**PROBLEM 1:** (10 points) What is the state of the circuit shown in Figure 1. Is the circuit state controllable? Is it state observable? Explain the reasoning for your answers.

**Figure 1:** Switched Circuit

**PROBLEM 2:** (10 points) Reduce the following nonlinear differential equation into two first order nonlinear differential equations.

\[ \frac{d^2y}{dt^2} - 2y^3 + u \frac{dy}{dt} = 0 \]

Take the nominal initial condition to be \( y(t_0) = 1, \dot{y}(t_0) = -1 \) at \( t_0 = 1 \) and nominal control to be \( u(t) = 0 \), then the nominal trajectory is \( \phi_1(t) = t^{-1} \) and \( \phi_2(t) = -t^{-2} \), then find the linearized dynamics of the system.

**PROBLEM 3:** (10 points) Find the matrix state equations in the first canonical form for the system

\[ \ddot{y} + 5\dot{y} + 6y = \dot{u} + u \]

**PROBLEM 4:** (10 points) Find the matrix state equations in the Jordan canonical form for the system

\[ \ddot{y} + 5\dot{y} + 6y = \dot{u} + u \]