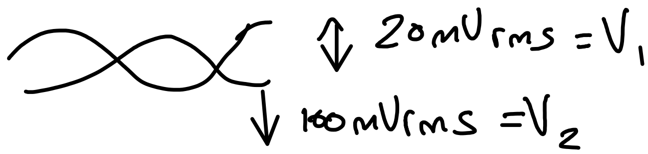
# ASSIGNMENT 2 SOLUTIONS

Q. 1/




for equal SNRs $\frac{SNR_2}{SNR_1} = \frac{S_2/N_2}{S_1/N_1} = 1 \Rightarrow \frac{S_2}{S_1} = \frac{N_2}{N_1}$

since $N_1$ & $N_2$ are rms measurements the noise powers are

$$N_1 = \frac{V_1^2}{R} \qquad N_2 = \frac{V_2^2}{R}$$

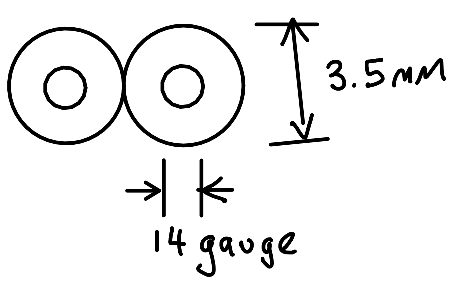
$$\frac{S_2}{S_1} = \frac{V_2^2}{V_1^2} = \frac{(0.1)^2}{(0.02)^2} = \left(\frac{1\times10^{-1}}{2\times10^{-2}}\right)^2 = \left(\frac{1}{2}\times10^{1}\right)^2 = \frac{1}{4}\times10^{2}$$

$$\frac{S_1}{S_2} = 25 \qquad 10\log(25) = 14\text{ dB}$$

∴ differential signalling requires less power

25 times (14 dB) more power is required for single-ended (non-differential) signalling in this example.

Q.2




D = wire diameter

S = separation between centers

$= D + (3.5 - D) = 3.5$ mm

24 ga = 0.5mm

difference in gauge: $\Delta = 24 - 14 = 10$

diameter ratio $= 2^{\frac{10}{6}}$

approx diameter of 14 ga wire $= 0.5 \cdot 2^{\frac{16}{6}} = 2^{-1} \cdot 2^{\frac{16}{6}}$

$= 2^{\frac{4}{6}} = 1.6 \text{ mm}$

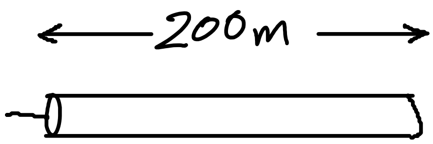
$$Z_0 = \frac{120}{\sqrt{\varepsilon_r}} \ln\left(\frac{2S}{D}\right)$$

$$Z_0 \approx \frac{120}{\sqrt{\varepsilon_r}} \ln\left(\frac{2S}{D}\right)$$

$\varepsilon_r$ for polyethylene $= 2.2$

$$= \frac{120}{\sqrt{2.2}} \ln\left(\frac{2 \cdot 3.5}{1.6}\right) \simeq 120\ \Omega$$

Q.3




$f = 600$ kHz

VF = 1 (air is mostly nitrogen)

$v = c = 3 \times 10^8$ m/s

propagation delay $= \frac{d}{v} = \frac{200}{3 \times 10^8} = 0.66 \times 10^{-6}$ s

phase shift $= 2\pi \cdot \frac{\text{delay}}{\text{period}} = 2\pi \cdot \text{delay} \cdot \text{frequency}$

$= 2\pi \cdot 0.66 \times 10^{-6} \times 600 \times 10^{3}$

$= 2\pi \cdot 400 \times 10^{-3}$

$= 0.8\,\pi$ radians or $144°$.

Q.4

A search shows that 9/125 is the common notation for F.O. cable with a 9µm core in a 125µm fiber.

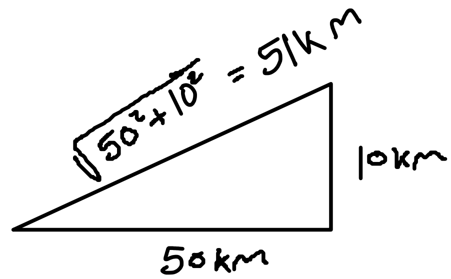
This is single-mode cable.

$$\frac{\text{area of 14 ga wire}}{\text{area of F.O. cable}} = \left(\frac{1.6\text{ mm}}{0.125\text{ mm}}\right)^2 \simeq \underline{\underline{160}}$$

if we use the diameter of the insulation:

$$\text{ratio} = \left(\frac{3.5\text{mm}}{0.125\text{mm}}\right)^2 \simeq \underline{\underline{780}}$$

Q.5




$G_T = G_R = 0\text{dB}$

$P_T = 100\text{ W}$

$f = 115\text{ MHz}$

$d = 51\text{ km}$

$$P_R(\text{dBm}) = \underbrace{P_T}_{\text{dBm}} + \underbrace{G_T + G_R}_{\text{dB}} + \underbrace{10\log_{10}\left(\frac{\lambda}{4\pi d}\right)^2}_{\text{path loss (dB)}}$$

$$P_T(\text{dBm}) = 10\log\left(100\times10^3\right) = 50\text{ dBm}$$

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{115\times10^6} \simeq 2.6\text{m}$$

$$P_R = 50 + 0 + 0 + 20\log\left(\frac{2.6}{4\pi\ 51\times10^3}\right) = 50 + -108$$

$$= \underline{\underline{-58\text{ dBm}}}$$