1.

a) Explain the term reactance reduction. (2p)
b) What is a transfer zero? (2p)
c) Explain the process of realising a lossless circuit when $|S_{21}|^2$ is known. (2p)
d) Why is the frequency response of a transmission line filter periodic? (2p)
e) Draw a circuit that has a driving point impedance with a zero at the origin. (2p)

2.

a) Below you see three impedance functions. Which is the correct category for each of them: LC / RC / RL / non-PR? Explain your decision. (3p)

$$Z_1(s) = \frac{3s^2+3}{s^3+4s} \qquad Z_2(s) = \frac{s^4+5s^2+10}{s^3+4s+1} \qquad Z_3(s) = \frac{s^2+2s}{s^2+4s+3}$$

b) How many components are required to realise the functions? For all realizable functions, explain how many components of each type are in canonical realization. (3p)
c) Find a canonical realisation for function Z_3. (4p)

3.

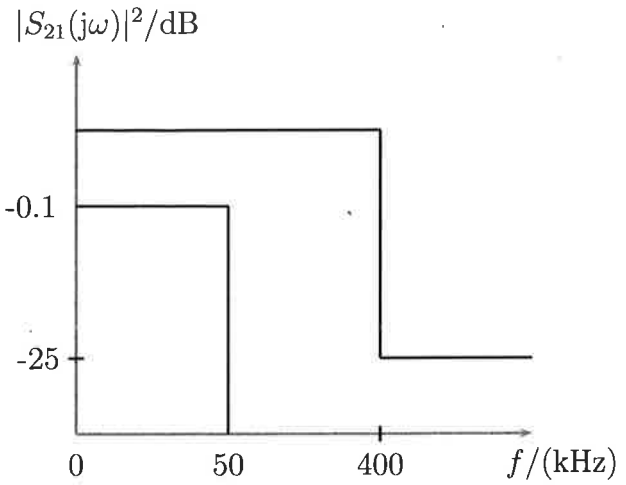
Realise the transfer function

$$Z_{21}(s) = \frac{Ks^2}{s^3+3s^2+s+2},$$

when the circuit is terminated in a $1\,\Omega$ resistance.

4.

a) Design a matched Chebyshev lowpass filter that satisfies the specifications in the figure. The source resistance is $100\,\Omega$.
b) Sketch the frequency response of your filter onto the given specifications.
c) At what frequency does the filter satisfy $|S_{21}(\mathrm{j}\omega)|^2 = -3$ dB?



$$\hat{\omega}_\mathrm{p} = \frac{1}{\cosh(\frac{1}{n}\operatorname{arcosh}(\frac{1}{\varepsilon}))}$$

$$n \geq \frac{\operatorname{arcosh}\left(\sqrt{\frac{10^{A_\mathrm{s}/10}-1}{10^{A_\mathrm{p}/10}-1}}\right)}{\operatorname{arcosh}(x)}$$

$$x = \hat{\omega}_\mathrm{s}/\hat{\omega}_\mathrm{p}$$