EE-5060 Quiz-2

Solutions

1. [4 marks]

$$P_b = \frac{E^M / M!}{\sum_{i=0}^{M} \frac{E^i}{i!}} \quad ; \quad M = 8 \text{ (\# of servers)} ; \quad \nu = \frac{(1-P_b)E}{M} ;$$

$-1-$

ν = output utilization factor

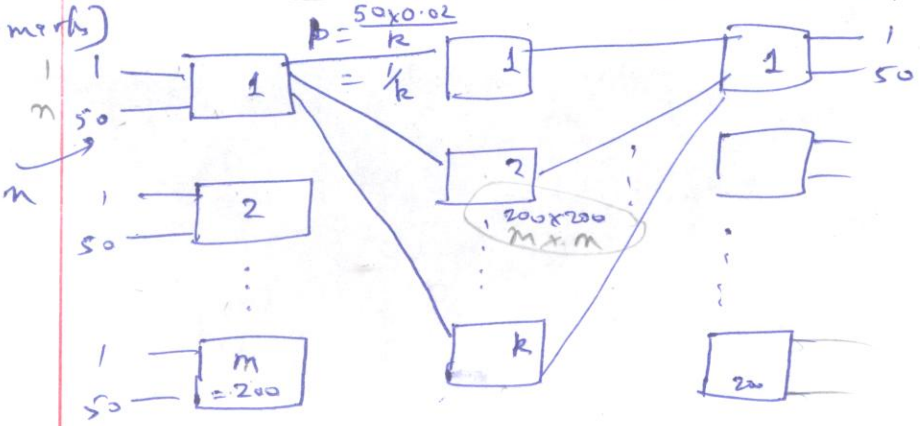
for E = 3 Erlangs $\longrightarrow \nu_{E=3} = \boxed{0.3719}$ ($P_b = 0.0081$) $-1\frac{1}{2}-$

for E = 4 Erlangs $\longrightarrow \nu_{E=4} = \boxed{0.4848}$ ($P_b = 0.0304$) $-1\frac{1}{2}-$

∴ The node accepting 4 Erlangs of traffic is better (has higher ν)

2. Given $m = 200 \Rightarrow n = 50$ such that $mn = N = 10,000$

[8 marks]



$$P_b = \left(1 - \left(1 - \tfrac{1}{k}\right)^2\right)^k < 10^{-4}$$

$-3-$

(a) $\Rightarrow \boxed{k = 7}$ gives $P_b = \left(\frac{13}{49}\right)^7 = \boxed{0.0000925}$;

(b) # of cross points $= 2 \times (n \times k \times m) + k m^2$ $-2-$

$= 2(N \cdot 7) + 7m^2 = \boxed{4,20,000}$ ($m = 200$)

(c) Since $k = 7$ is fixed, only "m" can be changed to change complexity (and P_b). However, no other choice of m will give lower complexity while keeping $P_b < 10^{-4}$ $-3-$

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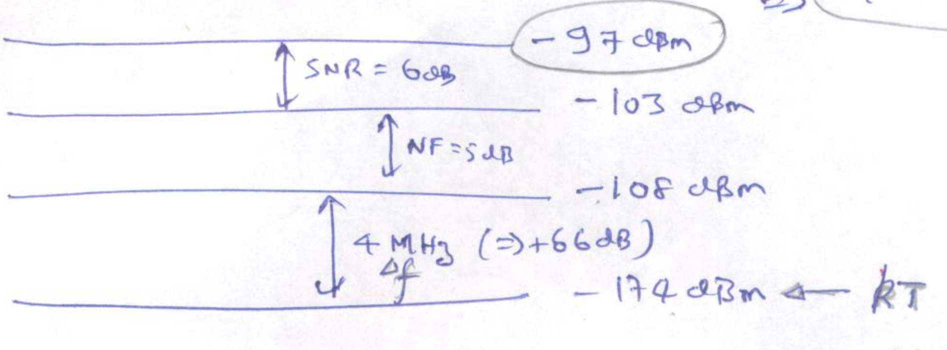
Solutions

3. [5 marks] To first find receiver sensitivity



⇒ R_x sensitivity = -97 dBm

-2-

To get max possible shadow margin (loss),

$$P_R = P_T + G_T + G_R - L_{1m} - 10\log_{10} d^n - \text{shadow loss}$$

G_T: dBi, G_R: dBi

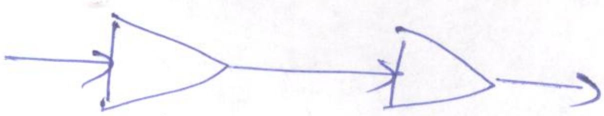
-1/2-

$$-97\,\text{dBm} = 24\,\text{dBm} + 15 + 6 - \underbrace{32.44}_{10\log_{10}\left(\frac{4\pi}{\lambda}\right)^2} - \underbrace{10\log_{10}(200)^4}_{92.04\,\text{dB}} - \text{shadow loss}$$

-1/2-

⇒ max shadow loss that can be tolerated = $\boxed{17.52\text{ dB}}$ -2-

4. [5 marks]



$A_1 ; F_1$ $A_2 = 20\text{dB}$

$F_1 = 0.32A_1$ $F_2 = 51$

$$\boxed{F = F_1 + \frac{F_2 - 1}{A_1}} = 0.32A_1 + \frac{50}{A_1}$$

$F^{\min}$ wrt A_1 ⇒ $A_1^2 = \frac{50}{0.32}$ ⇒ $\boxed{A_1 = 12.5}$ -2-

$\therefore F_{\min\,(\text{overall})} = \underbrace{0.32 \times 12.5}_{4} + \frac{50}{12.5} \leftarrow 4 = \boxed{8}$;

-3-

⇒ $\boxed{F_{\text{overall}} = 9\text{ dB}}$ (or 9.03 dB)

where each amp contributes ~~4.5dB~~ equally in linear scale (or 4 in linear scale)