



Prentice Hall Multimedia Series in Automotive Technology

AUTOMOTIVE STEERING, SUSPENSION, AND ALIGNMENT



Suranaree University of Technology



31051000594008

Second Edition

James D. Halderman

Chase D. Mitchell, Jr.

SOFTWARE ENCLOSED
Book not returnable if software
has been removed
PRENTICE-HALL, INC.

Contents

Preface	xiii
Acknowledgments	xiv

1 Chassis Design, Materials, Fasteners, and Safety

Objectives	1
Chassis Design	1
Platforms	3
Chassis Materials	4
Threaded Fasteners	5
Basic Tool List	7
Brand Name versus Proper Term	12
Safety Tips for Using Hand Tools	12
Safety Tips for Technicians	12
Safety in Lifting (Hoisting) a Vehicle	13
Hazardous Materials	16
Material Safety Data Sheets	17
Technician Certification	17
Certification in Canada	18
Summary	22
Review Questions	22
ASE Certification-Type Questions	22

2

Tires and Wheels 23

Objectives	23
Parts of a Tire	23
Tire Molding	27
Tire Valves	27
Older Tire Size Designation	28
Metric Designation	28
Service Description	31
High-Flotation Tire Sizes	31
Load Index and Equivalent Loads	32
Speed Ratings	33
Tire Pressure and Traction	34

Tire Conicity and Ply Steer	34
Vehicle Handling and Tire Slip Angle	35
Rim Width and Tire Size	36
Uniform Tire Quality Grading System	36
All-Season Tire Designation	37
DOT Tire Code	37
Spare Tires	38
Run-Flat Tires	39
Tire Selection Considerations	39
Wheels	41
Unsprung Weight	44
Lug Nuts	45
Summary	50
Review Questions	50
ASE Certification-Type Questions	50

3

Tire and Wheel Service 51

Objectives	51
Tire Mounting Recommendations	51
Wheel Mounting Torque	53
Tire Rotation	54
Tire Inspection	56
Radial Runout	57
Lateral Runout	58
Tire Balancing	59
Replacement Wheels	64
Tire Repair	65
Summary	75
Review Questions	75
ASE Certification-Type Questions	75

4

Wheel Bearings and Service 76

Objectives	76
Antifriction Bearings	76
Inner and Outer Wheel Bearings	77

Standard Bearing Sizes	78
Sealed Front-Wheel-Drive Bearings	78
Bearing Greases	78
Seals	80
Symptoms and Diagnosis of Defective Bearings	80
Non-Drive-Wheel Bearing Inspection and Service	80
Front-Wheel-Drive Sealed Bearing Replacement	83
Rear Axle Bearing and Seal Replacement	84
Bearing Failure Analysis	88
Summary	95
Review Questions	95
ASE Certification-Type Questions	95

5

Drive Axle Shafts and CV Joints 96

Objectives	96
Driveshaft Design	96
Driveshaft Balance	98
U-joint Design and Operation	99
Constant Velocity Joints	101
Differentials	107
Four-Wheel-Drive Systems	110
All-Wheel Drive	113
Summary	116
Review Questions	116
ASE Certification-Type Questions	116

6

Drive Axle Shaft and CV Joint Service 117

Objectives	117
Driveshaft and U-joint Inspection	117
U-joint Replacement	120
CV Joint Diagnosis	123
Replacement Shaft Assemblies	124
CV Joint Service	124
Summary	137
Review Questions	137
ASE Certification-Type Questions	137

7

Steering System Components and Operation 138

Objectives	138
Steering System Components	138
Power Steering Pumps	147
Integral Power Steering Gear Operation	151
Power Rack and Pinion Steering	152
Summary	162

Review Questions	164
ASE Certification-Type Questions	164

8

Steering System Diagnosis and Service 166

Objectives	166
Under-Vehicle Lubrication	166
Dry Park Test	167
Common Wear Items	168
Under-Vehicle Inspection	169
Steering Linkage Replacement	170
Manual Rack and Pinion Steering Service	176
Power Steering Diagnosis and Troubleshooting	178
Steering Gear Diagnosis	187
Steering Gear Overhaul and Service	189
Power Rack and Pinion Service	195
Summary	205
Review Questions	211
ASE Certification-Type Questions	211

9

Suspension System Components and Operation 212

Objectives	212
Unsprung Weight	212
Types of Suspensions	212
Hooke's Law	214
Coil Springs	214
Leaf Springs	217
Torsion Bars	219
Suspension Principles	221
Solid Axles	222
Twin I-Beams	222
Short/Long Arm Suspensions	225
MacPherson Struts	225
Multilink Suspensions	227
Ball Joints	227
Strut Rods	228
Stabilizer Bars	230
Shock Absorbers	232
Bump Stops	235
Rear Suspensions	237
Summary	245
Review Questions	246
ASE Certification-Type Questions	246

10

Suspension System Diagnosis and Service 247

Objectives	247
Road Test Diagnosis	247

Dry Park Test (Suspension)	249
Visual Inspection	249
Ball Joints	250
King Pin Diagnosis and Service	258
Shock Absorbers and Struts	258
MacPherson Strut Replacement	262
Stabilizer Bar Link and Bushings	266
Strut Rod Bushings	268
Rear Coil Springs	269
Front Coil Springs	272
Steering Knuckles	273
Torsion Bars	274
Control Arm Bushings	275
Rear Leaf Springs	276
Troubleshooting Electronic Leveling Systems	277
Summary	278
Review Questions	282
ASE Certification-Type Questions	282

II

Wheel Alignment Principles 283

Objectives	283
Alignment-Related Problems	283
Camber	284
Toe	287
Caster	292
Steering Axis Inclination (SAI)	294
Included Angle	294
Scrub Radius	295
Turning Radius (Toe-Out on Turns)	297
Setback	297
Thrust Angle	299
Tracking	300
Four-Wheel Alignment	300
Summary	301
Review Questions	301
ASE Certification-Type Questions	301

12

Alignment Diagnosis and Service 303

Objectives	303
Pre-Alignment Correction Techniques	303
Pre-Alignment Checks	304
Lead/Pull	305
Memory Steer	306
Torque Steer	307
Alignment Specifications	308
Alignment Setup Procedures	311
Measuring Camber, Caster, SAI, Toe, and TOOT	311
Specifications versus Alignment Readings	313
Checking for Bent Struts, Spindles, or Control Arms	313
Checking Frame Alignment of Front-Wheel-Drive Vehicles	313
Types of Alignments	316

Sample Alignment Specifications and Readings	317
Adjusting Rear Camber	319
Adjusting Rear Toe	319
Guidelines for Adjusting Front Camber/SAI and Included Angle	320
Front Camber/Caster Adjustment Methods	321
Adjusting Front Camber/Caster	321
Setting Toe	321
Centering the Steering Wheel	326
Steering Wheel Removal	328
Tolerance Adjustment Procedure	329
Aftermarket Alignment Methods	331
Hidden Structural Damage Diagnosis	331
Alignment Troubleshooting	334
Summary	342
Review Questions	342
ASE Certification-Type Questions	342

13

Vibration and Noise Diagnosis and Correction 343

Objectives	343
Causes of Vibration and Noise	343
Test Drive	344
Neutral Run-Up Test	346
Vibration during Braking	346
Vibration Speed Ranges	346
Frequency	348
Correcting Drive-Line Angles	351
Checking Driveshaft Runout	351
Measuring Driveshaft U-Joint Phasing	351
Companion Flange Runout	351
Balancing the Driveshaft	352
Noise Diagnosis	353
Noise Correction	355
Summary	356
Review Questions	356
ASE Certification-Type Questions	356

APPENDICES

1 ASE-Style Sample Test	357
2 Lug Nut Tightening Torque Chart	360
3 DOT Tire Codes	366
4 English-Metric (SI) Conversion	380
5 Decimal Equivalents	382
6 Alignment Angle Conversions	383
7 Automotive Names and Addresses	385

Answers to Even-Numbered ASE Certification-Type Questions 392

Glossary 393

Index 401