I want to control the pendulum to return to its equilibrium position using the swing-up algorithm and LQR control.

I obtained the nonlinear equations from quanser's document, and then I used MATLAB to solve the equations of thetadotdot($\ddot{\theta}$) and alphaldotdot.($\ddot{\alpha}$)

$$\left(J_r + J_p \sin\alpha^2\right)\ddot{\theta} + m_p lr\cos\alpha\ddot{\alpha} + 2J_p \sin\alpha\cos\alpha\dot{\theta}\dot{\alpha} - m_p lr\sin\alpha\dot{\alpha}^2 = \tau - b_r\dot{\theta}$$

$$J_p\ddot{\alpha} + m_p lr\cos\alpha\ddot{\theta} - J_p\sin\alpha\cos\alpha\dot{\theta}^2 + m_p gl\sin\alpha = -b_p\dot{\alpha}.$$