

APPENDIX A: STIFFNESS MATRICES OF ARM LINKS

The stiffness matrices of the upper and lower links \mathbf{K}_u and \mathbf{K}_l for the 5-dof robotic arm, computed by means of finite element analysis (FEA) with ANSYS, are given as

$$\mathbf{K}_u = \begin{bmatrix} 0.0309 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.2675 & 0 & 0 & 0 & 0.4176 \\ 0 & 0 & 0.3574 & 0 & -0.5957 & 0 \\ 0 & 0 & 0 & 15.3676 & 0 & 0 \\ 0 & 0 & -0.5957 & 0 & 1.6919 & 0 \\ 0 & 0.4176 & 0 & 0 & 0 & 1.7505 \end{bmatrix} \cdot 10^6 \quad (\text{A-1a})$$

$$\mathbf{K}_l = \begin{bmatrix} 0.0417 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1.0452 & 0 & 0 & 0 & 2.5493 \\ 0 & 0 & 1.1631 & 0 & -2.8369 & 0 \\ 0 & 0 & 0 & 17.2304 & 0 & 0 \\ 0 & 0 & -2.8369 & 0 & 8.3105 & 0 \\ 0 & 2.5493 & 0 & 0 & 0 & 8.2351 \end{bmatrix} \cdot 10^6 \quad (\text{A-1b})$$

where the blocks corresponding to rotation, translation, and coupling terms are given in Nm/rad, N/rad, and N/m, respectively.