

# Contents

<i>Preface</i>	viii	1.4.2 Units	31
<i>About the author</i>	ix	1.4.3 Velocity and acceleration	32
<i>Acknowledgements</i>	x	1.4.4 Friction	32
		1.4.5 Pressure	32
		1.4.6 Centre of gravity or centre of mass	32
<b>1 Overview and introduction</b>	<b>1</b>	1.4.7 Oscillation	33
1.1 Vehicle categories	1	1.4.8 Energy, work and power	33
1.1.1 Layouts	1	1.4.9 Force and torque	34
1.1.2 Types and sizes	2	1.4.10 Mass, weight and force	34
1.1.3 Body design	2	1.4.11 Volume and density	34
1.1.4 Chassis type and body panels	2	1.4.12 Heat and temperature	35
1.1.5 Main systems	5	1.4.13 Percentages	35
1.1.6 Summary	6	1.4.14 Fractions	36
1.2 The motor industry	6	1.4.15 Ratios	36
1.2.1 Introduction	6	1.4.16 Areas	36
1.2.2 Types of motor vehicle companies	6	1.4.17 Volumes	36
1.2.3 Company structure	10	1.4.18 Indices	36
1.2.4 Role of a franchised dealer	10	1.4.19 Drawings	37
1.2.5 Reception and booking systems	10	1.4.20 Mechanical machines	37
1.2.6 Parts department	10	1.4.21 Gears	38
1.2.7 Estimating costs and times	11	1.4.22 Hydraulics	39
1.2.8 Job cards and systems	11	1.4.23 Materials and properties	39
1.2.9 Invoicing	12	1.5 Tools and equipment	40
1.2.10 Warranties	12	1.5.1 Hand tools	40
1.2.11 Computerized workshop system	12	1.5.2 Test equipment	41
1.3 Working safely	15	1.5.3 Workshop equipment	42
1.3.1 Introduction	15	1.6 Workshop bench skills	42
1.3.2 The key UK regulations and laws	16	1.6.1 Introduction	42
1.3.3 Health and safety law: what you need to know	16	1.6.2 Fitting and machining	43
1.3.4 Personal protective equipment (PPE)	18	1.6.3 Filing	44
1.3.5 Identifying and reducing hazards	20	1.6.4 Drilling	44
1.3.6 Moving loads	21	1.6.5 Cutting	45
1.3.7 Vehicle safety	24	1.6.6 Thread cutting	45
1.3.8 Safety procedures	24	1.6.7 Joining	46
1.3.9 Fire	24	1.6.8 Nuts and bolts	47
1.3.10 Clean working environment	27	1.6.9 Adhesives	48
1.3.11 Signage	28	1.6.10 Soldering	49
1.3.12 Environmental protection	29	1.6.11 Brazing	49
1.4 Basic science, materials, mathematics and mechanics	29	1.6.12 Welding	49
1.4.1 Introduction	29	1.6.13 Shrinking	50
		1.6.14 Compression fitting	50
		1.6.15 Riveting	50

# Contents

1.6.16	Gaskets	50	2.8.1	Spark plug electrode designs	168
1.6.17	Sealants	51	2.8.2	V6 diesel with electric turbocharging	169
1.6.18	Oil seals	51	2.8.3	Water injection	170
1.7	Servicing and inspections	51	2.8.4	Cylinder deactivation	171
1.7.1	Introduction	51	2.8.5	Dynamic skip fire	172
1.7.2	Rules and regulations	52	2.8.6	Diesel particulate filters	172
1.7.3	Service sheets	52	2.8.7	Oil filter modules	174
1.7.4	Road test	53	2.8.8	Miller cycle	175
1.7.5	Effects of incorrect adjustments	53	2.8.9	Cooled EGR	175
1.7.6	Maintenance and inspections	56			
1.7.7	Information sources	56			
<b>2</b>	<b>Engine systems</b>	<b>59</b>	<b>3</b>	<b>Electrical systems</b>	<b>177</b>
2.1	Engine mechanical	59	3.1	Electrical and electronic principles	177
2.1.1	Introduction and operating cycles	59	3.1.1	Electrical fundamentals	177
2.1.2	Engine operating details	66	3.1.2	Electrical components and circuits	181
2.1.3	Engine components	78	3.1.3	Electronic components	188
2.2	Engine lubrication	95	3.2	Engine electrical	190
2.2.1	Friction and lubrication	95	3.2.1	Batteries	190
2.2.2	Methods of lubrication	96	3.2.2	Starting system	196
2.2.3	Lubrication system	97	3.2.3	Charging system	200
2.2.4	Oil filters	99	3.3	Lighting and indicators	204
2.2.5	Oil pumps	100	3.3.1	Lighting systems	204
2.2.6	Standards	101	3.3.2	Stoplights and reverse lights	207
2.3	Engine cooling	103	3.3.3	Interior lighting	208
2.3.1	Introduction	103	3.3.4	Lighting circuits	208
2.3.2	System operation	104	3.3.5	Indicators and hazard lights	210
2.3.3	Interior heater	113	3.4	Body electrical and electronic systems	212
2.4	Air supply, exhaust and emissions	114	3.4.1	Washers and wipers	212
2.4.1	Air pollution and engine combustion	114	3.4.2	Horns	215
2.4.2	Reducing pollution	115	3.4.3	Obstacle avoidance	216
2.4.3	Air supply system	117	3.4.4	Cruise control	216
2.4.4	Exhaust systems	119	3.4.5	Seats, mirrors, sunroofs, locking and windows	217
2.4.5	Catalyst systems	121	3.4.6	Screen heating	222
2.4.6	Emission control systems	122	3.4.7	Security systems	222
2.4.7	Turbocharging and supercharging	125	3.4.8	Safety systems	223
2.5	Fuel systems	128	3.5	Monitoring and instrumentation	226
2.5.1	Introduction	128	3.5.1	Sensors	226
2.5.2	Petrol fuel injection systems	132	3.5.2	Gauges	228
2.5.3	Diesel fuel injection systems	147	3.5.3	Global Positioning System (GPS)	230
2.6	Ignition systems	158	3.6	Air conditioning	233
2.6.1	Ignition overview	158	3.6.1	Air conditioning fundamentals	233
2.6.2	Electronic ignition	161	3.6.2	Air conditioning components	235
2.6.3	Distributorless ignition system (DIS)	162	3.7	Electrical systems: new developments and updates	237
2.6.4	Coil on plug (COP) direct ignition system	164	3.7.1	Touchscreen with haptic feedback	237
2.6.5	Spark plugs	165	3.7.2	Navigation and the new NDS data standard	237
2.7	Electric and hybrid cars	166	3.7.3	Battery diagnostics	239
2.7.1	Types of electric vehicle	166	3.7.4	Alternator developments	240
2.7.2	The EV experience	167	3.7.5	Electronic starter motor control and stop-start system	242
2.8	Engine systems: new developments and updates	168			

3.7.6	Advanced driver assistance systems (ADAS)	243	4.5.4	Antilock braking system (ABS) update	306
3.7.7	BMW laser headlamps	244	4.5.5	Predictive active ride control	308
<b>4</b>	<b>Chassis systems</b>	<b>245</b>	<b>5</b>	<b>Transmission systems</b>	<b>309</b>
4.1	Suspension	245	5.1	Manual transmission clutch	309
4.1.1	Overview of suspension	245	5.1.1	Clutch operation	309
4.1.2	Dampers/shock absorbers	253	5.1.2	Types of clutch	311
4.1.3	Suspension layouts	255	5.2	Manual transmission gearbox	314
4.1.4	Active suspension	258	5.2.1	Gearbox operation	314
4.2	Steering	260	5.2.2	Gear change mechanisms	316
4.2.1	Introduction to steering	260	5.2.3	Gears and components	318
4.2.2	Steering racks and boxes	262	5.3	Automatic transmission	321
4.2.3	Steering geometry	267	5.3.1	Introduction and torque converter	321
4.2.4	Power steering	273	5.3.2	Automatic transmission components	325
4.3	Brakes	276	5.3.3	Constantly variable transmission	331
4.3.1	Disc, drum and parking brakes	276	5.3.4	Direct shift gearbox	332
4.3.2	Hydraulic components	282	5.4	Transmission driveline	336
4.3.3	Brake servo operation	284	5.4.1	Propshafts and driveshafts	336
4.3.4	Braking force control	285	5.4.2	Wheel bearings	339
4.3.5	Anti-lock brake systems	286	5.4.3	Four-wheel drive	342
4.3.6	Traction control	290	5.5	Final drive and differential	344
4.4	Wheels and tyres	291	5.5.1	Final drive	344
4.4.1	Wheels and rims	291	5.5.2	Differential	346
4.4.2	Tyre basics	295	5.6	Transmission systems: new developments and updates	349
4.4.3	Tread patterns	298	5.6.1	Electronic clutch	349
4.4.4	Tyre pressure monitoring	299	5.6.2	Automatic transmission with nine speeds	350
4.4.5	Tyre pressure monitoring and the law in Europe	300	<b>6</b>	<b>Automotive Technology Academy</b>	<b>351</b>
4.4.6	Spare wheels and extended mobility	301	6.1	Introduction	351
4.5	Chassis systems: new developments and updates	302	6.2	Resources	352
4.5.1	Electric power steering	302			
4.5.2	Electronic parking brake	304			
4.5.3	Carbon ceramic brakes	305			
				<i>Index</i>	353