

## **AUT 141 (A4)**

### **SUSPENSION AND STEERING**

#### **COURSE DESCRIPTION:**

Prerequisites: None

Corequisites: None

This course covers principles of operation, types, and diagnosis/repair of suspension and steering systems to include steering geometry. Topics include manual and power steering systems and standard and electronically controlled suspension and steering systems. Upon completion, students should be able to identify steering and suspension problems, service and repair steering and suspension components, check and adjust alignment angles, and repair and balance tires. Course Hours per Week: Class, 2; Lab Hours, 3; Semester Hours Credits, 3.

#### **SAFETY DISCLAIMER:**

Automotive work presents many hazards. A moment's carelessness can cause injury to oneself or to others. Such mishaps can occur quickly due, in part, to the nature of the industrial tools used in automotive work. The weight of automobiles and the equipment used to fix them can even cause fatal injuries. Therefore, great care must always be taken in checking out equipment before use, and in using that equipment to work on automobiles.

As we work to insure the safety of everyone in the DTCC automotive lab, it is the instructor's responsibility to introduce students to equipment and to advise them on its safe operation. Those health and safety procedures are also presented in each textbook for each course in the automotive program. **Students are responsible for mastery of that safety information.** DTCC holds each student in every class responsible for reading and applying all of the information regarding personal and public safety and personal and public health in the required text.

While working in the DTCC automotive lab, safety glasses must be worn by everyone. However, safety glasses are only one small requirement so that students remain injury free. All safety recommendations in the text book and from the instructor must be followed. A student with any questions about a safety procedure should immediately ask an instructor for clarification.

Any student using equipment in the automotive lab must be responsible for using that equipment in a safe manner. Durham Technical Community College holds each student in automotive classes responsible for acting to ensure a safe environment and to ensure both the student's own safety and the safety of his classmates.

## **LEARNING OUTCOMES:**

Upon completion of this course the student will be able to:

- a. Identify vehicle information and observe steering safety procedures.
- b. Inspect, diagnose, and repair tire problems and perform tire maintenance.
- c. Inspect, diagnose and replace front suspension components.
- d. Diagnose suspension noise, vibration and harshness.
- e. Inspect, diagnose and replace rear suspension components.
- f. Diagnose and inspect steering wheel and steering shaft problems and replace components when necessary.
- g. Inspect, replace and adjust steering linkage components
- h. Service, inspect, and diagnose power and manual steering concerns.
- i. Diagnose and adjust vehicle alignment concerns and perform a four wheel alignment.

## **OUTLINE OF INSTRUCTION:**

- I. Vehicle Information
  - A. Identification numbers
    - 1) VIN
    - 2) Vehicle
    - 3) Component
  - B. Service information
  - C. Work order
  - D. Customer concern
  - E. Procedure to disarm supplemental restraint system
- II. Wheels and Tires
  - A. Tire construction
    - 1) Carcass
    - 2) Belts
    - 3) Tread
    - 4) UTQG
  - B. Check Tire Pressure
  - C. Tire Rotation Patterns
    - 1) Bias-belted
    - 2) Radial
  - D. Runout
    - 1) Radial/lateral
    - 2) Match mounting
    - 3) Specifications
  - E. Effects of Wheels and Tires Not Within Specifications
  - F. Tire Tread Wear Patterns and Causes
  - G. Wheel Balance (On-Car and Off-Car)
    - 1) Static
    - 2) Dynamic
    - 3) Tramp (pounding)
    - 4) Shimmy
    - 5) Radial Force Variation

- 6) Lateral Force Variation
- 7) Axle Flange/Rotor Hub Runout
- H. Tire Repair
- I. Tire pressure monitoring system

### III. Front Suspension and Construction

- A. Solid Axle Front End
  - 1) King pin and steering knuckle
  - 2) Linkage component identification
- B. Independent Front Suspension
  - 1) Lower coil spring mount
  - 2) Upper coil spring mount
  - 3) Torsion bar I
  - 4) Nomenclature of parts
- C. MacPherson Strut Suspension
- D. Twin I-Beam Design
- E. Types of springs
  - 1) Leaf
    - a) Rebound clip
    - b) Center bolt
    - c) Tapered single leaf
  - 2) Coil
    - a) Should be replaced in pairs
    - b) Importance of proper ride height
    - c) Variable rate
  - 3) Torsion Bar
    - a) Adjustable
  - 4) Controlling Spring Oscillation
    - a) Function of shock absorber
  - 5) Computer-Controlled Air Springs

### IV. Front Suspension Service

- A. Inspection
  - 1) Ball joints
    - a) Load carrying (on short and long-type suspension)
    - b) Follower
    - c) Compression
    - d) Tension
    - e) Jacking points
    - f) Wear indicator type joint
    - g) Axial and radial movement
    - h) Checking MacPherson strut ball joints
  - 2) Idler arms
    - a) Types
    - b) Installation (wheels straight ahead)
    - c) Acceptable looseness
    - d) Adjustment
  - 3) Control arm bushings
  - 4) Pivot shaft (cross shaft)

- 5) Tie rod ends/sleeves/clamps
  - 6) Relay rod (center link)
  - 7) Pitman arm and sector shaft
  - 8) King pins/bushings/knuckle
  - 9) Twin I-beam axle bushings and radius arms
  - 10) Shock absorbers
    - a) Conventional
    - b) Air
    - c) Strut cartridge installation
    - d) Computer actuated motors
  - 11) Rebound bumpers
  - 12) Torsion bars
  - 13) Steering knuckle assemblies
  - 14) Sway bar and linkage
  - 15) Strut rod bushings
  - 16) Wheel bearings/adjustments
  - 17) Steering damper
  - 18) Rack mounting bushings and brackets
  - 19) Spring insulators
- B. Determine Needed Repairs
- C. Replace Components (Procedures)
- 1) Tool identification
    - a) Spring compressors/clips
    - b) Ball joint press

## V. Rear Suspension Systems

- A. Function of Components
- 1) "U" Bolts
  - 2) Control arms
  - 3) Stabilizer bar
  - 4) Controlling "wrap-up"
  - 5) Shackles, brackets and mounts
  - 6) Springs
  - 7) Transverse links
- B. Rear Wheel Steering
- 1) Cars
  - 2) Trucks
- C. Replace Components (Procedures)

## VI. Steering

- A. Manual
- 1) Types
  - 2) Adjustments
  - 3) Diagnosis
    - a) Hard steering
    - b) Looseness
    - c) Roughness
    - d) Binding through the center of travel
    - e) Column noise

## B. Power

- 1) Types (including variable assist)
- 2) Inspect and. check system/adjustment tools
- 3) Replace components (procedures)
- 4) Bleeding
- 5) Inspect and replace steering shaft u-joint(s)
- 6) Inspect and replace flexible coupling ("rag"joint)
- 7) Diagnosis
  - a) Hard steering (reduced assist)
  - b) Loss of fluid (leakage points)
  - c) Checking procedures
  - d) Noises (including tilt and telescoping wheels) e. Checking pump pressures
  - e) Pull
  - f) Poor returnability out of a turn
  - g) Wrong fluid used (seal swelling)
  - h) Scan tool diagnostics
  - i) Clock spring problems/replacement
- 8) Adjustments
  - a) Worm bearing preload (torsion bar feel)
  - b) Sector (ball nut) mesh
  - c) Centering shims (spool valve)
  - d) Pump belt tension
- 9) Steering pump overhaul procedures
  - a) Vane and rotor/cam ring kit
  - b) Seal kit
- 10) Repairing steering gearbox mount cracks in tram.

## C. Rack and Pinion (Center and End Takeoff Types)

- 1) Components (including variable assist)
- 2) Diagnosis
  - a) Grind noise
  - b) Vibration
  - c) Looseness/rattle
  - d) Hard steering
  - e) Bump or orbital steer
  - f) Poor assist when cold
  - g) Poor returnability
  - h) Fluid in bellows boots
  - i) Momentary loss of assist
  - j) Shudder
  - k) Hiss
  - l) Whine
  - m) Squeal
  - n) Buzz
  - o) Click
  - p) Creak
  - q) Pop
- 3) Adjustments
- 4) Mounting levelness/bump steer
- 5) Seal replacement procedures

- 6) Hose replacement procedures
- 7) System flushing/filter installation
- 8) Short rack replacement

## VII. Emerging Suspension and Steering Technologies

## VIII. Alignment Factors

- A. Caster
- B. Camber
- C. Toe
- D. Steering Axis Inclination (SA I.)
- E. Toe-Out on Turns (Turning Radius)
- F. Included Angle
- G. Steering Wheel Centering
- H. Point of Intersection
- I. Riding Height/Frame Angle
- J. Thrust Angle
- K. Setback
- L. Scrub Radius
- M. Torsion Bar Adjustment

## IX. Alignment Angle Effects

- A. Caster
  - 1) Positive or negative
  - 2) A directional control angle
  - 3) Wander and weave
  - 4) Stability
  - 5) Turning effort
  - 6) Returnability
  - 7) Road crown pull
  - 8) Can cause outside shoulder "chew" if excessive
- B. Camber
  - 1) Positive or negative
  - 2) Is a tire wearing angle
  - 3) Pulling
  - 4) Provides for easy steering
  - 5) Brings road contact point of tire more nearly under point of load
- C. Toe
  - 1) Purpose
  - 2) Tire wear (feather edge or saw tooth wear)
  - 3) Toe wear can look like a camber problem
  - 4) Stability
- D. Steering Axis Inclination
  - 1) Provides a pivot point to produce easier steering
  - 2) Reduces need for excessive camber
  - 3) Effect on wheel bearings
  - 4) Non-adjustable

- E. "Included" Angle
  - 1) Can help determine a bent spindle or strut
- F. Toe-Out on Turns
  - 1) Built-in design angle (steering arms)
  - 2) Purpose
  - 3) Greater angle on inside wheel
  - 4) Oversteer and understeer
  - 5) Tire wear (scuffing)
- G. Determine Needed Repairs
- H. Front Alignment (Including Prealignment Inspection)
  - 1) Sequence procedure for alignment (2-wheel, 4 wheel, and electronic systems)
  - 2) Method of adjustment for caster and camber
    - a) Shims (understand adjustment location)
    - b) Eccentrics
    - c) Serrated/slotted cross shaft
    - d) Strut rods
    - e) Cold bending
  - 3) Toe
    - a) Scribing the tire
    - b) Adjusting sleeve tool
    - c) Left-hand and right-hand threads
    - d) Centering steering wheel
    - e) Shims
  - 4) MacPherson strut adjustment(s)
  - 5) Toe-out on turns (turning radius)
    - a) Left (outside wheel) turn in 20°
    - b) Right (inside wheel) should read?
    - c) Checks for a bent steering arm
    - d) Steering stops
  - 6) 4-wheel drive vehicle adjustment(s)
  - 7) Equipment identification and use
    - a) Magnetic gauge
    - b) Radius plate
    - c) Brake pedal jack
    - d) Toe gauge
    - e) Steering wheel holder
    - f) Wheel runout gauge
    - g) Scuff gauge
    - h) Tire scribe
    - i) Wheel clamp adapter
    - j) Pit rack
    - k) Fixed/power rack
    - l) Hoist rack
    - m) Mechanical balancer head
- I. Rear Wheel Alignment
  - 1) Dog tracking
  - 2) Tram gauges
  - 3) Setting camber (positive or negative)
  - 4) Checking axle housing bend

- 5) Setting toe (positive or negative)
  - 6) Full-circle shims
  - 7) Track/thrust line
- J. Problem/Diagnosis
- 1) Noise
  - 2) Sway
  - 3) Uneven riding height
  - 4) Torque steer/memory steer
  - 5) Cradle misalignment
  - 6) Twisted sector shaft splines
- X. Problem/Diagnosis
- 1) Idler Arm Wear
  - 2) Control Arm Bushing Wear
  - 3) Ball Joint Wear
  - 4) Pulling
  - 5) Wheel Shimmy
  - 6) Wheel Tramp
  - 7) First- and Second-Order Vibrations
  - 8) Conicity
  - 9) Handling Characteristics Poor
    - A. Interpreting wheel alignment readings and charts

**REQUIRED TEXTBOOKS AND MATERIALS:**

To be determined by instructor.

**NATEF:**

This course fulfills 80 of the 95 hours required by **NATEF** for A4. See COE 111.