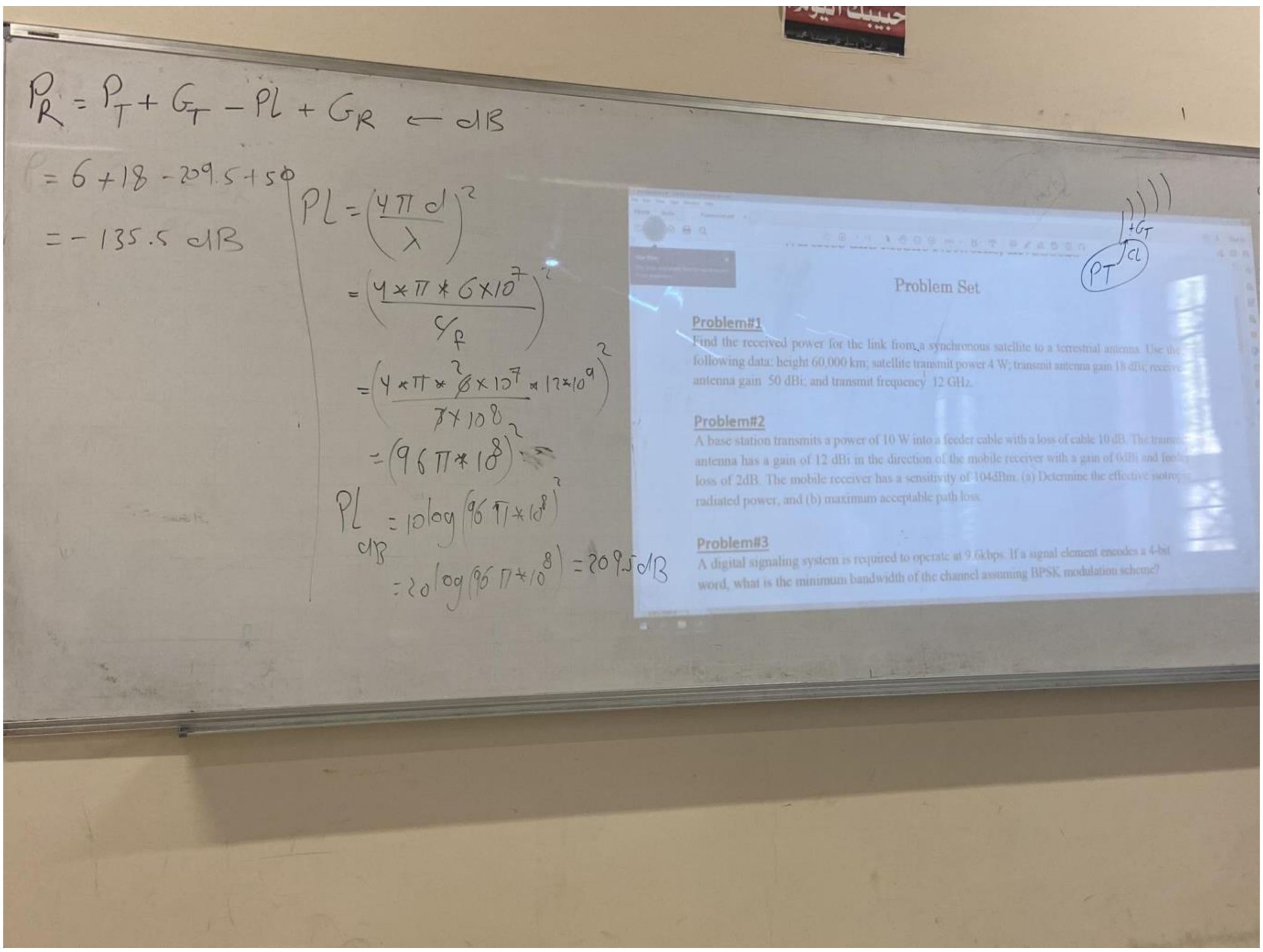
BIRZEIT UNIVERSITY

Department of Electrical and Computer Engineering
Second Semester, 2022/2023
Wireless and Mobile Networks, ENCS5323

Problem Set

Problem#1

Find the received power for the link from a synchronous satellite to a terrestrial antenna. Use the following data: height 60,000 km; satellite transmit power 4 W; transmit antenna gain 18 dBi; receive antenna gain 50 dBi; and transmit frequency 12 GHz.



Problem#2

A base station transmits a power of 10 W into a feeder cable with a loss of cable 10 dB. The transmit antenna has a gain of 12 dBi in the direction of the mobile receiver with a gain of 0dBi and feeder loss of 2dB. The mobile receiver has a sensitivity of 104dBm. (a) Determine the effective isotropic radiated power, and (b) maximum acceptable path loss.

P#2:

$P_t = 10W = 10dB$

$L_{f,t} = 10 dB$

$G_t = 12 dBi = 12 dB$

$G_r = 0 dBi = 0 dB$

$L_{f,r} = 2dB$

$P_r = 104 dBm = 104 - 30 = 74 dB$

~~a) EIRP = Pt + Gt~~

a) $EIRP = P_t + G_t - L_{f,t}$

$= 10dB + 12dB - 10dB$

$= 12 dB$

b) $P_r = P_t + G_t + G_r - L_p - L_{f,t} - L_{f,r}$

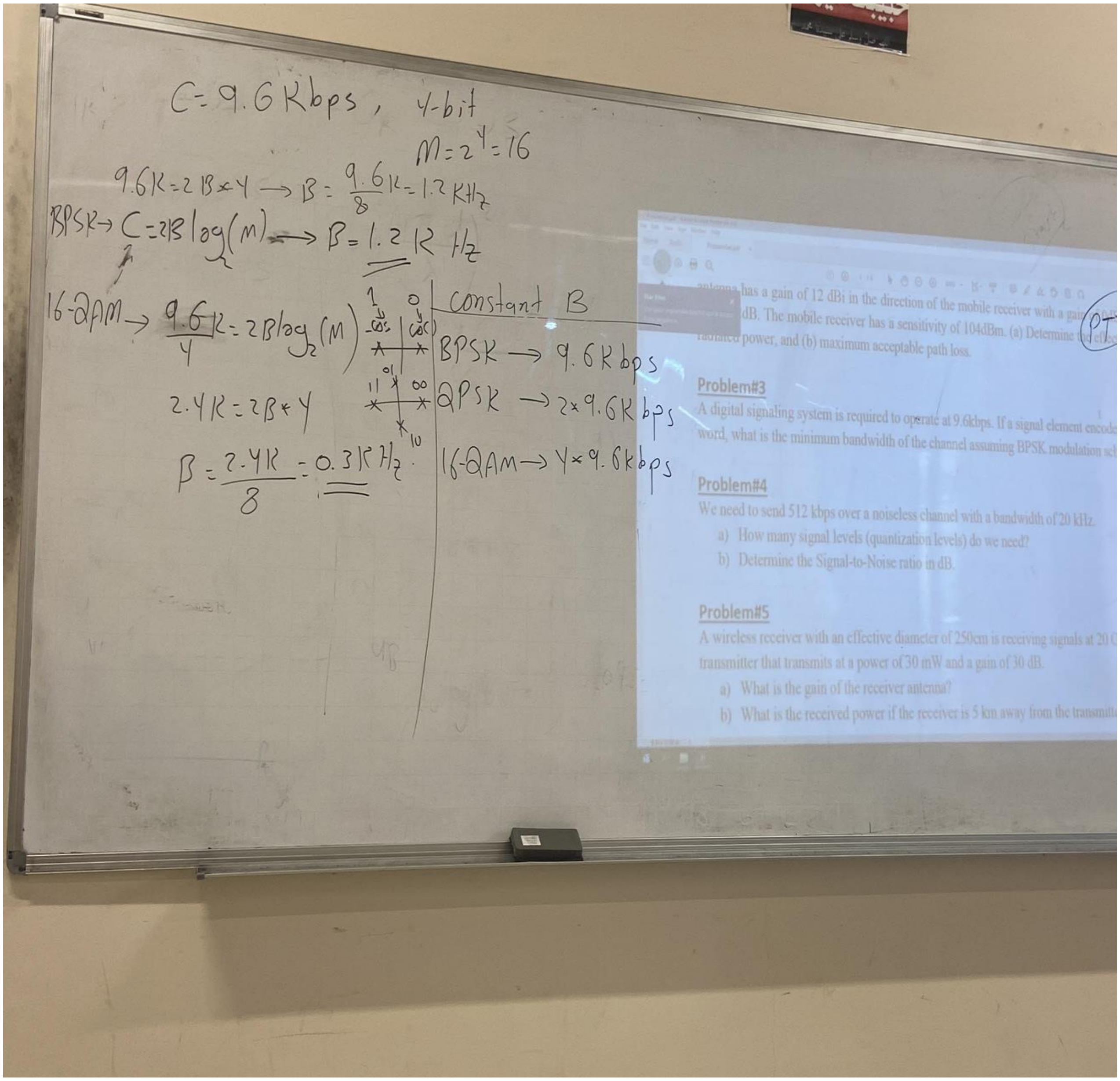
$74 dB = 10dB + 12dB + 0 - L_p - 10dB - 2dB$

$74 = 10 - L_p$

$L_p = 64 dB = 94 dBm$

Problem#3

A digital signaling system is required to operate at 9.6kbps. If a signal element encodes a 4-bit word, what is the minimum bandwidth of the channel assuming BPSK modulation scheme?



Problem#4

We need to send 512 kbps over a noiseless channel with a bandwidth of 20 kHz.

a) How many signal levels (quantization levels) do we need?

b) Determine the Signal-to-Noise ratio in dB.

P#4:

$C = 512\ Kbps$, $BW = 20KHZ$

a) $C = 2B \log_2 (M)$

$512K = 2 * 20K \log_2 (M)$

$12.8 = \log_2 (M)$

$M = 2^{12.8} = 7131.55$ levels

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

$512K = 20k \log_2 (1+SNR)$

$25.6 = \log_2 (1+SNR)$

$SNR = 2^{25.6} - 1 = 50859007.46 = 77.06\ dB$

Problem#5

A wireless receiver with an effective diameter of 250cm is receiving signals at 20 GHz from a transmitter that transmits at a power of 30 mW and a gain of 30 dB.

a) What is the gain of the receiver antenna?

b) What is the received power if the receiver is 5 km away from the transmitter?

a) $A_e = \pi r^2 = \pi \left(\frac{d}{2}\right)^2 = \frac{\pi}{4} d^2 = \frac{\pi \times (2.5)^2}{4} = 4.9107 m^2$

[2 points]

$G = \frac{4\pi f^2 A_e}{c^2} = \frac{4\times\pi\times(20\times10^9)^2 \times 4.9107}{(3\times10^8)^2}$

[2 points] $= \frac{4\times\pi\times 400 \times 4.9107}{9} \times 100$

[1 point] $= 274375.619 = 54.383 dB$

b) $P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2} = \frac{P_t G_t G_R c^2}{(4\pi d f)^2}$ → [1 point]

$= 30\times10^{-3} \times 10^3 \times 274375.619 \times \frac{(3\times10^8)^2}{(4\times\pi\times 5\times10^3 \times 20\times10^9)^2}$

(P_t, G_T, G_R)

[3 points]

$= \frac{30 \times 274375.619 \times 9}{16\times(\pi)^2 \times 25 \times 400} \times \frac{10^{16}}{10^{24}}$ [1 point]

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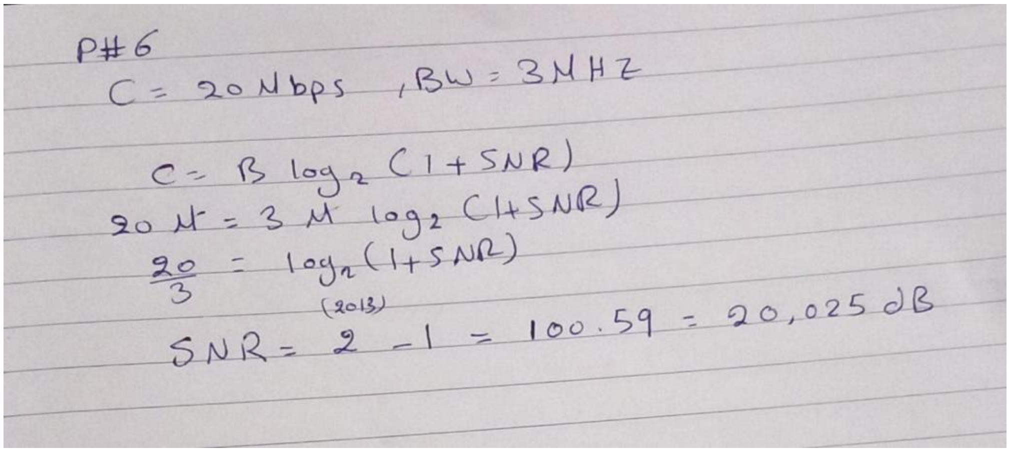
$= 46.9602 \times 10^{-8} = 0.469602\times10^{-6}$

$= 0.469602 \, \mu watt$

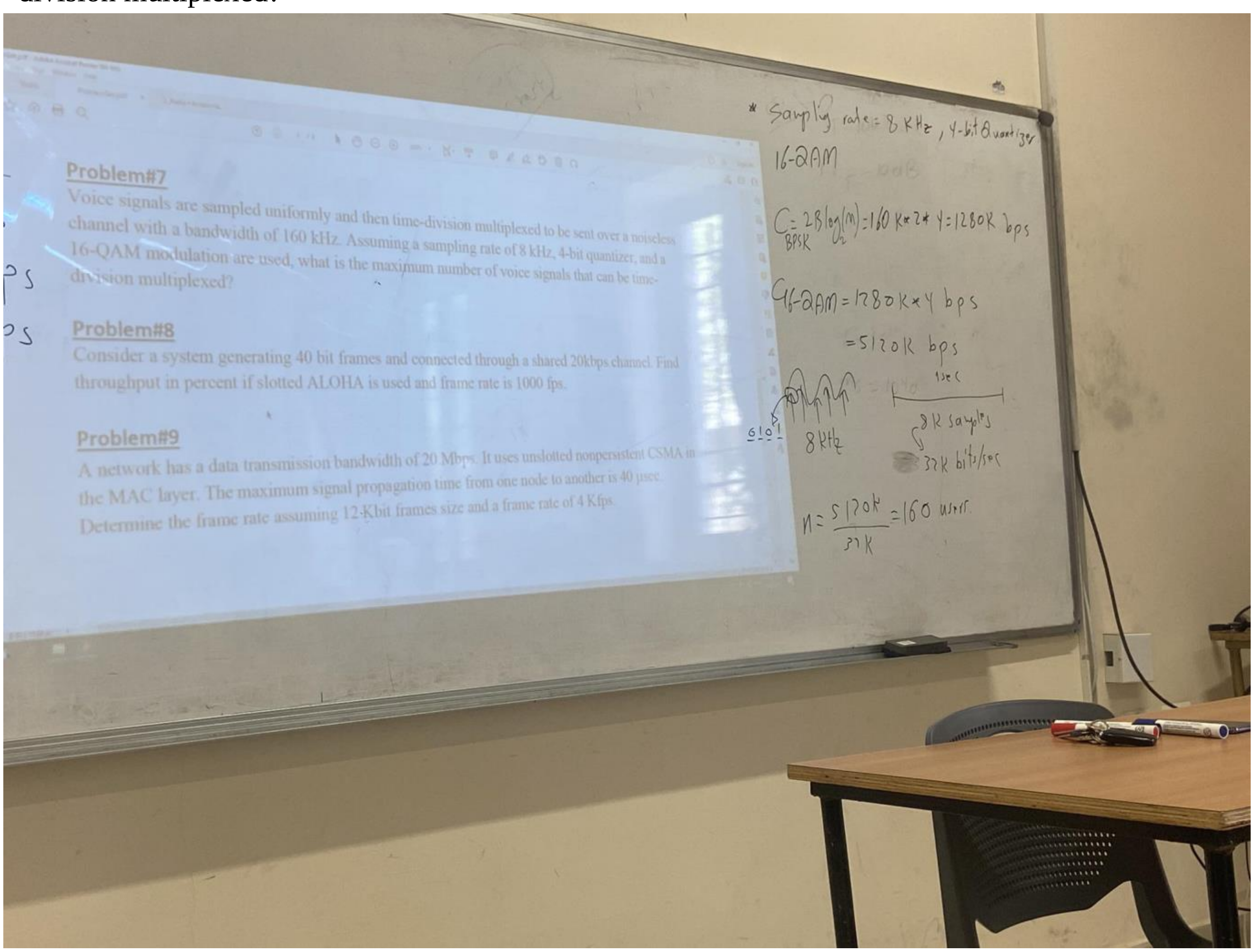
Problem#6

Given a channel with intended capacity of 20Mbps, the bandwidth of the channel is 3MHz. What signal-to-noise ratio is required to achieve this capacity?



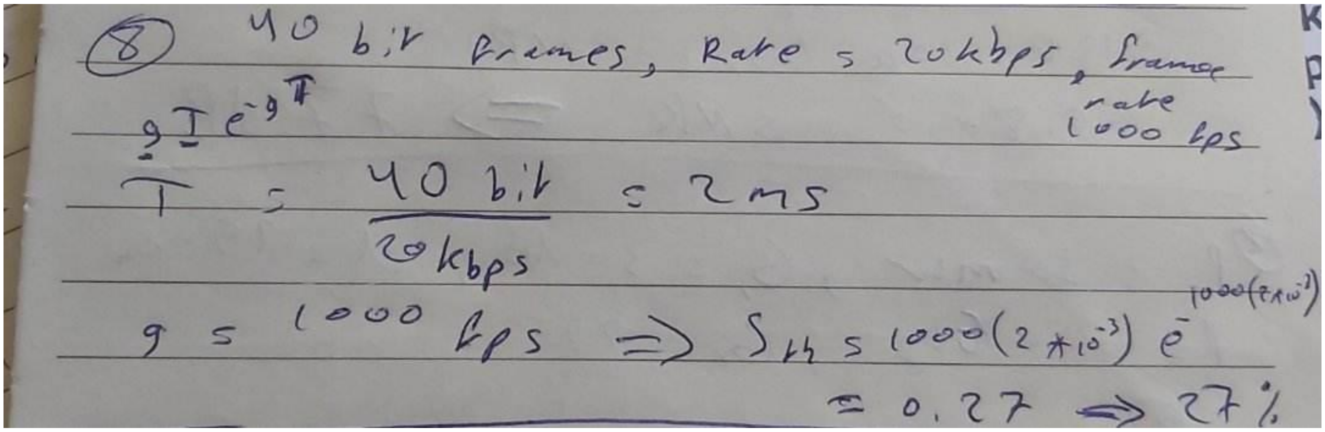
Problem#7

Voice signals are sampled uniformly and then time-division multiplexed to be sent over a noiseless channel with a bandwidth of 160 kHz. Assuming a sampling rate of 8 kHz, 4-bit quantizer, and a 16-QAM modulation are used, what is the maximum number of voice signals that can be time-division multiplexed?



Problem#8

Consider a system generating 40 bit frames and connected through a shared 20kbps channel. Find throughput in percent if slotted ALOHA is used and frame rate is 1000 fps.



Problem#9

A network has a data transmission bandwidth of 20 Mbps. It uses unslotted nonpersistent CSMA in the MAC layer. The maximum signal propagation time from one node to another is 40 μsec. Determine the frame rate assuming 12 Kbit frames size and a frame rate of 4 Kfps.