KOLEJ UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF APPLIED SCIENCES AND COMPUTING

ACADEMIC YEAR 2014/2015

JANUARY EXAMINATION

MICROELECTRONICS AAMP5044(A)
TELECOMMUNICATIONS AND NETWORKS

TUESDAY, 13 JANUARY 2015 TIME: 9.00 AM - 11.00 AM (2 HOURS)

ADVANCED DIPLOMA IN SCIENCE
(MICROELECTRONICS AND PHYSICS AND MICROELECTRONICS WITH COMPUTER COMMUNICATIONS)

Instructions to Candidates:

Answer **ANY 4** questions. All questions carry equal marks.

AAMP5044(A) TELECOMMUNICATIONS AND NETWORKS

Q1. (a) A single side-band suppressed carrier (SSBSC) signal carries a message signal $cos2\pi f_m t$. Write an equation of the modulated carrier signal. Design a block diagram of a modulator using phase shift method. Draw a block diagram of a demodulator to show coherent detection of SSBSC signal. Show that the demodulator you have drawn is able to demodulate the SSBSC signal. (10 marks)

(b) An amplitude modulated carrier is represented by

$$s(t) = [1 + 0.5cos2\pi(1000)t]cos2\pi(10^6)t$$

It is applied to the input of a non-linear device having a characteristic

$$v_{out} = 2v_{in}^2$$

(i) Identify the frequency components at the output of the device. (11 marks)

(ii) What process(s) has to be carried out to extract the message signal? (4 marks)

The following equation is given:

$$2cosAcosB = \cos(A + B) + \cos(A - B)$$

[Total: 25 marks]

Q2. A single tone signal, $m(t) = cos2\pi(1000)t$ frequency modulates a carrier, $c(t) = cos2\pi(10^6)t$. The frequency deviation constant k_f of the modulator is $3x10^3$ Hz/V.

(a) Write a mathematical expression that represents the frequency modulated (FM) signal. (3 marks)

(b) What is the maximum frequency deviation of the modulated signal? (2 marks)

(c) What is the modulation index? (2 marks)

(d) Determine the bandwidth of the modulated signal, using Carson's rule. Identify the frequency components within the calculated bandwidth. (6 marks)

(e) Determine the frequency deviation, modulation index and bandwidth of the FM signal if the amplitude of the message signal was increased to 2 V. (6 marks)

(f) Suggest a method to increase the carrier frequency to 2 MHz from the FM signal expressed in part (a). Show mathematically that your suggestion can generate the required FM signal. (6 marks)

[Total: 25 marks]

Q3. (a) State Shannon-Hartley theorem. (4 marks)

(b) Show that the channel capacity is finite for infinite bandwidth and fixed signal power. Given

$$\lim_{n\to 0}(1+n)^{\frac{1}{n}} = e$$

(7 marks)

(c) A digital communication system is required to work with a bandwidth efficiency of 8 bits/s/Hz. What is the minimum ratio $\frac{E_b}{N_o}$ required for error free communication?

(8 marks)

(d) The probability of bit error , P_b , for QPSK is given by $P_b = Q\left(\sqrt{2\frac{E_b}{N_o}}\right)$. Determine the bit error rate if the $\frac{E_b}{N_o}$ ratio was 10 dB. (6 marks)

[Total: 25 marks]

Q4. (a) Define noise figure of a system. (3 marks)

(b) Show that the overall noise figure of two sub-systems cascaded together is given by

$$F = F_1 + \frac{(F_2 - 1)}{G_1}$$

where the symbols have their usual meanings. (10 marks)

(c) A receiving system consists of a preamplifier connected through a length of cable to a main receiver. The noise figure of the preamplifier is 6 dB, while the corresponding value of the receiver is 3 dB. The attenuation of the cable is 10 dB.

(i) Calculate the minimum gain required in the preamplifier if the overall noise figure of the system is not to exceed 9 dB. (8 marks)

(ii) What is the reduction of the overall noise figure if the receiver was noise free? (4 marks)

[Total: 25 marks]

Q5. (a) Define figure of merit of an earth station. (3 marks)

(b) Information of a satellite communication system is given below.

Satellite --- Earth station downlink	
Downlink frequency	11.95GHz
RF bandwidth	36 MHz
Earth station, G/T	38 dBK-1
EIRP of satellite	30 dBW
Downlink range	40,000km
Earth station --- Satellite uplink	
Uplink frequency	14.25GHz
RF bandwidth	36 MHz
EIRP of earth station	80 dBW
Satellite receiving system noise temperature	160 K
Diameter of satellite antenna	5m
Antenna aperture effieciency	0.60
Uplink range	40,000km
Boltzman constant, k	-228.6 dBW/Hz/K
Speed of light, c	3×10^8 ms^{-1}

Calculate

(i) the satellite receive antenna gain in dB. (5 marks)

(ii) the uplink carrier to noise ratio in dB. (7 marks)

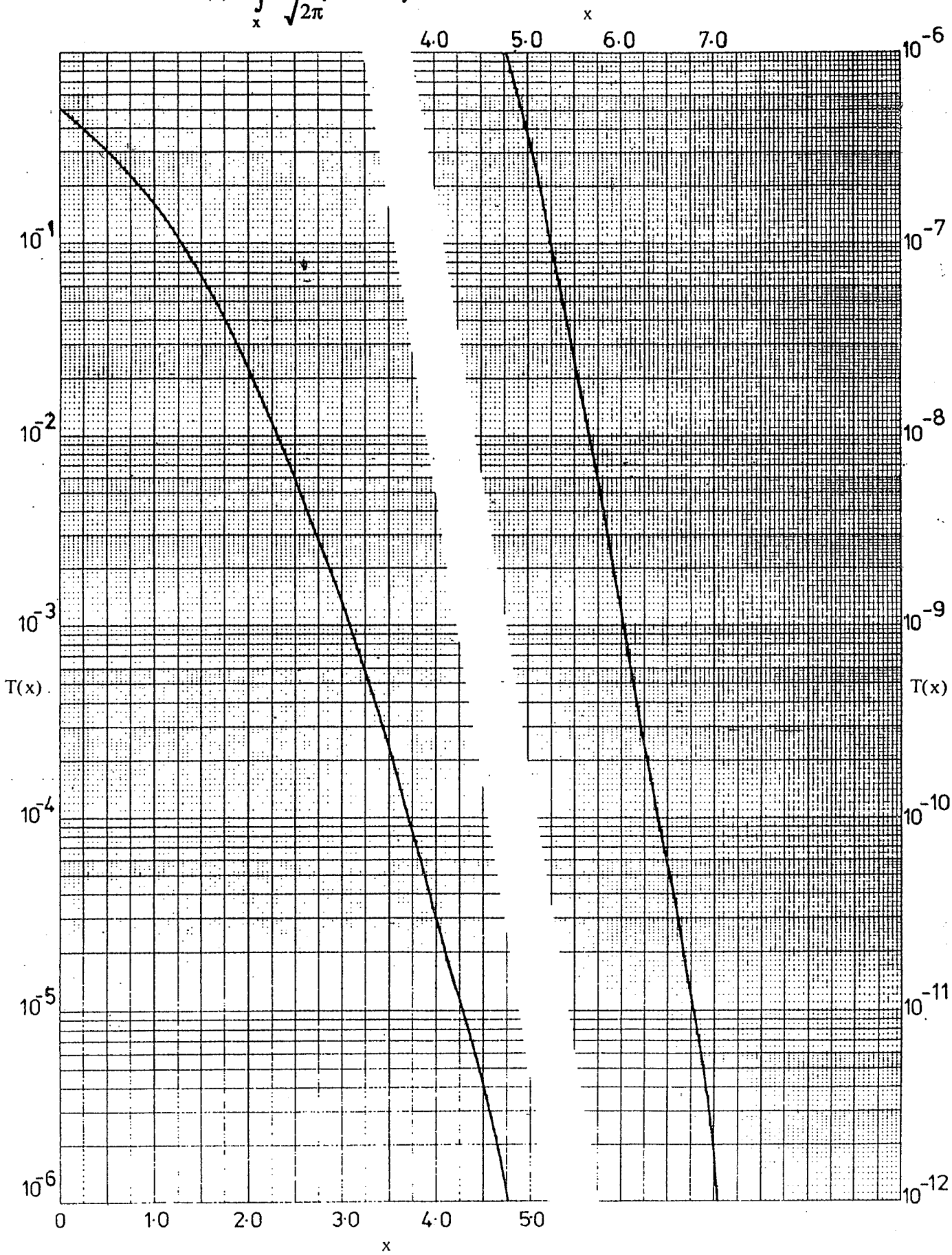
(iii) the downlink carrier to noise ratio in dB. (7 marks)

(iv) the overall carrier to noise ratio in dB. (3 marks)

[Total: 25 marks]

The graph below shows the function T(x), being the tail area from x to ∞ of the gaussian probability density function N(0, 1) with mean zero and variance 1, i.e.

$$T(x) = \int_x^\infty \frac{1}{\sqrt{2\pi}} e^{-y^2/2}\, dy$$



For $x > 6.5$, $T(x)$ may be approximated by $T(x) \approx \frac{1}{\sqrt{2\pi}\, x} e^{-x^2/2}$