Fayoum University
Faculty of Engineering
Electronics and Communications Dpt.
Subject: (Communications)
Examiner: Dr.Tamer Mohamed Barakat

جامعة الفيوم
Fayoum University

B.Sc. Communications
Academic year: 2009/2010
First Term Exam, January 2010
Time allowed: 180 minutes

Questions for Final Term Examination

Attempt All Questions	No. of Questions: 4	No. of Pages: 2

***First Question* (15 Marks)**

The signal component of a coherent **PSK** system is defined by:

$$s(t) = A_c k \sin(2\pi f_c t) \pm A_c \sqrt{1-k^2}\cos(2\pi f_c t)$$

Where $0 \leq t \leq T_b$ and the pluse sign corresponds to symbol **1** and the minus sign corresponds to symbol **0**. The first term represents a carrier components included for the purpose of synchronizing the receiver to the transmitter.

(10) **a)** Show that, in the presence of **AWGN** (Adaptive White Gaussian Noise) of zero mean and PSD $N_0/2$, the average probability of error is:

$P_{e_{min}} = Q\left(\sqrt{\frac{2E_{av}}{N_0}}(1-k^2)\right)$, where $E_{av} = E_b/2$, and $E_b = \frac{1}{2}A^2 T_b$

(5) **b)** Suppose that **10** percent of the transmitted signal power is allocated to the carrier component. Determine the E_b/N_0 required to realize a probability of error equal to 10^{-4}.

Second Question (15 marks)

(5) **a)** Explain briefly what is meant by dispersion on a glass fiber-optic and why it is important to reduce it. Describe the different kinds of dispersion and explain how these have been successfully reduced in the recent steps of development.

(10) **b)** Fiber channel is to be installed with the following characteristics:
Transmitter - laser diode with transmitter power $0\ dB_m$, Receiver – APD with sensitivity $-57\ dB_m$, T_x/R_x port losses $6\ dB$ each, Two connectors with losses $1\ dB$ each, Five splices with losses $0.5\ dB$ each, Fiber total loss $2\ dB/km$, Fiber total dispersion $0.505\ ns/km$, and Maximum desired rate $35\ Mbps$.

(3) **i)** Determine the loss-limited line length for a loss margin of $5\ dB$.
(2) **ii)** Determine the maximum bit rate that the link of <u>part (i)</u> will support.
(3) **iii)** Determine the dispersion-limited line length for the bit rate given.
(2) **iv)** Is the line is dispersion limited or attenuation limited? Clarify your answer in some details.

P.T.O

Third Question (15 marks)

A transponder receiver has a figure of merit of $3.3\ dB/K$ and a saturation flux density of $8.3\ dBW/m^2$. The transmitter part of this transponder has a saturated **EIRP** of $44.4\ dBW$. The transponder bandwidth is $72\ MHz$ centered at $14\ GHz$ up and $11.155\ GHz$ down. Assume that both uplink and downlink path lengths are $40,000\ Km$. The transmitting and receiving antenna gains are $53.3\ dB$ for the uplink and $51.2\ dB$ for down link. The receiving earth station has an overall noise temperature of $120^{\circ}K$. The link-operates with **4** dB **BO** (Back Off) on the satellite input and on satellite output. Determine the following:

(5) (i) The up-link **EIRP** and the up-link output power in **dBW**.
(5) (ii) The up-link carrier to noise ration in **dB**.
(5) (iii) The down –link carrier to noise ration in **dB**.

Fourth Question (25 marks)

(10) **a)** In a given telephone network, discuss the following in details:

1.5 (i) **Transmitter** and **Receiver** of the **D.T.M.F.** dialing system.
1.5 (ii) **CCITT's** acceptable attenuation characteristics of a telephone line.
1.5 (iii) Planning of the international numbering.
1.5 (iv) Concept of the wireless local loop.
(2) (v) Non- associated Common Channel Signaling system.
(2) (vi) Stability of the 4-wire loop.

(5) **b)** A central – office-to-PBX trunk group contains **10,000** subscriber lines originates one call per **day** and the average holding time is **four** minutes, determine each of the following:

(2.5) (i) The traffic intensity.
(2.5) (ii) The number of circuits required in a trunk group if the maximum desired blocking probability is **2%.**

(10) **(c)** Consider the telephone network shown ***Fig (1):***

(3) (i) Derive an expression for the overall **GOS** of the **alternate route.**
(3) (ii) Calculate the number of circuits, n, required to achieve $\beta_2 = 0.005$.
(4) (iii) Calculate the overall **GOS** of the network in ***Fig. (1).***

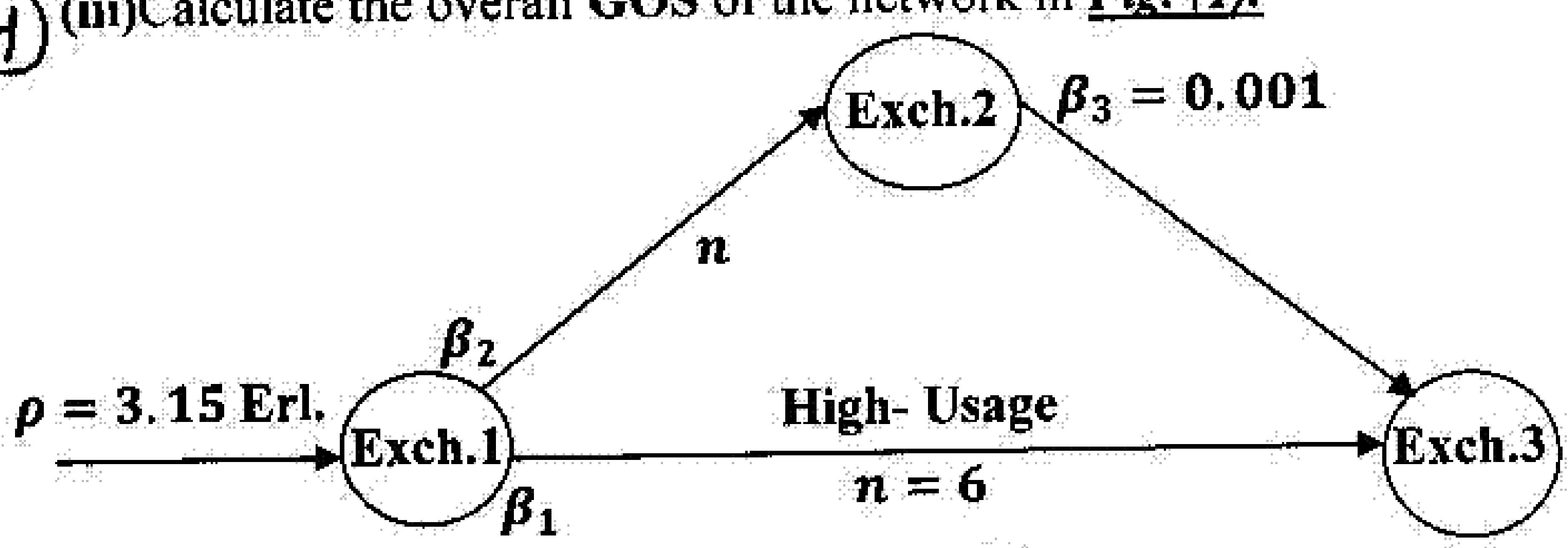


Fig (1)

$\beta = 0.02$		$\beta = 0.005$	
ρ_1	n	ρ_2	n
10	5.08	50.09	66
48.6	37.5	50.98	67
83	71.6	51.87	68

Good Luck

4th Year Comm

subject : Communications

Model Answer

First Question :

a) $\because S_1(t) = A_c k \sin(2\pi f_c t) + A_c\sqrt{1-k^2} \cos 2\pi f_c t$

$S_2(t) = A_c k \sin(2\pi f_c t) - A_c\sqrt{1-k^2} (\cos 2\pi f_c t)$

$\therefore S_{o_1}(kT_b) = \int S_1(t)[S_2(t) - S_1(t)]\, dt$

$\therefore S_{o_1}(kT_b) = A^2(1-k^2)T_b$

$\therefore S_{o_2}(kT_b) = \int S_2(t)[S_2(t) - S_1(t)]\, dt$

$S_{o_2}(kT_b) = -A^2(1-k^2)T_b$

The optimum threshold setting is T_o^* which is independent of the carrier strength at the receiver i/p:

$$\therefore \gamma_{max}^2 = \frac{2}{N_o}\int \rho^2(t)\,dt$$

$$\therefore \gamma_{max}^2 = \frac{2}{N_o}(2A_c^2 T_b(1-K^2))$$

$$\therefore \gamma_{max}^2 = \frac{8E_b}{N_o}(1-K^2)$$

$$\therefore P\Big|_{min} = Q\left(\frac{\gamma_{max}}{2}\right) = Q\left(\sqrt{\frac{2E_{av}}{N_o}(1-K^2)}\right)$$

b) $\because P_e = 10^{-4}$, $K^2 = 0.1$

$$10^{-4} = \frac{1}{2}Q(u)$$

$$u^2 = 0.9\frac{E_b}{N_o}$$

$$\therefore Q(u) = \frac{\exp(-u^2)}{\sqrt{\pi}\;u} \Rightarrow u = 2.64$$

$$\therefore \frac{E_b}{N_o} = 7.64$$

Second Question

a) Despersion determine the limit of the information Capacity of the fiber. It is the incident rays arrive the receiving end at different times.

* Kinds of despersion:

1- Modal dispersion; which occures when the propagating energy is distributed among a discrete set of super imposed fields called modes.

2 - Material dispersion; the single mode suffer from the material dispersion

3. Waveguid dispersion; take place when part of the transmitted wave pass through the cladding this part will propagate faster than the wave traveling in the Core - ~~cladding~~ Causing the dispersion.

b) (i) $\because P_t - P_R = L_{Tx} + L_{Rx} + N_c L_c + N_s L_s + Z L_f + M$

$\therefore 0 - (-57) = 6 + 6 + 2 + 5(0.5) + 2Z + 5$

$\therefore Z = 17.75 \text{ km}$

(ii) $\because \beta = \frac{1}{5 \Delta t Z} \rightarrow \beta = 22.312 \text{ Mbps}$

(iii)

$\because \beta = \frac{1}{5 Z \Delta t}$, $\beta = 35 \text{ Mb/s}$

$\therefore Z = 11.315 \text{ km}$

(iv) The line is dispersion limited because the value of $Z <$ loss limited line

Third Question:

(1) $\because eirp = \phi_s - G_1 + L - B_o$

$\because L = 32.5 + 20 \lg f + 20 \lg d$

$\therefore L = 207.46 \ dB$

$\because G_1 = 10 \lg \frac{4\pi}{\lambda^2} = 44.55 \ dB$

$\therefore eirp = 167.38 \ dBW$

$\because eirp = P_o \times G_T$

$eirp|_{dB} = P_o|_{dB} + G_T|_{dB}$

$\therefore P_o|_{dB} = 113.9 \ dBW$

(ii) $\because \frac{C}{N_o} = \phi_s + M - G_1 + 228.6$

$\therefore \frac{C}{N_o} = 191.65 \text{ dB}$

(iii) for down-link;

$\because M = \frac{G_R}{T} \Rightarrow G_R = 51.2$

$\therefore M = 72 \text{ dB/K}$

$\therefore \frac{C}{N_o} = 8.3 + 72 - G_1 + 228.6$

$\because G_1 = 10 \log \frac{4\pi}{\lambda^2}$

$\therefore \frac{C}{N_o} = 266.54 \text{ dB}$

Fourth Question:

a) see Telephone lecture

b)

(i) $\because \rho = \frac{N}{T} \bar{h}$, $\bar{h} = 4$ min.

and $N = 10,000$

$$\therefore \rho = \frac{10,000 * 4}{24 \times 60} = 27,77\ E$$

(ii) $\because \beta = (\rho, n) = \frac{\rho^n / n!}{\sum_{m=0}^{n} \rho^m / m!}$

from the given table:

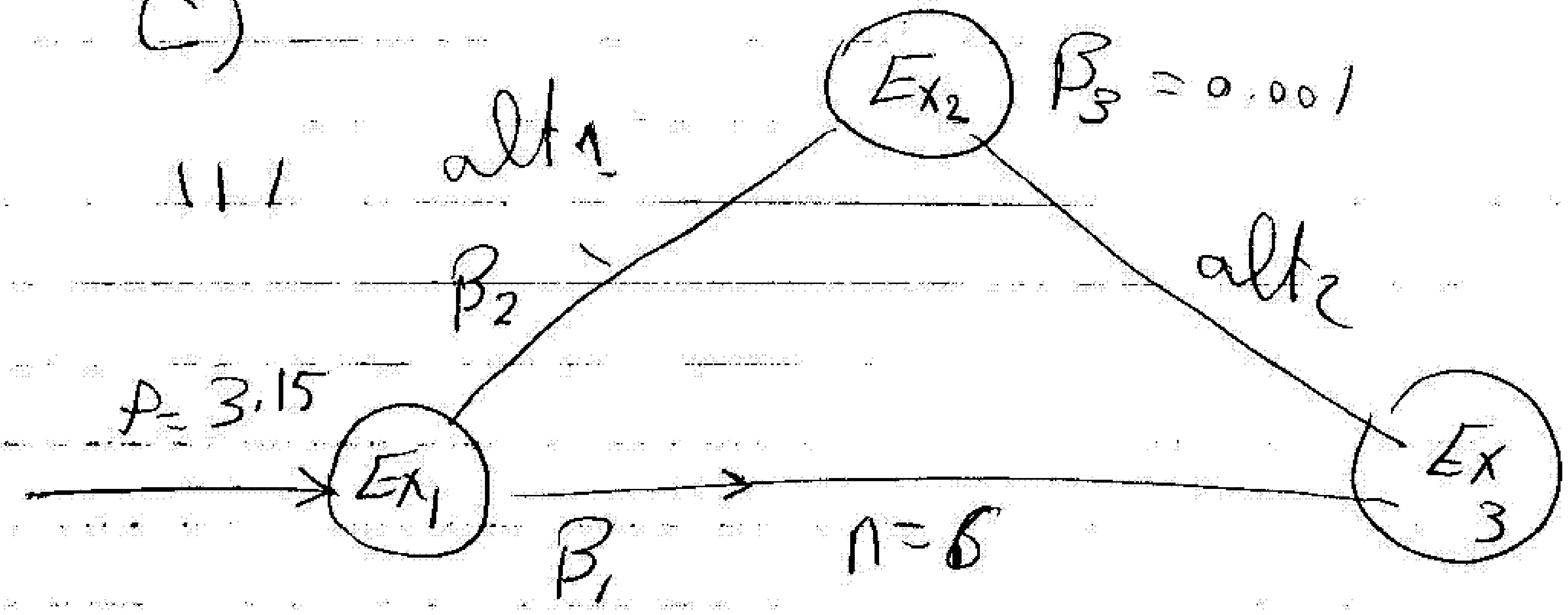
$\therefore \beta = 0.02$

$\rho \simeq = 27,77\ E$

$\therefore n \simeq = 21,29$ Circuits

c)

ii) alt 1



$\therefore \rho_{c_1} = \rho(1-\beta_1)$

$\therefore \rho_c|_{alt} = \rho\beta_1(1-\beta_2)$

at $n = 6 \Rightarrow \beta_1 \simeq 0.002$

$$\rho_c|_{alt} = 6.26 \times 10^{-3} \text{ Erl.}$$

iii) $\because \beta = 0.005$ and $\rho = 6.26 \times 10^{-3}$

$\therefore$ from table :

$\therefore n \simeq 8.25$

iiii) $\because \rho_{c_1} = \rho(1-\beta_1)$

$$\rho_c\Big|_{alt\,1} = \rho\beta_1(1-\beta_2)$$

$$\rho_c\Big|_{alt_2} = \rho_c\Big|_{alt_1}(1-\beta_3)$$

~~$\rho_{c_2} = \rho_\beta$~~

$$\rho_{c_2} = \rho\beta_2(1-\beta_2)(1-\beta_3)$$

$$\therefore \rho_c\Big|_{overall} = \rho(1-\beta_1+\beta_1(1-\beta_2)(1-\beta_3))$$

$\therefore$ at $n=6$, $\beta_2 = 0.005$

$$\therefore \rho_c\Big|_{overall} = 3.26 \text{ Erl.}$$