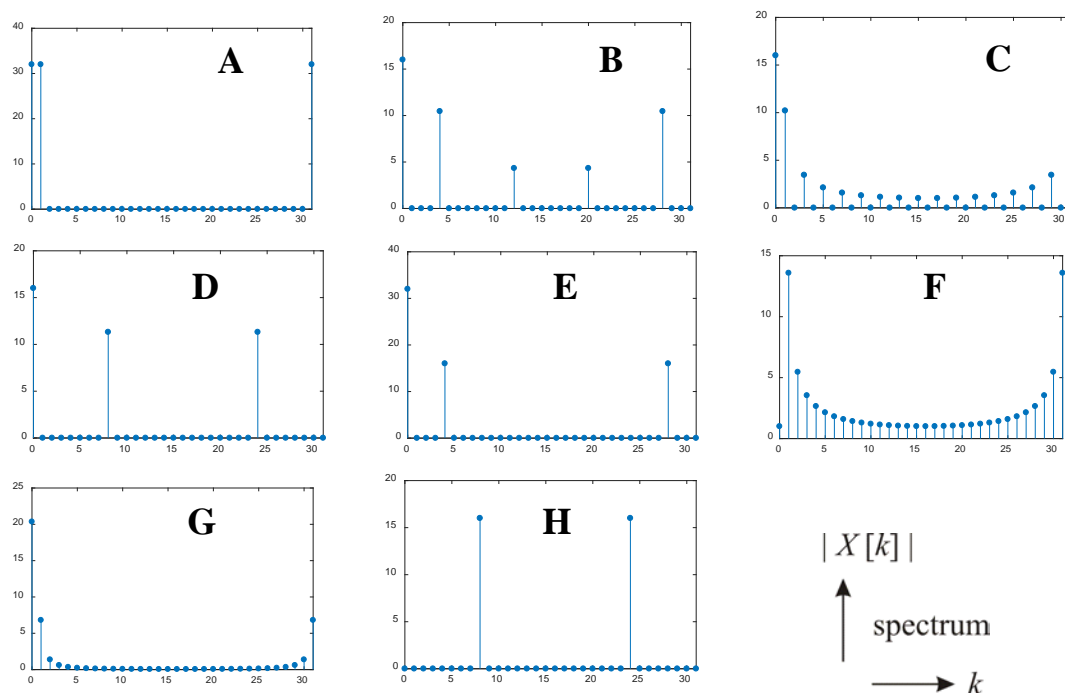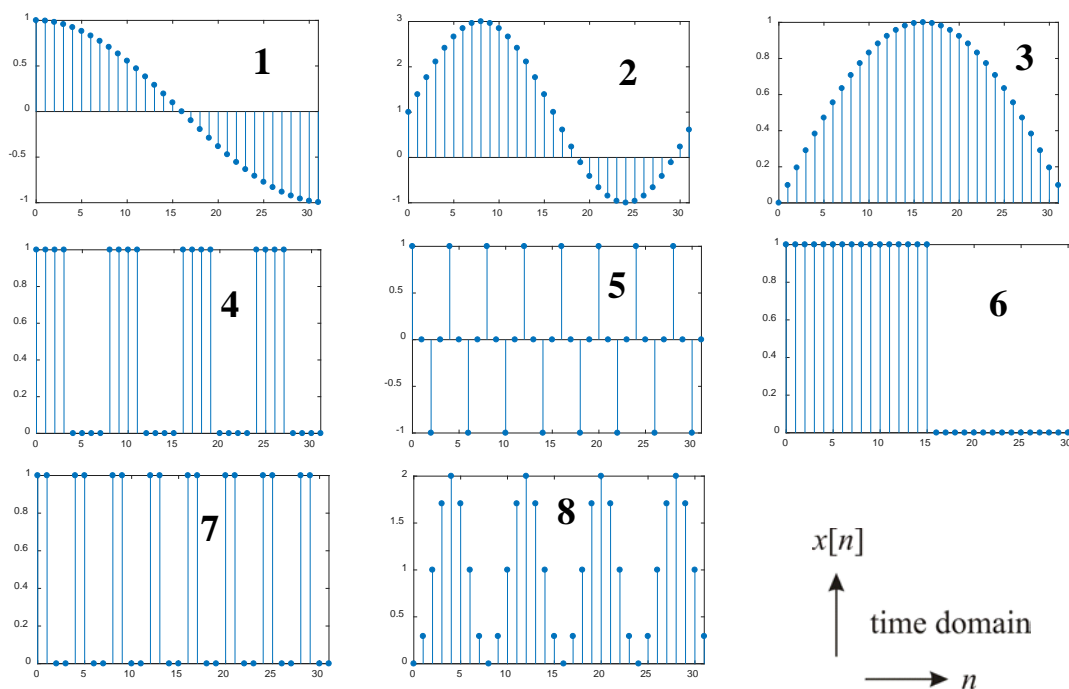**Written Exam: Discrete Signals and Systems (DSS)**
Degree Programmes: Information Technology (M.Sc.), Elektrotechnik (M.Sc.)
2018-02-14, 120 min, 100 points available → no notebooks, no books

*Please: Don't use red ink; start the solution of each problem on a **new** sheet or side of paper; present all solutions thoroughly.*

Problem 1 Mapping task: 8 different discrete-time sequences $x[n]$ and their discrete FOURIER transforms $|X[k]|$ are given. Unfortunately, the relations are missing. Find the correct relations and give the answer in the form (1, C), if you think, that this is correct. *You are allowed to guess without proving your answer. But thinking might increase your success.* ☺

Problem 2 Check, if the following systems are linear, time invariant, causal, and memoryless. $x(t)$, $x[n]$ and $y(t)$, $y[n]$ are the input and output signals, respectively. *Short proof sufficient for saving time.*

1) $y(t) = x(t) \cdot \cos(\omega \cdot t)$

2) $y(t) = \sqrt{t} \cdot x(t+2) + 1$
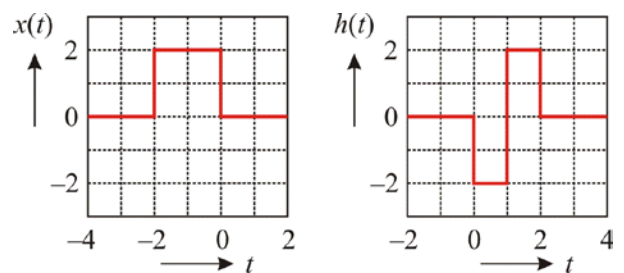
3) $y[n] = 2 \cdot x[n] + x[n-3]$

15 points

Problem 3 Compute the missing term **???** by applying the FOURIER transform.

$$\cos(2\pi \cdot a \cdot t) \cdot \sin(2\pi \cdot b \cdot t) = \frac{1}{2} \cdot \sin(2\pi \cdot (a+b) \cdot t) + \textbf{???}$$

15 points

Problem 4 Plot the convolution result of the two signals $x(t)$ and $h(t)$. *Tip:* Consider characteristic points.
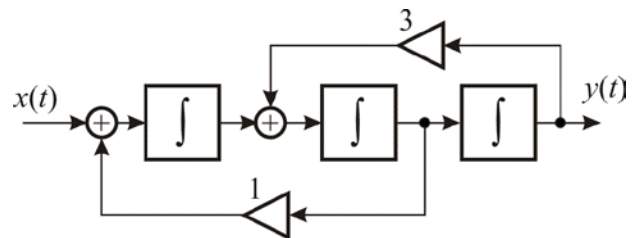

10 points

Problem 5 The block diagram of a continuous-time system is given.

5.1 Determine the system function $H(s) = Y(s) / X(s)$.

5.2 Is the system stable?

5.3 Compute the impulse response?

15 points

Problem 6 The z-transform of a discrete signal is given:

$$X(z) = \frac{0.75 \cdot z + 1.5}{z^2 + 5 \cdot z + 4}$$

6.1 Determine the region of convergence.

6.2 Compute the causal inverse z-transform.

15 points

Problem 7 A discrete-time system is characterized by the difference equation

$$x[n] = 3 \cdot y[n] - 4 \cdot y[n-1] + y[n-2]$$

7.1 Determine the system function $H(z) = Y(z) / X(z)$.

7.2 Is the system stable?

7.3 Plot a canonic block diagram.

7.4 Stabilize this system with a proportional feedback system and compute **ONE** possible value of the gain element.

15 points

Good luck !