Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2011-12 (2.0 hours)

EEE206 Communication Systems

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

1. **a.** Explain why modulation is used in communication systems **(4)**

b. Explain why the equation below describes an AM DSB signal

$$V_{AM} = V_c\big(1 + m sin(\omega_m t)\big) sin(\omega_c t)$$ **(2)**

c. Draw a circuit that will generate an AM DSB signal and explain the operation of each element. **(4)**

d. A carrier of 3 V r.m.s. and frequency 2 MHz is added to a modulating signal of 2 V r.m.s. and frequency 3 kHz. The composite signal is applied to a biased diode rectifier in which the relationship between current and voltage is $i = (2 + v + 0.1\ v^2)$ μA, where v is the instantaneous voltage.

Calculate the modulation index of the resulting AM DSB signal?

What frequencies are present in the circuit? **(6)**

e. A second message signal is added to the AM DSB signal. If the modulation index of the second signal is 0.3 calculate the total modulation index. **(4)**

2. **a.** Describe three differences between amplitude and frequency modulation **(3)**

b. Describe, with the aid of diagrams, how a frequency modulated signal can be demodulated with the use of a limiter circuit followed by a Foster-Seeley discriminator. **(7)**

c. An FM signal, given below, is transmitted using an antenna with an input resistance of 50Ω.

Calculate the following

- The total average power transmitted
- The average transmitted power at the carrier frequency
- The average transmitted power in the 1st side bands
- The average transmitted power in the 2nd side bands

- The bandwidth of the signal according to Carson's rule

$$V_{FM} = 100\sin\left(628 * 10^6 t + 3.7\sin(127 * 10^3 t)\right) \text{ Volts}$$

Note: The required Bessel functions are given at the end of the paper.

(10)

3. **a.** Explain, with the use of diagrams, how to generate a PPM signal from a PAM signal. **(10)**

b. A High Definition Television (HDTV - 1080p) signal is required to be continually streamed via an internet connection.

Calculate the bit rate of the signal.

Calculate the minimum bandwidth required to transmit the signal.

HDTV specifications

- Frame resolution = 1920*1080
- Pixels represented by red, blue and green information using 10 bits for each colour.
- Frame rate = 24Hz
- S/N = 30dB

Note : log2(x) = log10(x)/log10(2)

(6)

c. Could this signal be streamed using standard internet download rates? What methods could be used to reduce the high bit rates for HDTV internet streaming? **(4)**

4. **a.** Explain, with the aid of diagrams, the operation of a superhet receiver with Automatic Gain Control. Explain the operation of the mixer. **(7)**

b. A receiver, of the double superhet type, receives signals from a mobile phone Base Transceiver Station (BTS) at 950MHz. The receiver first and second IFs are 70 MHz and 10 MHz, respectively. The first local oscillator operates above the signal frequency and the second operates below the first IF. Determine all possible image frequencies.
What other signal frequencies received will cause 2^{nd} IF image problems? **(7)**

c. The receiver antenna from part b. is connected to the first mixer via a tuned circuit whose loaded Q factor is 30. What is the image frequency rejection ratio for all the possible image frequencies in part b.?

(6)

TABLE OF BESSEL FUNCTIONS

x	$J_0(x)$	$J_1(x)$	$J_2(x)$
0.0	1.000	0.000	0.000
0.1	0.998	0.050	0.001
0.2	0.990	0.100	0.005
0.3	0.978	0.148	0.011
0.4	0.960	0.196	0.020
0.5	0.938	0.242	0.031
0.6	0.912	0.287	0.044
0.7	0.881	0.329	0.059
0.8	0.846	0.369	0.076
0.9	0.808	0.406	0.095
1.0	0.765	0.440	0.115
1.1	0.720	0.471	0.137
1.2	0.671	0.498	0.159
1.3	0.620	0.522	0.183
1.4	0.567	0.542	0.207
1.5	0.512	0.558	0.232
1.6	0.455	0.570	0.257
1.7	0.398	0.578	0.282
1.8	0.340	0.582	0.306
1.9	0.282	0.581	0.330
2.0	0.224	0.577	0.353
2.1	0.167	0.568	0.375
2.2	0.110	0.556	0.395
2.3	0.056	0.540	0.414
2.4	0.003	0.520	0.431
2.5	-0.048	0.497	0.446
2.6	-0.097	0.471	0.459
2.7	-0.142	0.442	0.470
2.8	-0.185	0.410	0.478
2.9	-0.224	0.375	0.483

x	$J_0(x)$	$J_1(x)$	$J_2(x)$
3.0	-0.260	0.339	0.486
3.1	-0.292	0.300	0.486
3.2	-0.320	0.261	0.484
3.3	-0.344	0.221	0.478
3.4	-0.364	0.180	0.470
3.5	-0.380	0.137	0.459
3.6	-0.392	0.095	0.445
3.7	-0.399	0.054	0.428
3.8	-0.403	0.013	0.409
3.9	-0.402	-0.027	0.388
4.0	-0.397	-0.066	0.364
4.1	-0.389	-0.103	0.338
4.2	-0.377	-0.139	0.315
4.3	-0.361	-0.172	0.281
4.4	-0.342	-0.203	0.250
4.5	-0.321	-0.231	0.218
4.6	-0.296	-0.257	0.185
4.7	-0.269	-0.279	0.151
4.8	-0.240	-0.298	0.116
4.9	-0.210	-0.315	0.081
5.0	-0.178	-0.328	0.047
5.1	-0.144	-0.337	0.012
5.2	-0.110	-0.343	-0.022
5.3	-0.076	-0.346	-0.055
5.4	-0.041	-0.345	-0.087
5.5	-0.007	-0.341	-0.117
5.6	0.027	-0.334	-0.146
5.7	0.060	-0.324	-0.174
5.8	0.092	-0.311	-0.199
5.9	0.122	-0.295	-0.222

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