Essential Formulæ

Although I don't believe in "memory tests" for the sake of it, certain key formula will not be given in the examination. You certainly **do not** need to memorise any governing equations (Navier–Lamé or Beltrami–Michell), the equations of strain compatibility or even the linear constitutive law. You should definitely make sure that you know the following, however:

- Index notation and summation convention including the definition of the Kronecker delta:

$$\delta_{ij} = \begin{cases} 1 & \text{for} \quad i = j \\ 0 & \text{for} \quad i \neq j \end{cases}$$

- The definitions of the strain, e_{ij}, and rotation, w_{ij}, tensors

$$\frac{\partial u_i}{\partial x_j} = e_{ij} + w_{ij},$$

  where

$$e_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right), \qquad w_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} - \frac{\partial u_j}{\partial x_i}\right).$$

- The definition, meaning and how to calculate the principal strains and principal axes of strain.
- How to compute resultant forces and moments over surfaces or volumes.
- The boundary condition of "continuity of stress" and use of the formula $t_i = \tau_{ij} n_j$.
- The definition of plane strain, the equation satisfied by the Airy stress function ($\nabla^4 \phi = 0$) and how to write this biharmonic equation in Cartesian coordinates.
- The formulæ to recover the stresses from the Airy stress function in Cartesian coordinates:

$$\tau_{11} = \frac{\partial^2 \phi}{\partial y^2}, \quad \tau_{22} = \frac{\partial^2 \phi}{\partial x^2}, \quad \tau_{12} = -\frac{\partial^2 \phi}{\partial x \partial y}.$$

- St. Venant's principle.