1. An AISI 1020 carbon steel strip, 400 mm wide and 10 mm thick, rolled to a thickness of 5 mm. The roll radius is 200 mm, and it rotates at 200 rpm. The work material has strength coefficient of 400 MPa and strain hardening coefficient of 0.2. Calculate the following parameters: (25 pts.)
   (1) The roll strip contact length (5 pts)
   (2) True strain (5 pts)
   (3) The average flow stress (5 pts)
   (4) The rolling force (5 pts)
   (5) If a rolling machine of total 500 KW is available. Can this machine perform the job? (5 pts)

2. A billet 2.0 in. long and 1.0 in. diameter is to be extruded in an indirect extrusion operation with extrusion ratio of 4. The extrudate has a round cross section. The billet strength coefficient is 50,000 lb/in² and strain hardening exponent is 0.1. Let $a = 0.8, b = 1.5$ to estimate extrusion strain. If your boss asks you to buy a machine tool to perform the required job, what is the minimum capacity in terms of ram force you would order? (25 pts.)

3. A 50 mm diameter rod will be drawn to a final 15 mm diameter product. (25 pts.)
   (1) How many passes are required to achieve the final diameter if the material is perfectly plastic? (10 pts.)
   (2) What is the smallest diameter can be drawn in one pass if the material strain hardening coefficient is 0.2? (8 pts.)
   (3) If friction is accounted for in (1) and (2), would the final diameter be different? Why? (7 pts.)