Norwegian University of Science and Technology
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Exercise 3
Directed graph and SOS2 sets

Problem 1

a) Consider the production system shown below.

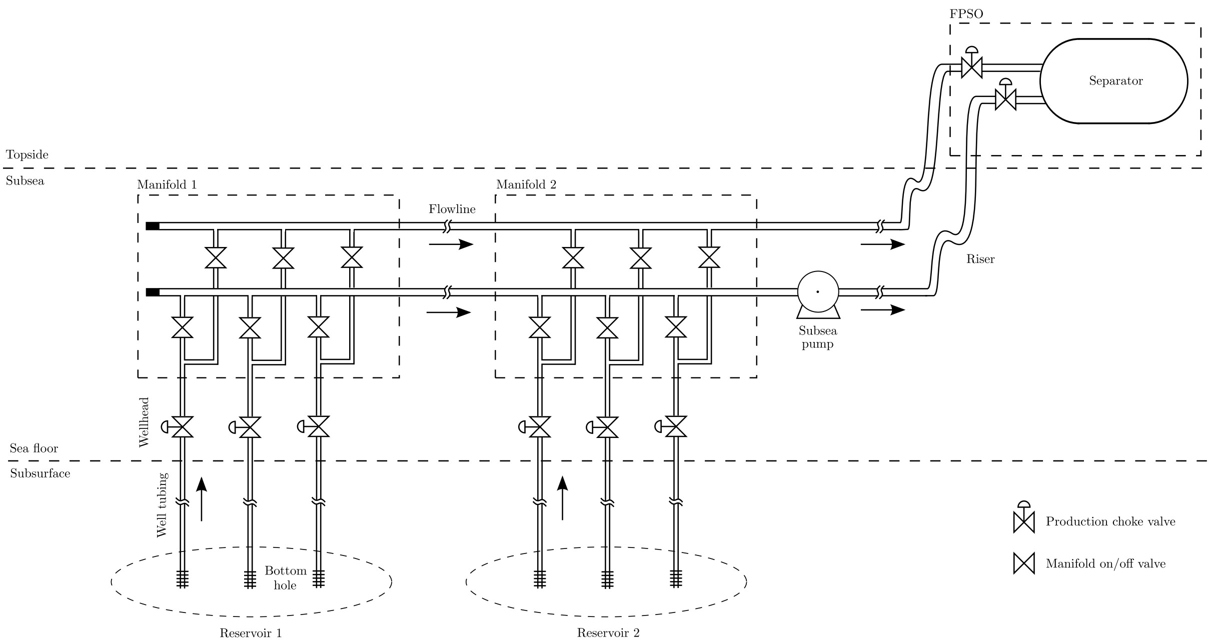

Figure 1:

Derive a directed graph description by defining all the necessary sets. You may simplify by assuming only two phases, oil and water. Use the same notation as in Foss et al. (2015).

b) Assume that there exists a simulator that calculates the pressure drop Δp_c across a pipeline defined by $\mathbf{E}^e$. Further, we assume that

$$\Delta p_e = f_e(\mathbf{q}_e, p_i), \tag{1}$$

as shown in Foss et al. (2015), can be simplified to

$$\Delta p_e = f_e(q_{e,oil}) \tag{2}$$

since there only flows oil in the pipeline $\mathbf{E}^e$. The simulator has been sampled for 7 oilrate values (using http://www.pressure-drop.com/Online-Calculator/ with realistic parameter values). This gave rise to the values for Δp_e and $q_{e,oil}$ shown in Table 1.

Table 1: Sampled flowrate and pressure-drop data from the simulator.

Flowrate [m^3/h]	Pressure drop [bar]
0.00	0.00
5.00	0.25
8.00	0.59
11.00	1.04
13.00	1.41
15.00	1.84
20.00	3.13

Substitute the nonlinear constraint $p_e = f_e(q_{e,oil})$ using a piecewise linear approximation and SOS2 sets. Formulate the new constraints.
How many constraints and variables are needed to replace one nonlinear constraint in this case?

c) Discuss the pros and cons of transforming an MINLP problem to a MILP problem by using piecewise linear approximation and SOS2 sets.

References

Foss, B., Grimstad, B., and Gunnerud, V. (2015). Production optimization–facilitated by divide and conquer strategies. *IFAC-PapersOnLine*, 48(6):1–8.