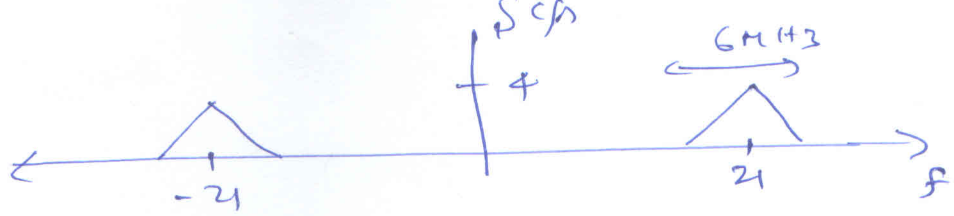
EE 5151

Nov, 2019

END SEM

1. [4+4=8 marks]

(a)



$$R(0) = \int S(f)\,df = 4 \times \left(\tfrac{1}{2} \times 3 \times 4\right) = \boxed{24}$$

-1-

$$\underset{20\text{ dB}}{\underset{\uparrow}{SQNR}} = \frac{R(0)}{\Delta^2/12} \quad \text{where } \Delta = \frac{2A_{max}}{2^n}$$

n-bit quantizer (ADC)

Given $A_{max} = 6$,

$$400 = \frac{24}{\left(\frac{2\times 6}{2^n}\right)^2/12}$$

$$= 2^{2n+1} \Rightarrow n = \lceil 3.83 \rceil = \boxed{4 \text{ bi}}$$

-3-

(per sample)

(b) To get band-pass sampling rate of DSB-SC signal

$$\left\lfloor \frac{21}{6} \right\rfloor = 3 \Rightarrow f_s = \frac{21}{3} = \boxed{7 \text{ MHz}}$$

-2-

$$\therefore \text{Bit Rate at ADC output} = 7 \times 4 = \boxed{28 \text{ Mbps}}$$

-2-

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2. [4+2 = 6 marks]

Minimum Complexity of $N = 5000$ line Switch with blocking ($q < P_b = 10^{-5}$) is obtained by picking

$$n = \sqrt{\frac{N}{2}} = \boxed{50\ ;} \quad -\frac{1}{2}$$

$$\Rightarrow \quad m = N/n = \boxed{100\ ;} \quad -\frac{1}{2}$$

Eu per user

(a) $$q = \frac{50 \cdot Eu}{k} = \frac{50 \times 0.02}{k} = \frac{1}{k}$$

where $k \rightarrow$ # of middle-stage arrays (each of size $m \times m = 100 \times 100$)

Blocking Probability $P_b = \left(1 - (1-q)^2\right)^k$, with $q = \frac{1}{k}$ in above case

$$= \left(\frac{2}{k} - \frac{1}{k^2}\right)^k \quad -1$$

$k = 7 \longrightarrow P_b = 9.2 \times 10^{-5}$

$-2 \rightarrow \boxed{k = 8} \longrightarrow = 9.1 \times 10^{-6}$ ← which is $< 10^{-5}$

(b) Total # of Crosspoints

$$= 2 \times (N \times k) + k\, m^2$$

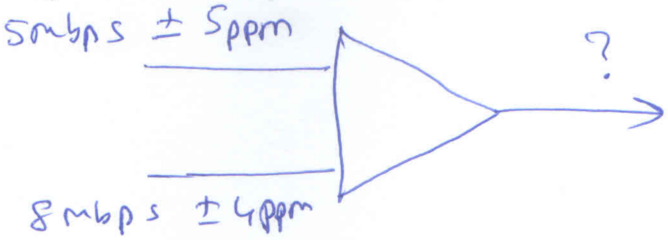
$$= \underbrace{2 \times 5000 \times 8}_{80,000} + \underbrace{8 \times 100^2}_{80,000}$$

$$= \boxed{1,60,000}$$

-2

3. [3 + 3 = 6 marks]

Digital Mux



Bit Rate $= \frac{780,020}{60 \times 10^{-3}}$ -1-

$= \boxed{13.00033\overline{3} \text{ Mbps}}$

(a) For L = 60 msec.

- 5 Mbps ± 5ppm ⟶ 300,000 ± ~~1.5~~ bits
  ⇒ ± 2 bits -½-
- 8 Mbps ± 4ppm ⟶ 480,000 ± 1.92 bits
  ⇒ ± 2 bits -½-

⟵ 60 msec ⟶ -1-

5	300,000 − 2	480,000 − 2	4	4	3	3	5
Marker	A	B	stuff bits for A	stuff bits for B	SBI for A	SBI for B	CRC

(0, 1, 2, 3, 4)

SBI → Stuff Bits Indicator

∴ Total overhead (OH) $= 5 + 5 + \underbrace{2 + 2}_{\frac{1}{2}\text{ of stuff bits}} + 3 + 3 = 20$ bits

⇒ OH percentage $= \left(\frac{20}{780,000 + 20}\right) \times 100 = \boxed{0.002564\ \%}$

(b) Now, we want 8% less overhead

⇒ ~ 0.002359% ; Thus L has to increa

For $\boxed{L = 70 \text{ msec}}$ -1-

5	350,000 − 2	560,000 − 3	4	6	3	3	5

-2-

OH = 21 bits & OH % = 0.002307 %

Approximately OK

4. [6 marks]

-1-

(i) Buffer Status | (1,6) → (2,7) → (2,7) → (2,7) → (2,

-2-

(ii) SN | 1, 2, 3, 4 | 5 , 6 , 2

(iii) RN | 1.00, 1.00, 2.00, | 2.00, 2.11, 2.11, 2.11, 2.11

-3-

(iv) { 3 & 4 are accepted; other DL packets will not be accepted

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5. [6 marks] In linear scale

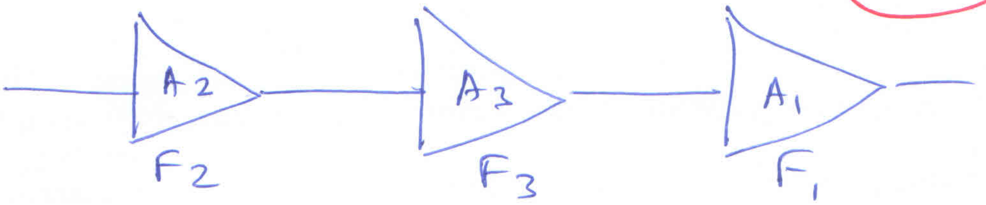
$A_1 = 1000$; $F_1 = 5.62$

$A_2 = 10$; $F_2 = 3.98$

$A_3 = 3.98$; $F_3 = 3.80$

Sln:

-4-



Overall Noise figure | $= F_T = 4.376$

$= \boxed{6.41 \text{ dB}}$ -2-

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6. [~~5~~ 4 + ~~3~~ 4 = 8 marks]

gain of PA

Total loss per link = 26dB Im loss

$$-26\,dB = 29\,dBi + 29\,dBi - 38\,dB - 10\log_{10} d^{2.5}$$

-1-

$$\Rightarrow 25\log_{10} d = 46$$

$$\Rightarrow \boxed{d = 69.183\ m}$$ -1-

∴ # of hops (or) (Repeaters) $= \left\lceil \frac{20,000}{69.183} \right\rceil = \boxed{1735 = N\ ;}$ -2-

(b) Since $SNR_o = 16\,dB$

$-174 + 70\,dB$ 10MHz

$$16 = P_T - (-104) - 10\log_{10}(1735)$$

$$- 26 \quad - \cancel{46} \quad - 6$$

$\left(\text{From } P_R = \frac{1}{NLF}\left(\frac{P_T}{N_0 W}\right)\right)$

$$\Rightarrow \boxed{\begin{aligned} P_T &= -23.6\,dBm \\ &= 0.4365 \text{ milliwatts} \end{aligned}}$$

-1-

-3-

~~2.36~~

~~60~~

4.35×10^{-3} mW

6/~~7~~

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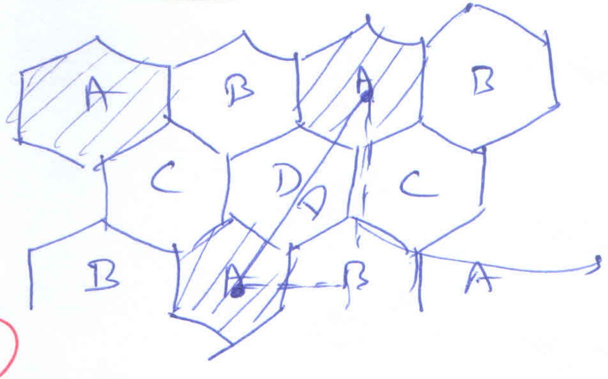
3 3½

[~~3½~~ + 3 + 3½]

7. $D = \sqrt{3N}\ R$

for Reuse $\boxed{N = 4,}$ $D = \sqrt{12}\ R$

(a)



-3-

Can prove $D = \sqrt{12}\ R$ by taking this right ∠ed Δ

(b) worst case SIR (using only 1st tier interference)

$n = 3$

$$SIR = \frac{R^{-n}}{2(D+R)^{-n} + 2(D-R)^{-n} + 2D^{-n}}$$

$$= \frac{1}{2\cdot\left(\frac{1}{(\sqrt{12}+1)^3} + \frac{1}{(\sqrt{12}-1)^3} + \frac{1}{(\sqrt{12})^3}\right)}$$

$= \cancel{7.9737}$ 4.88

$SIR = \boxed{\cancel{9.0166}\ dB \quad 6.88\ dB}$ -3½-

(c) Total # of servers ~~per base-station~~ $= \frac{12\,000}{200\,kHz} = 60$ servers (full duplex) -1-

with 4 cell re-use per base-station $= \frac{60}{4} = 15$ server -1-

$\boxed{P_b = E^M/M! \Big/ \sum_{k=0}^{M} E^k/k!}$ $\boxed{E = 50 \times E_u = 1}$ -½-

$\longrightarrow P_b < 7.64 \times 10^{-13}$ -1

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8. [2+3+5 = 10 marks]

- 2 MHz DS-CDMA with W = 256
- SINR required = 7 dB = 5.012

(a) Pole Capacity N_p

$$\text{SINR} = \frac{P W^2}{(N-1)PW + W N_0}$$

↳ Noise variance kTΔf

For $N_0 W$ being very small compared to $(N-1)PW$, we get pole capacity.

$$5.012 = \frac{256}{(N-1)\cdot}$$

$\Rightarrow \boxed{N_p = 52}$ ← (-2-)

(b) For Noise-Rise of 4.5 dB = 2.82

$(N-1)P + N_0 = 2.82 N_0$ (-1-)

from which we get $N_0 = (N-1)P/1.82$

and finally $N-1 = \frac{256}{5.012 \times (1.55)}$ (-2-)

$\Rightarrow N = 33.96 \simeq \boxed{34}$

(c) For M^{th} user Uplink Power Required $P(M) = \frac{\sigma^2}{\frac{W}{SINR} - (M-1)}$ (-1-)

$P_{10} = \frac{\sigma^2}{42}$ (-1/2-) ; $P_{20} = \frac{\sigma^2}{32}$ (-1/2-) ;

∴ Percentage ↑ in power $= \frac{P_{20} - P_{10}}{P_{10}} \times 100 = \boxed{31.25\%}$ (-3-)