Signal Processing
Final Exam

Istanbul University - Cerrahpaşa
Computer Engineering Department - FALL 2019

December 26$^{\text{th}}$, 2019

PLEASE READ: The duration for this exam is **70** minutes. Please answer the questions in ENGLISH briefly and clearly. **Bad handwriting, unclear statements, ambiguous answers will result in credit loss**. You may bring one calculator, an A4 sized formula sheet and a copy of Appendix A from the book to the exam. The formula-sheet MUST NOT contain any problems and solutions. Every other material is forbidden. Sharing of materials is not allowed and will be considered cheating if done so. Please read the questions before solving them. Please RETURN your exam papers and but KEEP the other materials at the end of the examination. This test has total of **110** points worth of questions. Anyone attempting to cheat, help someone else to cheat or make an effort to do these will receive 0 points for the exam and will be reported to the Dean's office. Good Luck. (Mustafa Dağtekin)

Q1: Consider the following DISCRETE TIME signal. Answer the following questions.

$$x[n] = \sum_{k=-3}^{3} k^2 \, \delta[n-k]$$

(a) **(5 pts)** Carefully sketch $x[n]$.

(b) **(10 pts)** Carefully sketch $x[3n-3] + x[2n+2]$.

(c) **(5 pts)** Is $x[n]$ an even signal, odd signal or neither? Explain.

(d) **(10 pts)** Is $x[n]$ a power signal, energy signal or neither? Calculate its average power and total energy.

Q2: For the CT LTI system $\mathcal{H}_1$, the step response is given as:

$$s(t) = \begin{cases} 0 & , \quad t < 0 \\ 1 - \mathrm{e}^{-t} & , \quad 0 \le t \end{cases}$$

(a) **(5 pts)** What is the impulse response of this system?

(b) **(10 pts)** Find the output of this system when the input is the following:

$$x(t) = \mathrm{e}^{-2t} \, u(t-3)$$

Q3: Consider the following DISCRETE TIME system. Answer the following questions.

$$y[n] = \mathcal{H}_2\{x[n]\} = \sum_{m=-2}^{2} x[n-m]$$

(a) **(5 pts)** Is $\mathcal{H}_2$ stable? Show your work.

(b) **(10 pts)** Is $\mathcal{H}_2$ linear? Show your work.

(c) **(10 pts)** Is $\mathcal{H}_2$ time invariant? Show your work.

(d) **(10 pts)** Find and sketch the impulse response of $\mathcal{H}_2$.

(e) **(10 pts)** Find the frequency response of $\mathcal{H}_2$.

(f) **(10 pts)** Find the output of this system when the input signal is $x[n] = \delta[n-1]$.

Q4: **(10 pts)** Determine whether the following CT signal is periodic. If it is periodic then calculate its period.

$$x(t) = \cos\left(\frac{3}{4}t + \frac{4}{7}\right) + \sin\left(\frac{5}{16}t + \frac{3}{8}\right)$$