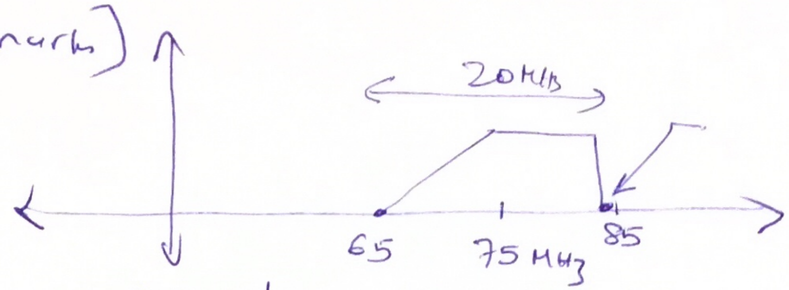
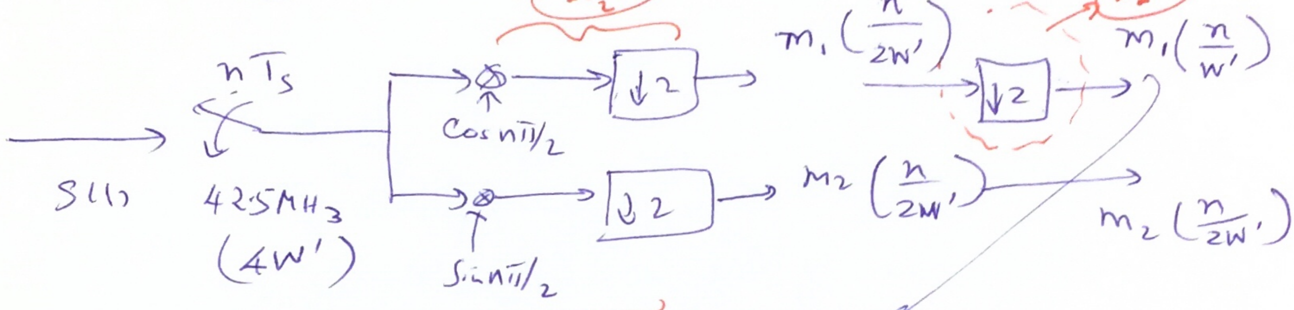
1. [4 marks]



use $W_2 = 10$ MHz to finalise f_s

$\therefore \quad 2\times 2W_2 = 40 \rightarrow \left\lfloor \frac{85}{2\times 20} \right\rfloor = 2 \Rightarrow \frac{85}{2} = \boxed{42.5\text{ MHz}} = f_s$

-1/2   -1 1/2



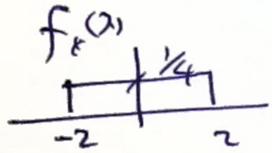
this is good enough since $W_1 = W_2/2$

2. [3 marks] for an RV X,

$$SQR = 4.76 + 6.02n + 10\log_{10}\left(\frac{P_x}{x_{max}^2}\right)$$

where $P_x = R_X(0) = E[(X-\mu)^2]$

$= E[x^2]$ if $\mu = 0$



$\Rightarrow X_{max} = 2$ (or -2)

$\Rightarrow E[x^2] = P_x = \frac{(b-a)^2}{12} = \frac{4^2}{12}$; -1-

$\frac{16/12}{2^2} = \frac{4}{12}$

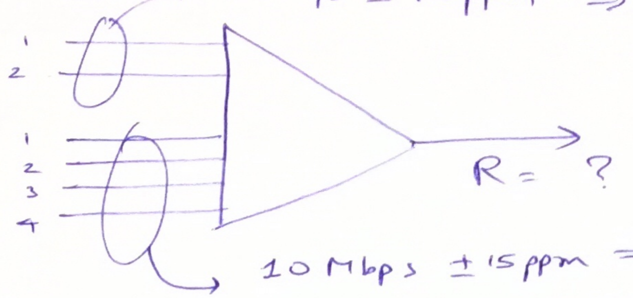
Putting all this together

$$60 = 4.76 + 6.02n + \underbrace{10\log_{10}\left(\frac{1}{3}\right)}_{-4.77}$$

$$\Rightarrow \boxed{n \simeq \frac{60}{6} = 10 \text{ bits}} \;;$$

-2-

3. [4 marks]



20Mbps ± 10ppm ⇒ every 1 sec $20 \times 10^6 \pm 200$ bits

10 Mbps ± 15ppm ⇒ every 1 sec $10 \times 10^6 \pm 150$ bits

(a) → Given framing $\boxed{L = 2 \text{ sec}}$

$$\underbrace{32}_{\text{frame marker}} + (40\times10^6 - 400)\times 2 + (20\times10^6 - 300)\times 4 + (\underbrace{800}_{\text{stuff bits}} + \underbrace{10}_{\text{SBI}})\times 2 + (600+10)\times 4 + \underbrace{16}_{\text{CRC}}$$

$= 80\times10^6 + 80\times10^6 + 2108$ (every 2 secs)

⇒ Bit Rate $R = \boxed{80.001054 \text{ Mbps}}$; -2-

(b) Given that upto 80.02 Mbps is allowed, to find the least choice for L ~~fk~~ → can use trial and error

L	2 sec	20 msec	5 msec	4 msec	3 msec	2 msec
Rate	80.001054	80.0068	80.0108	80.0165	80.01933	80.054

Lower (4 msec) · closest to 80.02 (3 msec) · higher (2 msec)

-2-

Ans : $\boxed{L \approx 3 \text{ msec}}$ is the best choice

4. [6 marks] → single stage complexity = $\boxed{400 \text{ million}}$

Given $N = 20{,}000$ user, each of $E_u = 0.03$ erlangs

(a) To find 3-stage non-blocking switch, either

$n = \sqrt{\frac{N}{2}} = \sqrt{10{,}000}$

i.e., $\boxed{n = 100}$; -½-

or find the roots of $2n^3 - Nn + N = 0$ can be used with $N = 20{,}000$ to get $n = 100$

$\Rightarrow k = 2n - 1$

$= 200 - 1$

i.e. $\boxed{k = 199}$ -½-

Total Complexity (# of cross-points) $= 2 \times \left(\frac{N}{n}\right) \times k \times n + k \cdot \left(\frac{N}{n}\right)^2$

$= 2 \times 20{,}000 \times 199 + 199\,(200)^2$

$= \boxed{15.92 \text{ million}}$ (15,920,000) -1-

(b) $P_b = 10^{-5}$ or less required

(i) for $n = 80$

$q = \frac{80 \times 0.03}{k} = \frac{2.4}{k}$ → Complexity $\boxed{1{,}230{,}000}$ (1.23 million) -½-

$k = 10 \Rightarrow 0.00018$

$k = 11 \Rightarrow 0.000030655 \approx 3 \times 10^{-5}$

$\boxed{k = 12}$ $\Rightarrow 0.0000047 \approx 0.47 \times 10^{-5} < 1 \times 10^{-5}$ -1.5-

(ii) for $n = 125$

$q = \frac{125 \times 0.03}{k} = \frac{3.75}{k}$

$k = 13 \Rightarrow 0.000103$

$k = 14 \Rightarrow 0.000046 \approx 4.6 \times 10^{-5}$

$\boxed{k = 15}$ $\Rightarrow 0.00000412 \approx 0.412 \times 10^{-5} < 1 \times 10^{-5}$ -1.5-

→ Complexity: $\boxed{984{,}000}$ -½-

(0.98 million)

5. [3 marks]

(a) With $M = 2$ servers and 5% blocking, the total traffic load (in Erlangs) that can be accepted is given by

$$0.05 = \frac{E^2/2!}{E^2/2! + E/1! + 1}$$

$$\Rightarrow \quad 19E^2 - 2E - 2 = 0$$

$$\Rightarrow \quad E = \frac{1 \pm \sqrt{39}}{19}$$

Since $E > 0$, taking the $(+)$ve root

$$\boxed{E = 0.3813 \text{ Erlangs}} \; ;$$

-1½-

(b) If now one more server is added (i.e. $M = 3$), the new P_b becomes

$$P_b = \frac{E^3/3!}{E^3/3! + E^2/2! + E + 1}, \text{ for } E = 0.3813$$

-1½-

This gives $P_b = \boxed{0.0063}$;

$\Rightarrow$ 0.63% blocking ;