Task 1: Restorative Work

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5) $f_c = 6 \times 10^9$ Hz $B_W = 40$ MHz $C = 320 \times 10^6$ bps

$G_R = 3$dB $P_T = 3$w $G_T = 2$dB $T = 295$K

$C = B \log_2(1 + SNR)$ $SNR = \frac{P_r}{K \cdot B}$

$2^{C/B} - 1 \cdot K \cdot B = P_r$

$\left[2^{\frac{320 \times 10^6}{40 \times 10^6}} - 1\right](1.38 \times 10^{-23})(295)(40 \times 10^6) = P_r$

$P_r = 7.74 \times 10^{-14}$ w

6) $2^{\frac{C}{2B}} = SL$

$2^{\frac{320 \times 10^6}{2 \cdot 40 \times 10^6}} = SL = 16\ SL = 4$ bits

10) $C = 200 \times 10^6$ $f = 3 \times 10^9$ $G_T = 30$dB $A_e = 0.6A$ $A = 1.8 \times 1$ $B_W = 50 \times 10^6$ $T = 300$K

$G_R = \frac{4\pi A_e}{\lambda^2} = \frac{4\pi(0.6)(1.8)}{\lambda^2}$ $\lambda = \frac{3 \times 10^8}{3 \times 10^9} = 0.1$

$G_R = 1.35 \times 10^3$ $G_R dB = 10 \log_{10}(1.35 \times 10^3) = 31.326$ dB

11) Path loss = ? $d = 1 \times 10^3$ m

$\frac{(4\pi d)^2}{\lambda^2} = L$

$L_{dB} = -20 \log(f) + 20 \log(d) - 10 \log(A_T A_R) + 169.54$

$= -20 \log(3 \times 10^9) + 20 \log(1 \times 10^3) - 10 \log\left[10^{\frac{31.33}{10}} \times 18^{\frac{3}{10}}\right] + 169.54$

$L_{dB} = -21.328796$ dB

12) $P_n = ?$ $= KTB$

$C = B \log_2(1 + SNR)$ $SNR = \frac{P_r}{P_n} \rightarrow KTB$

K T B

$P_n = (1.38 \times 10^{-23})(300)(50 \times 10^6)$

$P_n = 204 \times 10^{-15}$ W

13) 2/3 Shannons SNR = ?

$C = B \log_2(1 + SNR)$

$\left(2^{\frac{100 \times 10^6 \ (1/3)}{50 \times 10^6}} - 1\right) = SNR = 63$

$SNR_{dB} = 10 \log_{10}(63) = 17.993$ dB

Task 1

14) $P_r = ?$

$SNR = \frac{P_R}{P_N}$

$SNR \times P_N = P_R$

$(63)(2.04 \times 10^{-13}\ W) = P_R$

$P_R = 1.304 \times 10^{-11}\ W$

15) $P_t = -20\ dBm = -50dB$

$P_r = \frac{P_T \cdot G_T \cdot G_R \cdot \lambda^2}{(4\pi d)^2}$ $\quad d = \frac{\sqrt{\frac{P_T \cdot G_T \cdot G_R \cdot \lambda^2}{P_r}}}{4\pi} = \frac{\sqrt{\frac{(10^{\frac{-40}{10}} \cdot 10^{\frac{25}{10}} \cdot 10^{\frac{2.125}{10}})\lambda^2}{1.304 \times 10^{-12}}}}{4\pi} = 24.859\ km$

16) No Noise SL

$2^{\frac{C}{2B}} = SL$ $\quad 2^{\frac{(200 \times 10^6)}{2 \times 50 \times 10^6}} = 2^2 = 4$

25) $f_{max} = 50\ Hz$ $\quad f_S = 100\ Hz$

$f_S \geq 2f_{max}$ $\quad 50\lambda \cdot 2 = 100 Hz$ ✓

26)

$q = \frac{V_2 - V_1}{2^N}$ $\quad N = 2\ bits$ $\quad T = \frac{1}{100} = 0.01\ s$

$\frac{20 - -20}{2^2} = \frac{40}{4} = 10v$

27) Quantization error is the difference between an analog and digital signal at a given sample. To reduce the quantization error by increasing the number of bits used.