Instructions:

This is an Open Book Examination

Please state all assumptions and write clearly.

Please be to-the-point. This exam can be completed within an hour if you keep things simple and budget time carefully.

Good luck!
Question 1: Cutting

a. What are the SI units of specific energy of cutting? Describe the physical basis of specific energy. How is it related to other material properties. How is specific energy related to hardness (and why)?

b. The specific energy of cast iron is 2 (substitute SI units here). You are asked to machine a pocket that is 30 mm wide, 30 mm long and 10 cm deep. You are using a 5HP motor (1 HP=750 W). How long do you expect it to take?

c. If you keep the depth of cut constant in orthogonal cutting and double the cutting speed, what happens to the cutting force? Does it increase or decrease? What about power?

Question 2: Bending

Consider bending. Does springback:

i. increase or decrease when the thickness of the sheet increases? Why? (One sentence physical intuition)

ii. increase or decrease when the modulus of elasticity increases? Why? (One sentence physical intuition)

iii. increase or decrease when the yield strength increases? Why? (One sentence physical intuition)

Question 3: Variation

$C_p$ for a certain process is 2.0. $C_{pk}$ for the process is 1.5. Calculate the difference between the midpoint of the upper and lower control limits and the mean of the process. In other words, what is the skew or offset?

Question 4: DFM

For each of the following processes, please suggest two or more “thumb rules” to aid design-for-manufacture:

1. Turning (on a lathe)
2. Wire EDM with a 2-dof head
3. 3-dof Die-sinking EDM
4. Drilling
5. 3D Printing