UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
MAIN EXAMINATION 2009

TITLE OF PAPER : COMMUNICATION SYSTEMS

COURSE NUMBER : E410

TIME ALLOWED : THREE HOURS

INSTRUCTIONS : READ EACH QUESTION CAREFULLY ANSWER ANY **FOUR** OUT OF **FIVE** QUESTIONS. EACH QUESTION CARRIES **25 MARKS**. MARKS FOR EACH SECTION ARE SHOWN ON THE RIGHT-HAND MARGIN.

THIS PAPER HAS 6 PAGES INCLUDING THIS PAGE.

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QUESTION 1

(a) A Telecommunication receiver has a 4 - dB noise figure, a noise bandwidth of 500 kHz and an input resistance of 50 kΩ. What rms signal input will yield an output signal - to - noise ratio (S/N) of unity, when the amplifier is connected to a 50 Ω input at 290 K?

(11 marks)

(b) Using appropriate approximations, derive a circuit for implementing narrow band phase modulation.
Present a well labelled block diagram explaining its operation.

(8 marks)

(c) (i) What are the possible causes of intersymbol interference(ISI)?

(3 marks)

(ii) Explain how ISI may be reduced. (3 marks)

QUESTION 2

(a) A 4 - Vpk audio signal is to be transmitted at 32 kbps using Pulse Code Modulation.

(i) If the quantization error is to be kept at 0.25 V, determine the bandwidth of the audio signal.

(10 marks)

(ii) How can the quantization be modified to ensure that a signal - to - quantization error greater than 60 dB is achieved at the output?

(9 marks)

(b) (i) Sketch a simple radio receiver using the minimum required number of components, explaining its operation.

(5 marks)

(ii) Explain one of its weaknesses.

(1 marks)

QUESTION 3

(a) What type of modulation scheme is used for the video signal in television transmission and why?

(5 marks)

(b) (i) A commercial standard AM radio broadcast channel has a local oscillator working above the RF signal. The image frequency is located at 1510 kHz. Given that the total quality factor of the system, Qt = 50, compute the attenuation of the image frequency signal in decibels.

(9 marks)

(ii) Explain why the standard intermediate frequency for FM broadcast is chosen as 10.7 MHz. Show supporting calculations.

(6 marks)

(c) Show how a synchronous detector can be used to detect the modulating signal from a single sideband suppressed carrier signal.

(5 marks)

QUESTION 4

(a) Consider a multistage amplifier with power gains G1, G2, G3 and stage noise factors N1, N2, N3, respectively. Derive an expression for the overall noise figure of the system.

(7 marks)

(b) An FM signal with a carrier frequency of 100.3 MHz, a modulating frequency of 15 kHz, and a modulation index of 2.5 is to be verified using a spectrum analyzer.

(i) predict the frequency spectrum of the signal, showing the relative amplitudes and frequencies of each component.

(9 marks)

(ii) Compute the frequency deviation Δf. (2 marks)

(iii) Compare the power in the 1st sideband with that in the 3rd sideband.

(5 marks)

(c) Explain why Single Sideband transmission is commonly used for multichannel line telephony. (2 marks)

QUESTION 5

(a) (i) How does slope overload condition occur? (2 marks)

(ii) Derive an expression for the peak message signal amplitude at which slope overload will occur. (4 marks)

(iii) Give the corresponding sampling frequency. (1 mark)

(b) The AM detector of Figure 5.0 has an input impedance of 1 kΩ and R = 2 kΩ. The values of R and C at the detector output are chosen to give a time constant of 16 μs and optimize the demodulation process. The highest frequency in the modulating signal is 5 kHz.

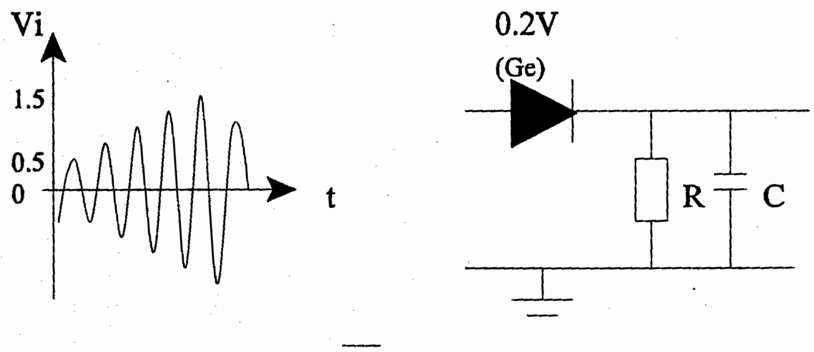

Figure 5.0

Compute

(i) the total power delivered to the detector circuit; (10 marks)

(ii) the maximum and minimum output voltages; (2 marks)

(iii) the average current and (3 marks)

(iv) the highest frequency in the modulating signal. (3 marks)

USEFUL INFORMATION

Cos (A ± B) = Cos A Cos B ∓ Sin A Sin B

Sin (A ± B) = Sin A Cos B ± Cos A Sin B.

Sin A Sin B = ½ [Cos (A - B) - Cos (A + B)]

Cos A Cos B = ½ [Cos (A + B) + Cos (A - B)]

Sin A Cos B = ½ [Sin (A + B) + Sin (A - B)]

Boltzmann constant k = 1.38 x 10^{-23} J/K

$$m(t) = V_m Sin\omega_m t$$

PM signal, $V_{PM}(t) = V_c Sin[\omega_c t + \beta p \; Sin\omega_m t]$

FM signal, $V_{FM}(t) = V_c \; Sin[\omega_c t - M_f \; Cos\omega_m t]$

$$\int Sinax \; dx = -\frac{1}{a} Cosax \qquad \int Cosax \; dx = \frac{1}{a} Sinax$$

TABLE A

Bessel functions of the first kind

m	$J_0(m)$	$J_1(m)$	$J_2(m)$	$J_3(m)$	$J_4(m)$	$J_5(m)$	$J_6(m)$	$J_7(m)$	$J_8(m)$	$J_9(m)$	$J_{10}(m)$
0.0	1.000	——	——	——	——	——	——	——	——	——	——
0.2	0.990	0.099	0.005	——	——	——	——	——	——	——	——
0.4	0.960	0.196	0.019	0.001	——	——	——	——	——	——	——
0.6	0.912	0.286	0.043	0.004	——	——	——	——	——	——	——
0.8	0.846	0.368	0.075	0.010	0.001	——	——	——	——	——	——
1.0	0.765	0.440	0.114	0.019	0.002	——	——	——	——	——	——
2.0	0.223	0.576	0.352	0.128	0.034	0.007	0.001	——	——	——	——
3.0	-0.260	0.339	0.486	0.309	0.132	0.043	0.011	0.002	——	——	——
4.0	-0.397	-0.066	0.364	0.430	0.281	0.132	0.049	0.015	0.004	——	——
5.0	-0.177	-0.327	0.046	0.364	0.391	0.261	0.131	0.053	0.018	0.005	0.001
6.0	0.150	-0.276	-0.242	0.114	0.357	0.362	0.245	0.129	0.056	0.021	0.006
7.0	0.300	-0.004	-0.301	-0.167	0.157	0.347	0.339	0.233	0.128	0.058	0.023
8.0	0.171	0.234	-0.113	-0.291	-0.105	0.185	0.337	0.320	0.223	0.126	0.060
9.0	-0.090	0.245	0.144	-0.180	-0.265	-0.055	0.204	0.327	0.305	0.214	0.124
10.0	-0.245	0.045	0.254	0.058	-0.219	-0.234	-0.014	0.216	0.317	0.291	0.207