10 Solutions to exercises

Chapters 2 to 8 include questions which allow the reader to test and deepen his/her understanding. Exercises start with the letter E. In the following solutions to these exercises are given. In addition problems (labeled with P) are provided. Solutions of those problems are available for lecturers only and can be obtained directly from the publishers.

E2.1: Test method: sled test, it allows for a variation of parameters at lower cost than full scale tests. Furthermore, dummy motion can be better monitored in a sled test. Crash pulse: choose a crash pulse measured in the target vehicle in e.g. a FMVSS or European homologation test for frontal impacts. If successful, further tests may be considered at more severe pulses, e.g. Euro-NCAP. ATD: use a Hybrid III dummy for comparability with the aforementioned full size tests.

E2.2: a) EES: related to the deformation, b) pre- and post-collision velocities, c) delta-v, (mean, peak) acceleration. Normally, only c. related to the injured person’s car is significant. Of course, if a. and b. are known, c. may be derived thereof. Qualitative parameters e.g. integrity of the passenger compartment are also important.

E2.3: a) Since the force-deformation characteristic may be directly input into the calculation, a single-mass system is the quickest approach. The problem could even be solved using e.g. a Matlab or Excel programme. b) FE-method. Explicit (forward time-integration) approach is preferred, since large deformations are expected.

E3.1: AIS 1, non-contact injury, (minimal) diffuse (non-focal) injury, GCS 15 (after re-gaining consciousness)

E3.2: a) Padding is used to absorb impact energy, thereby attaining a lower
peak head acceleration.
b) The hard shell distributes the impact load on a larger surface. Concentrated loads would cause e.g. skull fractures.

E3.3: True. If the time interval where the HIC formula evaluates to its maximum is:
a) Shorter than or equal to 15 ms: HIC36 and HIC 15 yield the same value
b) Longer than 15 ms: HIC 36 is higher

E4.1: See figures in section 4.2. Possible injuries involving compression are fractures or facet dislocation due to compression-flexion and compression-extension loading. Axial compression also seen in sports can result in fracture of the atlas.

E4.2: The Quebec Task Force (QTF) has developed a suitable scale for soft tissue neck injury (Table 4.2). AIS is less suitable since complaints under question are hardly life-threatening.

E4.3: As shown in Figure 4.13 the occupant movement can be divided into three parts: backward movement, forward movement (rebound) and belt restraint phase. The belt interacts with the occupant in the last phase.

E4.4: A slight flexion straightens the neck and thus increases the injury risk when the neck is impacted axially.

E5.1: 

E5.2: $C = 45/200; \ V = 0.045/0.04; \ VC = 0.25$

E5.3: In the CTI the effects of both belt and airbag on the thorax in a frontal crash are included in combined form. The first term ($A_{\text{max}}/A_{\text{int}}$) thereby reflects the action of the airbag, in that it is postulated that the airbag mainly decelerates the thorax by application of a load distributed over large parts of