PRINT YOUR NAME ____________________________
Signature ____________________________________
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<table>
<thead>
<tr>
<th>Problem</th>
<th>Weight</th>
<th>Score</th>
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<tbody>
<tr>
<td>1 (a)</td>
<td>15 pts</td>
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<tr>
<td>1 (b)</td>
<td>10 pts</td>
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<td>1 (c)</td>
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<td>1 (d)</td>
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<td>1 (e)</td>
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<td>1 (f)</td>
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<td>1 (g)</td>
<td>20 pts</td>
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Useful tables are at the back of the exam.

Good luck!
Problem 1

An LTI discrete-time system with input $x[n]$ and output $y[n]$ has an input response given by

$$h[n] = 12 \left[ \left( -\frac{1}{3} \right)^n - \left( -\frac{1}{2} \right)^n \right] u[n],$$

where $n$ is an integer and

$$u[n] = \begin{cases} 
1, & n \geq 0, \\
0, & n < 0, 
\end{cases},$$

denotes the step function.

(a) Give an expression for the system transfer function $H(z)$. 

Problem 1 (cont.)

(b) Specify poles and zeros of $H(z)$. 
Problem 1 (cont.)

(c) Find the output $y[n]$ when input is $x[n] = 3^n$. 
Problem 1 (cont.)

Let $H(e^{j\omega})$ denote the system frequency response, i.e., the discrete-time Fourier transform, of $h[n]$.

(d) Evaluate $\int_{0}^{2\pi} H(e^{j\omega})e^{j\omega}d\omega$ without explicitly using the expression for $H(e^{j\omega})$. 
Problem 1 (cont.)

(e) Evaluate $\int_{-\pi}^{\pi} |H(e^{j\omega})|^2 d\omega$ without explicitly using the expression for $H(e^{j\omega})$. 
(f) Find the output $y_s[n]$ when the input is the step functions $u[n]$. 
Problem 1 (cont.)

The step response $y_s[n]$ exhibits overshoot, which is undesirable in many applications. It is proposed to compensate for the overshoot by filtering $y_s[n]$ with another LTI system, whose output $w[n]$ is given by

$$w[n] = ay_s[n] + by_s[n - 1] + cy_s[n - 2].$$

(1)

(g) Find values of the constant $a$, $b$, $c$, such that $w[n] = u[n - 1]$. 