Wireless and Mobile Networks, ENCS5323
Equations Sheet

Equations of Chapter 1

- Speed of light (c) → c = 3×10^8 meter/s
- Wave Length (λ) → $\lambda = \frac{c\ (m/s)}{f\ (Hz)} = \frac{3*10^8\ (m/s)}{f\ (Hz)}$
- Convert to dB → $P_{x,dB} = 10\log_{10}P_x$
- Convert dB to dBm → X dB = (X+30) dBm
- Nyquist channel capacity → $C = 2B \log_2(M)$
- Shannon–Hartley theorem for Channel Capacity, $C = B \log_2(1 + SNR)$
- Antenna Gain (G) and Antenna Effective Area (A_e) → $G = \frac{4\pi A_e}{\lambda^2} = \frac{4\pi f^2 A_e}{c^2}$
- Free Space Path Loss (Lp) → $L_P = \frac{(4\pi d)^2}{\lambda^2} = \frac{(4\pi f d)^2}{c^2}$
- Power Received (P_r) → $P_r = \frac{P_t G_t G_r A_t A_r}{L_p L_f L_o F_{margin}}$, A_t: Amplifier at transmitter, A_r: Amplifier at receiver, L_f: feeders (cables) losses. L_o: other losses, F_{margin}: Fading Margin.
- Effective Isotropic Radiated Power (EIRP) → $EIRP = \frac{P_t A_t G_t}{L_{f,t} L_{o,t}}$, $L_{f,t}$: cable loss at transmitter, $L_{o,t}$: other losses at transmitter.
- Doppler Shift → $f_d = \frac{v}{\lambda} \cos\theta$, v is the moving speed
- Frequency deviation due to doppler shift → $f_r = f_c - f_d$, f_c: frequency of source
- Diameter of First Fresnel Zone in foot → $D_3 = 72.1\sqrt{\frac{(D1)(D2)}{f(D1 + D2)}}$, D1 and D2 in miles
- Thermal Noise Power at receiver (N) → $N = kTB_W$; k: Boltzmann's constant (1.38×10^{-23} W/Kelvin-Hz)
- Spectral noise density (N_0) → $N_0 = \frac{N}{Bw} = kT$, Bw: Bandwidth at reciver

- $\frac{E_b}{N_0}$ before modulator → $(\frac{E_b}{N_0})_{\text{at detector}} = \frac{P_r}{kTN_{f,total}R}$, $N_{f,total}$: Noise figure of receiver
- $\frac{E_b}{N_0}$ margin before modulator (M) → $M = \frac{P_r}{kTN_{f,total}R(\frac{E_b}{N_0})_{required}}$
- Power Received (P_r) based on a reference distance power → $P_r(d) = P_r(d_o)\left(\frac{d_o}{d}\right)^{\gamma}$
- Power Received (P_r) based on a reference distance power and shadowing → $P_r(d) = P_r(d_o)\left(\frac{d_o}{d}\right)^{\gamma} + X_{\sigma}$

Equations of Chapter 2

- Throughput of pure ALOHA, $S_{th} = gTe^{-2gT}$
- Throughput of slotted ALOHA, $S_{th} = gTe^{-gT}$
- Throughput unslotted nonpersistent CSMA, $S_{th} = \frac{Ge^{-2\alpha T}}{G(1+2\alpha)+ e^{-\alpha G}}$
- Throughput slotted nonpersistent CSMA, $S_{th} = \frac{\alpha Ge^{-2\alpha T}}{G(1- e^{-2\alpha G}+\alpha)}$
- Throughput unslotted 1-persistent CSMA,

$$S_{th} = \frac{G\left[1 + G + \alpha G\left(1 + G + \frac{\alpha G}{2}\right)\right]e^{-G(1+2\alpha)}}{G(1+2\alpha) - (1 - e^{-2\alpha G}) + (1+\alpha G)e^{-G(1+\alpha)}}$$

- Throughput slotted 1-persistent CSMA,

$$S_{th} = \frac{G(1+\alpha - e^{-\alpha G})e^{-G(1+\alpha)}}{(1+\alpha)(1 - e^{-\alpha G}) + \alpha e^{-G(1+\alpha)}}$$