Problem #1

Ideal Signal

\[ \text{Data rate} = \frac{1}{T_B} \]

10 Mbps = \(10 \times 10^6\) = \(\frac{1}{T_B}\) \implies T_B = 10^{-7} \text{ sec}

Actual Signal

\[ \text{Rise Time} \]

If \(T_R << T_B\)

\[ T_R \leq (0.1)T_B \]

\[ T_R \leq (0.1)10^{-7} \]

\[ T_R \leq 10^{-8} \]

Highest Frequency = \(\frac{1}{T_R} = \frac{1}{10^{-8}} = 10^8 \)

Need freq from 0 to 100 MHz
Problem # 2

Signal uses DC to 100 MHz

Wavelength at highest frequency (Assume 50% VF)

\[ \lambda = \frac{c}{f} \]

\[ (0.05) (3 \times 10^8) = (15) \lambda \]

\[ 15 = \lambda \]

\[ 0.15 = \frac{\lambda}{15} \]

Any cable longer than 15 cm (\( \frac{3}{4} \)"")

is electrically long. The cable in the problem is clearly longer than 15 cm.
Problem #3

\[ T_B = \frac{1}{10 \times 0.6} = 10^{-7} \]

\[ \text{Rise Time} = T_B = 10^{-7} \]

\[ \text{Highest Frequency} = \frac{1}{\text{Rise Time}} = \frac{1}{10^{-7}} = 10^7 \text{Hz} \]

Freq. Range: DC \to 10 \text{ MHz}
Problem # 4

Estimate Rise time as when signal hits 90% of steady-state

\[(0.9)(40) = (40)(1 - e^{-1000 t})\]

\[e^{-1000 t} = 1 - 0.9 = 0.1\]

\[-1000 t = \ln(0.1)\]

\[t = -10^{-3} \ln(0.1) \approx 2.3 \text{ ms}\]

Highest Frequency \(\approx \frac{1}{2 \times 10^{-3}} \approx 430 \text{ Hz}\)

Cable passes about DC to 430 Hz
Problem #5

\[
\frac{1}{10^9 \text{ sec}} = T_B
\]

\[
\frac{1}{10^9} \leq (0.4) T_B
\]

\[
\leq (0.4) \left( 10^{-9} \right)
\]

\[
\leq 400 \times 10^{-12} \text{ sec}
\]

Highest frequency

\[
\frac{1}{400 \times 10^{-12}} = 2.5 \text{ GHz}
\]

DC to 2.5 GHz
Problem #6

From previous homework.

\[ R' = 10.4 \, \text{mS/m} \quad C' = 58 \, \text{pF/m} \]

\[ L' = 210 \, \text{mH/m} \quad G' = 0 \quad \text{(assume)} \]

A) \[ f = \sqrt{\frac{R' + j2\pi fL'}{L' + j2\pi fC'}} \quad \text{(Insert)} \]

Can't say much more without knowing frequency, \( f \)

B) \[ \alpha = \text{real}(f) \quad \text{mH/m} \]

C) \[ \alpha = (8.7) \, \text{real}(f) \quad \text{dB/m} \]

D) \[ \beta = \text{imag}(f) \quad \text{rad/m} \quad \text{for cycles/sec} \]

E) \[ VF = \frac{2\pi f}{\beta c} \cdot 100 \quad \% = \frac{200 \cdot 2 \cdot f}{\text{imag}(f)(3 \times 10^8)} \quad \% \]
Problem #7

A) \( \log_{10} \left( \frac{7.889 \times 10^{-3}}{132} \right) \approx 4.08 \) 5 orders of magnitude

B) \( \log_{10} \left( \frac{20 \times 10^3}{20} \right) = 3 \) decades

C) \( 10 \log_{10} \left( \frac{7.8 \times 10^6}{3.3 \times 10^3} \right) = 34 \text{ dB} \)

D) \( 20 \log_{10} \left( \frac{7.8 \times 10^6}{3.3 \times 10^3} \right) = 68 \text{ dB} \)

E) DO NOT ANSWER.
   DO NOT USE dB FOR NON-POWER PROBLEMS

F) \( 10 \log_{10} \left( \frac{3.03 \times 10^3}{1} \right) \approx 35 \text{ dBm} \)

G) \( 10 \log_{10} \left( \frac{3.03}{1 \times 10^{-3}} \right) \approx 35 \text{ dBm} \)
Problem #8

A) \( \alpha = \left(10.05 \text{ m}^{-2} \right) \left(8.07 \text{ dB/\mu B} \right) \left(1000 \text{ m/km} \right) \)
\[
\alpha \approx 430 \text{ dB/km}
\]

b) Output Voltage = \( 5 e^{-\alpha x} \)
\[
1 = 5 e^{-\alpha x} \quad \Rightarrow \quad \alpha = 0.05 \text{ dB/m}
\]
\[
x = 32 \text{ meters}
\]

C) I cannot find velocity exactly based on the info in the problem.

Estimate \( 10\% \leq VF \leq 100\% \)

Assume \( VF = 0.6 \)

Then velocity = \( (0.6)(3 \times 10^8) = 2 \times 10^8 \text{ m/s} \)

D) \( v = f \lambda \)
\[
(2 \times 10^8) = (2 \times 10^{-6}) \lambda
\]
\[
100 = \lambda
\]
\[
10 = \frac{\lambda}{10}
\]

Webley longer than 10 m electrically long
Problem #9

A) It is very difficult to estimate $\alpha$.

B) Without $\alpha$, I cannot answer.

C) $v = \frac{2\pi f}{\beta} = \frac{2\pi (2 \times 10^6)}{5402} \approx 2.3 \times 10^5 \text{ m/s}$

That is less than 0.1% of speed of light, that is unusually low. I suspect $\beta$ is wrong.

D) $v = f\lambda$

$(2.3 \times 10^5) = (2 \times 10^6) \lambda$

$\lambda \approx 0.1$

$\Delta \approx 0.01$

Cables longer than 1 cm are electrically long.
Problem #10

A) Can't tell or estimate

B) Can't answer - insufficient info

C) \[ v = \frac{2\pi f}{\beta} = \frac{2\pi (2 \times 10^6)}{5.042} \approx 2.3 \times 10^6 \]

Still under 1% of speed of light \( \beta \) probably still wrong.

D) \[ v = f \lambda \]

\[ (2.3 \times 10^6) = (2 \times 10^6) \lambda \]

\[ 1 = \lambda \]

\[ 0.1 = \frac{\lambda}{c} \]

10 cm cable electrically long.