1. What are the microbiological steps of anaerobic digestion? Describe the steps shortly (6 p)

2. Explain shortly (6 p)
   a. What is HRT and how it affects to anaerobic digestion (in CSTR)? (2 p)
   b. What is OLR and how it affects to anaerobic digestion (in CSTR)? (2 p)
   c. Compare mesophilic and thermophilic anaerobic digestion. (2 p)

3. What issues limit or hinder the use of digestate as a fertilizer product. What can be done to enhance digestate utilization? Think the whole AD process-chain, starting from the feedstocks. (12 p)

4. Biogas plant receives 15 000 t organic waste per year. Waste characteristics are TS: 20 %, VS: 15%, N_{tot}: 2% of TS and methane production potential: 400 m^3 CH₄/VS. (12 p)
   a. How much heat and electricity the plant produces per year when biogas is burned in CHP-unit? Overall efficiencies of CHP-engine are 30% for electricity and 50% for heat? (1 m³ CH₄ = 10 kWh) (3 p)
   b. How much income it is possible to get from energy production when biogas plants own energy demand is 25% of produced heat and 10% of produced electricity? (Electricity price 40 e/MWh, heat price 70 e/MWh) (3 p)
   c. For how many hectares digestate can be spread when maximum allowed N_{tot} load is 110 kg N_{tot} /ha? (3 p)
   d. What is the reactor (liquid) volume when it is operated with design OLR of 3 kg VS/m³ d? (3 p)