ECE517: ADVANCED DIGITAL SIGNAL PROCESSING
Continuous Assessment 2
Max. Marks: 40

Date of CA Allotment: 27/10/20
Last Date of Uploading the Solution through UMS: 07/11/20

Note: 1. Late submission will strictly not be accepted. In case, in prior any issue for submission within the time limit, you may intimate and get the permission beforehand.

2. It is compulsory to attend all the questions.

3. Bold face numbers to the right indicate marks of the question. Total marks are 40. They will be mapped to that out of 30.

4. The symbol * denotes multiplication.

5. This is an open book test. So, you are all free to use the online resources. But the final writings of a solution must be from your understanding and in your own words. A solution or a part of the solution copied from other student's solution or from open source, will directly fetch zero.

Q. 1 Answer in short: **[10]**

a. Verify whether the given sequence x(n) is a valid autocorrelation sequences of a WSS random process or not: x(n) = {2, 5, **4**, 5, 2 }.
b. Verify whether the following matrix A is a valid autocorrelation matrices of a WSS random process or not: A = [5 -2+j j; -2-j 7 -2j; -j 2+j 4]
c. Find the autocovariance sequence of a random process with power spectrum defined as: $P_x(e^{jw}) = 5$.
d. Find the power spectrum of a random process with power spectrum defined as: $r_x(k) = 3(\frac{1}{3})^{|k|}$.
e. Discuss how to generate a WSS random process.

Q. 2 **[10]**

a. Find the autocorrelation sequence of an output available by filtering unit variance white noise w(n) through a system described by H(z) = $1/(1 - 0.75\,z^{-1})$. **[5]**
b. Design H(z) that generates a random process having power spectrum of the form as
$$P_x(e^{j\omega}) = \frac{10 + 6\cos 2\omega}{17 + 8\cos\omega}$$
by filtering unit variance white noise. **[5]**

Q.3. **[10]**

Suppose awe are given a linear shift-invariant system having a system function $H(z) = (1 - (1/2)\,z^{-1})/(1 - (1/3)\,z^{-1})$ that is excited by zero mean exponentially correlated noise x(n) with an autocorrelation sequence $r_x(k) = (1/2)^{|k|}$.
Let y(n) be the output process, y(n) = x(n) * h(n). Then,

a. Find the power spectrum, $P_y(z)$ of y(n).
b. Find the autocorrelation sequence, $r_y(k)$, of y(n).
c. Find the cross-correlation, $r_{xy}(k)$, between x(n) and y(n).
d. Find the cross-power spectral density, $P_{xy}(z)$, which is the z-transform of the cross-correlation $r_{xy}(k)$.

Q.4 **[10]**

Suppose we are given a zero mean process x(n) with autocorrelation sequence given by

$$r_x(k) = 10\left(\frac{1}{2}\right)^{|k|} + 3\left(\frac{1}{2}\right)^{|k-1|} + 3\left(\frac{1}{2}\right)^{|k+1|}.$$

a. Find a filter which, when driven by unit variance white noise, will yield a random process with this autocorrelation.
b. Find a stable and causal filter which, when excited by x(n), will produce zero mean unit variance white noise.