4. Many processes operate on rolled material that moves from a supply reel to a take-up reel. Typically, these systems, called winders, control the material so that it travels at a constant velocity. Besides velocity, complex winders also control tension, compensate for roll inertia while accelerating or decelerating, and regulate acceleration due to sudden changes. A winder is shown in Figure P1.3. The force transducer measures tension; the winder pulls against the nip rolls, which provide an opposing force; and the bridle provides slip. In order to compensate for changes in speed, the material is looped around a dancer. The loop prevents rapid changes from causing excessive slack or damaging the material. If the dancer position is sensed by a potentiometer or other device, speed variations due to buildup on the take-up reel or other causes can be controlled by comparing the potentiometer voltage to the commanded speed. The system then corrects the speed and resets the dancer to the desired position (Ayers, 1988). Draw a functional block diagram for the speed control system, showing each component and signal. [Section 1.4: Introduction to a Case Study]

![FIGURE P1.3 Winder](image)

5. In a nuclear power generating plant, heat from a reactor is used to generate steam for turbines. The rate of the fission reaction determines the amount of heat generated, and this rate is controlled by rods inserted into the radioactive core. The rods regulate the flow of neutrons. If the rods are lowered into the core, the rate of fission will diminish; if the rods are raised, the fission rate will increase. By automatically controlling the position of the rods, the amount of heat generated by the reactor can be regulated. Draw a functional block diagram for the nuclear reactor control system shown in Figure P1.4. Show all blocks and signals. [Section 1.4: Introduction to a Case Study]

![FIGURE P1.4 Control of a nuclear reactor](image)