1. It is proposed to pick up a delicate instrument package of mass $M$ lying on the ground by means of a helicopter lifting one end of a nylon rope straight up (neglect lateral motion) at velocity $V_h$. The rope is tied to the package on the other end and has a spring coefficient $K$ and viscous damping $B$. Model the system by a block diagram, signal flow graph or other means relating $V_p$ to $V_h$. Sketch $V_h$ and $V_p$ as functions of time.

2. It is proposed to reduce any sudden acceleration of the package by having a reel (attached rigidly to the helicopter) which pays out a steel cable (which in turn is attached to the top end of the nylon rope) at a velocity $V_c = K_c$ times the tensile force $F$ on the rope. How would you model this element? Would it help alleviate sudden acceleration of the package?

3. It is alternatively proposed to actively control the velocity of the helicopter (without the system in (2) by proportional, derivative and/or integral linear control as a function of the difference between a fixed upward velocity $V^*$ and the measured package velocity $V_p$. Using a root locus, show whether that could help reduce acceleration on the package, and which of the proportional, derivative and/or integral terms would help.

4. Comment on how the required sensing for (3) might be done in practice, and whether active control would be practical.