements
        ii. effects of SAI
        iii. SAI and scrub radius
            1. scrub radius effects
    e. Toe-out on turns
    f. Thrust angle
    g. Setback
49. Wheel alignment
    a. Two-wheel alignment
    b. Four-wheel alignment
50. Laboratory Topics: Safety precautions
    a. Emergencies
    b. Fire
    c. Solvents and chemicals
    d. Operating vehicles in the shop
    e. Electrical safety
    f. Using lifts
    g. Jacks and safety stands
    h. Supporting undercarriage components
    i. Compressing springs
        i. compressor plates
        ii. spring clips
        iii. integral-spring strut compressors
    j. Mounting and dismounting tires
    k. Brake service safety
51. Shop practices
52. Special tools

a. Steering wheel puller
b. Tie rod adjuster
c. Snapring pliers
d. Torque wrenches
e. Parts washer
f. Air compressor
g. Grease gun
h. Pickle fork
i. Spring scale

53. Power steering service tools
    a. Flare nut wrench
    b. Pressure gauge
    c. Pulley puller
    d. Drive belt tension gauge
    e. Dial indicator
54. Tire changing machine
55. Wheel bearing tools
    a. Wheel bearing pullers and drivers
    b. Wheel bearing packer
56. Seal pullers and drivers
57. Wheel balancer
    a. Spin balancer
    b. On-chassis balancer
58. Wheel alignment equipment
    a. Steering wheel lock
    b. Brake lock
59. Gathering information for chassis diagnosis
    a. The vehicle owner
    b. Visual inspection
    c. Road test
60. Analyzing the information
61. Electrical and electronic safety
62. Organized troubleshooting
    a. Ask the owner or driver
    b. Know the system
    c. Recreate the problem
    d. List the possible causes
    e. Isolate the problem circuit
    f. Know the problem circuit
    g. Test systematically
    h. Verify your findings
    i. Repair
    j. Test the repair
63. Electricity and electronics principles
    a. Electrical current
        i. amperage
    b. Electromotive force
        i. voltage
        ii. voltmeter
    c. Resistance
        i. ohms
        ii. Ohm's Law
64. Electrical test instruments and testing
    a. Test lamp
        i. external-powered test lamp
        ii. self-powered test lamp
        iii. sealing wires after probing
    b. Jumper wires
    c. Voltmeter

        i. testing with a voltmeter
            1. checking source voltage
            2. checking voltage drop
            3. checking continuity
    d. Ammeter
        i. testing with an ammeter
    e. Ohmmeter
        i. testing with an ohmmeter
    f. Multimeter
    g. Scan tool
65. Steering wheel and column
    a. Preliminary checks
        i. steering wheel freeplay test
        ii. steering wheel neutral position check
        iii. visual inspection
        iv. test drive
    b. Steering wheel removal
        i. air bag module removal
        ii. steering wheel removal
    c. Steering column accessory removal
    d. Steering column removal
    e. Steering column and shaft inspection
        i. steering shaft joint inspection and replacement
            1. checking and replacing u-joints
            2. checking and replacing flexible couplings
            3. checking and replacing pot joints
        ii. steering shaft and bearing service
        iii. checking for a collapsed steering column
    f. Steering column and steering wheel installation
        i. steering column assembly
        ii. steering column installation
66. Steering gears
    a. Steering gear troubleshooting
67. Standard steering gears
    a. Visual inspection
    b. Steering gear adjustment
        i. checking and adjusting worm bearing preload
        ii. checking and adjusting gear mesh preload
        iii. checking and adjusting sector shaft endplay
    c. Steering gear removal
    d. Steering gear teardown and inspection
        i. worm and roller steering gear
            1. disassembly
            2. inspection
            3. assembly
        ii. recirculating ball steering gear
            1. disassembly
            2. inspection
            3. assembly
    e. Standard steering gear installation
68. Rack and pinion steering gears
    a. Visual inspection
    b. Rack and pinion adjustments
        i. pinion torque
        ii. pinion bearing preload
    c. Rack and pinion assembly removal
    d. Rack and pinion disassembly and inspection
    e. Rack and pinion assembly
    f. Rack and pinion installation

69. Identifying the steering linkage
70. Inspecting and replacing components
    a. Inspecting the overall condition
    b. Ball joint service
        i. checking ball joints
        ii. lubricating ball joints
        iii. separating and installing ball joints
        iv. Ford RBS ball joints
    c. Pitman arm
        i. inspection
        ii. replacement
    d. Center link, relay rod, and drag link service
        i. inspection
        ii. replacement
    e. Idler arm
        i. inspection
        ii. removal
        iii. repair
        iv. installation
    f. Tie rods
        i. inspection
        ii. replacement
    g. Steering damper
        i. inspection
        ii. replacement
    h. Steering arm
        i. inspection
        ii. replacement
71. Measurements and adjustments
    a. Parallelism
        i. checking parallelism
        ii. adjusting parallelism
    b. Rack horizontal position
72. Power steering fluid
    a. Power steering fluid level check
    b. Interpreting power steering fluid condition
    c. Checking the hydraulic system for leaks
    d. Flushing the system
    e. Bleeding the system
73. Drive belt service
    a. Drive belt inspection
    b. Drive belt tension
        i. checking belt tension
        ii. adjusting belt tension
    c. Drive Belt replacement
        i. v-belt removal
        ii. serpentine belt removal
        iii. checking for causes of belt wear
        iv. drive belt installation
74. Power steering testing
    a. System pressure test
    b. Pump pressure test
    c. Steering gear pressure test
    d. Oil pressure switch test
75. Hoses and fittings
    a. Hose and fitting inspection
    b. Hose replacement
76. Power steering pump

    a. Inspection
        i. pump inspection
        ii. mount inspection
        iii. pulley inspection
    b. Pump replacement
    c. Pump mount and pulley replacement
        i. pump mount replacement
        ii. pump pulley replacement
    d. Pump rebuilding
77. Power-assisted steering gears
    a. Hydraulic
    b. Electric
    a. Power steering gear inspection
        i. standard steering gear
        ii. rack and pinion steering gear
    b. Steering gear removal and installation
    c. Steering gear adjustments
        i. standard steering gear
            1. control valve centering
    d. Rack and pinion steering gear
78. Identifying a four-wheel-steering system
1. Steering angle transfer shaft
2. Electronic and hydraulic controls
3. Power steering pump
4. Identifying shocks, struts, and springs
5. Shock absorbers
    a. Inspection
        i. bounce test
        ii. visual inspection
        iii. bench test
    b. Shock absorber replacement
        i. removal
        ii. installation
6. Struts
    a. Inspection
    b. Removal
    c. Disassembly
        i. coil spring removal
        ii. cartridge replacement
        iii. assembly
        iv. installation
7. Springs
    a. Inspection
        i. visual inspection
        ii. coil spring inspection
        iii. leaf spring inspection
        iv. torsion bar inspection
    b. Coil Spring Service
        i. securing coil springs
            1. safety clips
            2. compressor plates
        ii. coil spring replacement
            1. with control arms
            2. with a solid or semi-independent axle
    c. Leaf Spring Service
        i. leaf spring removal
            1. longitudinal leaf springs
            2. transverse leaf springs
        ii. leaf spring inspection
        iii. leaf spring installation

1. longitudinal leaf springs
2. transverse leaf springs

iv. auxiliary leaf springs

d. Torsion bar service
   i. torsion bar adjustment
      1. SLA front suspension
      2. trailing arm rear suspensions
   ii. torsion bar removal
      1. longitudinal SLA front suspensions
      2. transverse SLA front suspensions
      3. transverse trailing arm rear suspension
   iii. torsion bar installation
      1. longitudinal SLA front suspensions
      2. transverse SLA front suspensions
      3. transverse trailing arm rear suspension

8. Suspension ball joints
   a. Identification
   b. Inspection
      i. checking wear
         1. non-load-carrying ball joint
         2. load-carrying ball joint
   c. Lubrication Service
   d. Replacement
      i. separating the ball joint
      ii. removing the ball joint
      iii. installing the ball joint
9. Bushings
   a. Inspection
   b. Replacement
10. Knuckles
   a. Inspection
   b. Removal
      i. ball joint-to-knuckle connection
      ii. strut base-to-knuckle connection
      iii. pivot bushing-to-knuckle connection
         1. kingpin-to-knuckle connection
11. Control arms
   a. Inspection
   b. Replacement
      i. removal
      ii. installation
   c. Bushing replacement
12. Trailing and semi-trailing arms
   a. Inspection
   b. Replacement
      i. independent trailing arms
      ii. solid axle trailing arms
         1. solid non-driven axle trailing arms
         2. solid driven axle trailing arms
      iii. semi-trailing arms
   c. Trailing arm bushing replacement
13. Antiroll bars and other suspension links
   a. Antiroll bar
   b. Strut rod
   c. Radius arm
   d. Trailing and lateral links
   e. Panhard rod
   f. Torque arm
14. Axles

a. Non-driven axles
    i. rear axle replacement
        1. removal
        2. installation
    ii. front I-beam axle replacement
    iii. solid axles
        1. inspection
        2. removal
        3. installation
    iv. axle shafts
        1. inspection
15. Driveline joints
    a. Constant velocity joints
        i. inspection
        ii. axle removal
        iii. cv joint replacement
16. Identifying electronically controlled suspensions
17. Electronic suspension precautions
    a. Lifting and towing
    b. Wheel alignment
18. Electronic control system inspection
    a. Hydraulic system
    b. Pneumatic system
    c. Electronic system
        i. vehicle electrical system
        ii. electronic self-diagnostic programs
19. Electronic component service
    a. Sensors
        i. ride height sensor
        ii. vehicle speed sensor
        iii. steering angle sensor
        iv. g-force sensor
    b. Actuators
        i. flow control valve
        ii. motors
20. Wheel and tire service
    a. Removal and installation
    b. Tire mounting and dismounting
    c. Inspection
        i. tire pressure check
        ii. tire inspection
        iii. wheel inspection
        iv. tire leak check
        v. tire injury repair
        vi. valve stem and valve core replacement
    d. Selecting custom wheels and tires
21. Basic wheel bearing service
    a. Bearing replacement tips
    b. Cleaning
    c. Inspection
    d. Lubrication
    e. Adjustable dual wheel bearing service
        i. tapered roller bearings adjustment
            1. hand adjustment
            2. torque wrench adjustment
            3. dial indicator adjustment
    f. Sealed wheel bearing service
        i. rear axle sealed bearing replacement
        ii. front axle sealed bearing replacement
    g. Solid driven axle wheel bearing service

i. c-lock axle service
ii. retainer plate axle service

22. Runout
    a. Measuring radial runout
    b. Measuring lateral runout
    c. Reducing radial and lateral runout
23. Balancing
    a. Bubble balancing
    b. Spin balancing
        i. off-the-vehicle
        ii. on-the-vehicle
24. Tire Rotation
25. Pre-alignment inspection
    a. Visual inspection
    b. Test drive
    c. Preliminary measurements
        i. ride height
        ii. engine cradle alignment
        iii. toe-out on turns
        iv. setback
26. Measuring alignment angles
    a. Alignment rack maintenance
    b. Computerized four-wheel alignment
        i. preparing the vehicle
        ii. equipment programming
            1. setting up the specifications screen
        iii. installing the sensors
            1. compensating the sensors
        iv. reading alignment angles
            1. caster and cross caster
            2. SAI and included angle
        v. adjusting alignment angles
            1. adjusting rear wheel alignment angles
            2. adjusting front wheel alignment angles
        vi. printing the alignment report
    c. Two-wheel alignment
        i. computerized two-wheel alignment
        ii. bubble gauge alignment
27. Alignment angle adjustments
    a. Shim adjustments
    b. Eccentric cam bolt adjustments
    c. Suspension component adjustment
    d. Strut rod adjustments
    e. Ball joint sleeve adjustment
    f. Strut mount adjustment
    g. Bending the axle
    h. Camber, caster, and toe adjustments
        i. adjusting front wheel camber
        ii. adjusting caster
        iii. adjusting front camber and caster simultaneously
        iv. adjusting front wheel toe
        v. adjusting rear wheel camber
        vi. adjusting rear wheel toe
        vii. adjusting rear camber and toe simultaneously
28. Special considerations
    a. Camber
    b. Caster
    c. Toe
    d. Steering axis inclination

e. Included angle
f. Setback

Resources

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Top of page
Key: 746