1. Atomic packing factor of BCC (four decimals)?

   _____

2. A 10.0 mm rod at 15.0 kN: engineering stress in MPa (one decimal)?

   _____ MPa

3. Eutectoid composition of the iron-carbon system in wt% C (two decimals)?

   _____ wt%

4. Rule of mixtures along the fibres: E_1 with $V_f = 0.60$, $E_f = 230$ GPa and $E_m = 3.0$ GPa (one decimal)?

   _____ GPa

5. Quenched and tempered at 600°C: yield strength in MPa?

   _____ MPa

6. A service amplitude of 160 MPa against a Goodman limit of 175 MPa:

   ☐ it is exactly at the limit

   ☐ you cannot tell without the yield strength

   ☐ it passes, with an 8.6% margin

   ☐ it fails by 15 MPa

7. The atomic packing factor measures:

   ☐ the density of the metal

   ☐ the binding energy per atom

   ☐ the number of slip planes

   ☐ the geometric fraction of the cell filled by atoms as hard spheres

8. By the usual rule, the yield strength is read at:

   ☐ the ultimate point

   ☐ the 0.2% strain offset line's crossing of the curve

   ☐ 50% of ultimate

   ☐ fracture

9. Martensite is best described as:

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   ☐ a soft equilibrium mixture

   ☐ a hard supersaturated phase that must be tempered before service

   ☐ a fine precipitate in aluminium

10. A laminate datasheet should give the modulus as:

    ☐ one value per direction, because E1 and E2 differ 19 times

    ☐ one average of E1 and E2

    ☐ only E2, to be safe

    ☐ only E1, along the fibres

1. **0.6802**

   pi*sqrt(3)/8.

2. **191.0 MPa**

   $A_0 = \pi \times 10.0^2/4 = 78.54$ mm^2, so $\sigma = 15\,000/78.54 = 191.0$ MPa.

3. **0.76 wt%**

   The eutectoid point of the iron-carbon diagram: 0.76 wt% C at 727°C.

4. **139.2 GPa**

   $E_1 = V_f E_f + V_m E_m = 0.60 \times 230 + 0.40 \times 3.0 = 139.2$ GPa.

5. **620 MPa**

   620 MPa, with 16% elongation.

6. **it passes, with an 8.6% margin**

   $(175 - 160)/175 = 8.6\%$.

7. **the geometric fraction of the cell filled by atoms as hard spheres**

   It is geometry only. The density also depends on the mass of the atoms.

8. **the 0.2% strain offset line's crossing of the curve**

   Draw a line parallel to the elastic slope from 0.2% strain; it crosses the curve at the yield strength.

9. **a hard supersaturated phase that must be tempered before service**

   As quenched it is hard and brittle, so it is tempered before use.

10. **one value per direction, because E1 and E2 differ 19 times**

    The stiffness depends on direction, so give each direction.

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