1) Given the sampled-data system:

\[ \begin{array}{c}
\text{with: } R(s) = k_p + k_i/s \\
G(s) = \frac{J_r}{s} \\
\text{representing the digital control of a DC motor with negligible armature inductance.}
\end{array} \]

a) Find \( G_{\text{tot}}(s) \) as a function of \( k_p, k_i, k_r, J_r, \) and \( T. \)

b) Removing the sample-and-hold circuitry, we get an analog control. Find \( G_{\text{tot}}(s). \)
c) Starting with \( G_{\text{tot}}(z) \), we let \( T \to 0 \).

Since: \( z = e^{Ts} = 1 + Ts + \frac{T^2 s^2}{2!} + \frac{T^3 s^3}{3!} + \ldots \)

For sufficiently small \( T \): \( z = 1 + Ts \).

We made the substitution, before we let \( T \to 0 \). We should get \( G_{\text{tot}}(s) \) back.

Notice: This approach will work only if all samplers have 20Hz circuitry.
2) Given the sampled-data system:

\[ u(t) \rightarrow G_1(s) \rightarrow H(s) \rightarrow G_2(s) \rightarrow G_3(s) \rightarrow y(t) \]

Find \( G_{\text{tot}}(z) \) as a function of \( G_1(z) \), \( G_{23}(z) \), and \( G_3(z) \).

3) Given the multirate sampled-data system:

\[ u(nT) \rightarrow e^{-nT/2} \rightarrow G_1(s) \rightarrow e^{nT/2} \rightarrow G_2(s) \rightarrow y(t) \]

\( G_1(s) = \frac{s+3}{s+5} \); \( G_2(s) = \frac{s}{s(s+2)} \); \( T = 0.1 \text{ sec} \).
a) Find $G_{tot}(z)$ using frequency-domain method.

b) Find $G_{tot}(z)$ using time-domain method.

Program in Matlab as appropriate.