



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: July 2016

Module Number: EE7209

Module Name: Digital Signal Processing

[Three Hours]

[Answer all questions, each question carries 10 marks]

Q1 a) A system is described by

$$y[n] = \frac{1}{2} \sum_{k=-\infty}^{+\infty} x[k] (\delta[n-k] + \delta[n+k])$$

- Explain what this system does.
- Is the system linear? Justify your answer.
- Is the system time invariant? Justify your answer.
- Is the system BIBO (Bounded-Input Bounded Output) stable? Justify your answer.

[6 Marks]

b) Consider the discrete-time system

$$y[n] - y[n-1] + 0.75 y[n-2] = \sqrt{x[n-8]}$$

Determine the zero-input response, if $y[-1] = 1$ and $y[1] = 1$

[4 Marks]

Q2 a) The Z-transform expression of a discrete-time sequence $x[n]$ is

$$X(z) = \frac{4 - \frac{7}{4}z^{-1} + \frac{1}{4}z^{-2}}{1 - \frac{3}{4}z^{-1} + \frac{1}{8}z^{-2}}$$

Use the long division method to determine $x[n]$ assuming that $x[n]$ is

- an anti-causal sequence.
- a causal sequence.

[4 Marks]

b) Consider a discrete-time, causal and linear time-invariant system whose system transfer function is given by

$$H(z) = \frac{1 - 5z^{-1} + 6z^{-2}}{1 - \frac{5}{2}z^{-1} + z^{-2}}$$

- Determine the difference equation of the system that relates the output $y[n]$ to the input $x[n]$.
- Determine the step response of the causal system obtained in part i).

[6 Marks]

Q5 A linear time-invariant system (LTI) realized by a flow graph is shown in Figure Q5.

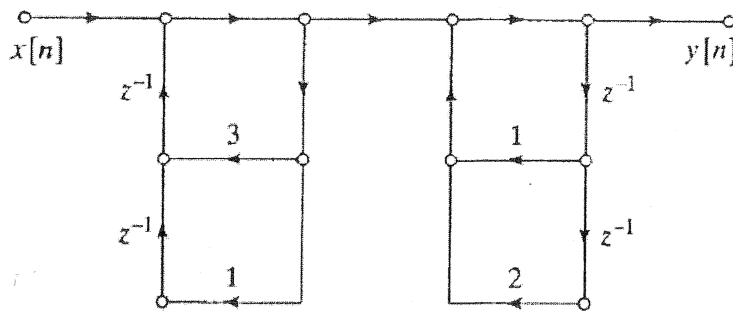


Figure Q5

- a) Write the difference equation to relate $x[n]$ and $y[n]$ for this flow graph. [3 Marks]
- b) Determine how many real multiplications and real additions are required to compute each sample of the output.
Note: Assume $x[n]$ is real and multiplication by 1 does not increase the total count. [3 Marks]
- c) This realization requires four delay elements. Is it possible to reduce the number of delay elements using a different structure? If so, draw the flow graph of the new realization. If not, explain why. [4 Marks]