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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	ELECTRONIC COMMUNICATION SYSTEMS
COURSE CODE	:	BEB 31803
PROGRAMME	:	3 BEJ / 3 BEV
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

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Q1 (a) Classify whether the following communication systems are simplex, half-duplex or duplex system. Justify your answer.

(i) Walkie-talkie
(ii) Land-line telephone
(iii) Baby monitors
(iv) Citizen's Band (CB) radio
(v) Satellite TV Direct Broadcasting

(5 marks)

(b) A Category 3 (Cat. 3) unshielded twisted pair (UTP) is an example of commonly used cable in telephone system. It has bandwidth of 16 MHz which allows for multiplexing of high number of voice channels.

(i) Using relevant diagram, discuss a suitable multiplexing technique for transmitting voice channels over the cable.
(ii) If each channel occupies 4 kHz of bandwidth, calculate the theoretical number of channels the cable is capable of carrying.
(iii) Describe **TWO (2)** types of signal degradation that is prevalent when using this type of cable for transmitting voice channel.

(5 marks)

(c) A log amplifier is specified as having a noise figure of 4 dB. For an input signal of 70 μW, the amplifier produces an output power of 25 mW. If the noise out of the amplifier is measured to be 1.5 mW, calculate the following:

(i) The power gain, A_p.
(i) The power gain in decibels, A_p [dB].
(ii) The noise factor, F.
(iii) The input noise to the log amplifier, N_i.
(iv) The noise contributed by the log amplifier, N_A.

(10 marks)

Q2 (a) A conventional amplitude modulation (AM) transmitter has maximum output power of 24 kW when modulated to a depth of 100%. The modulator however is set to modulate the carrier signal to a depth of 75%. The carrier component of the modulator is reduced by 26 dB and one of the sideband is suppressed.

(i) Calculate the power contained in the carrier and each sideband if conventional AM is used.

(3 marks)

(ii) Evaluate the system efficiency in term of the percentage of power saved at this modulation depth with the carrier power reduced and one of the sideband is suppressed as compared to a conventional AM technique.

(9 marks)

(b) A superhyterodyne transmitter/ receiver is an example of a system often used in amplitude modulation. In this system, the information signal modulates a subcarrier frequency known as the intermediate frequency (IF) before being upconverted to the radio frequency (RF) for transmission.

(i) Sketch the block diagram of a basic superheterodyne amplitude modulation (AM) receiver.

(2 marks)

(ii) If the IF and the RF are 455 kHz and 1055 kHz respectively, determine the local oscillator frequency f_{Lo} if high side injection is used in the mixer.

(2 marks)

(iii) Identify the image frequency of the receiver.

(2 marks)

(iv) Suggest a method to prevent the image frequency from distorting the AM signal.

(2 marks)

Q3 (a) Compare the effect of noise on a signal modulated using frequency modulation (FM) and amplitude modulation (AM).

(4 marks)

(b) A FM modulator with deviation sensitivity, $k_f = 1000$ Hz/V, is used to modulate a carrier $v_c(t) = 8\cos(2\pi 10 \times 10^6 t)$ with a signal $v_m(t) = 4\cos(2\pi 4000 t)$. This signal is then applied to a 50-Ω antenna for transmission. Determine;

(i) Modulating frequency, f_m

(1 mark)

(ii) Modulation index, β_f.

(2 marks)

(iii) Power at the output of the modulator for the largest and smallest sidebands predicted by Bessel function table.

(4 marks)

(iv) Total power at the output of the modulator using the Bessel function table.

(2 marks)

(v) Compare the total power from your calculation in Q3(b)(vi) with total power calculated directly using the carrier signal amplitude. Give reason if there is any difference.

(3 marks)

(c) Commercial FM radio remains one of the most popular application of frequency modulation. Describe the FM radio in terms of its frequency assignment, channel bandwidth, maximum deviation and highest audio frequency.

(4 marks)

Q4 (a) Public Switched Telephone Network (PSTN) uses Quadrature Amplitude Modulation (QAM) modulation scheme in transmitting data over band limited channels. Justify the choice of QAM modulation based on its strengths and weaknesses for this type of communication.

(6 marks)

(b) The analogue signal in Figure **Q4(b)** is sampled at a rate that is 12.5% higher than the minimum sampling frequency of the Nyquist rate. The bit rate of this pulse code modulation (PCM) transmission is fixed at 54 kbps.

(i) Determine the quantization level.

(4 marks)

(ii) Based on the quantization level that you state in part (i), write down the corresponding voltage for each quantization level if uniform quantization is used and maximum and minimum quantization levels are +6V and -4V respectively.

(4 marks)

(iii) Calculate the bandwidth of the PCM encoded signal if a $\text{sinc}\,(x)$ shape pulse is used to generate the waveform.

(2 marks)

(iv) The conversion from analog signal to digital signal produces what is known as quantization noise. Describe what is quantization noise and suggest a technique to reduce the quantization noise.

(4 marks)

Q5 (a) A transmission line (cable) terminated with a load impedance that is not equal to the characteristic impedance of the cable will produce standing waves.

(i) Describe the term characteristic impedance.

(2 marks)

(ii) If the end of the cable is left open, analyse the formation of the standing waves on the cable.

(3 marks)

(iii) List **TWO (2)** effects of having an unmatched transmission line.

(2 marks)

(b) An antenna with impedance 100 + j150 Ω is to be matched to a 75Ω lossless line with a quarter wavelength transformer. Analyse the following by using only Smith chart:

(i) The voltage standing wave ratio, VSWR.

(3 marks)

(ii) The reflection coefficient, Γ.

(2 marks)

(iii) The location of the first V_{max} and V_{min} with respect to the load.

(2 marks)

(iv) Z_{in} at the generator if the line is 0.9λ long.

(3 marks)

(v) The characteristic impedance and the distance between the transformer and the antenna.

(3 marks)

Q6 (a) An isotropic antenna is an ideal antenna often used as the reference antenna in the study of antenna.

(i) Describe the meaning of an isotropic radiator using suitable diagram.
(ii) If the isotropic antenna is fed with 1 W of power, calculate the power density 50 meters away from the radiator.

(4 marks)

(b) A half wavelength dipole is designed to operate at 300 MHz.

(i) Determine the length of the dipole.
(ii) Find the far-field distance of the antenna.
(iii) Suggest ways of improving the gain of the half-wavelength dipole.

(6 marks)

(b) MEASAT-III is an example of Digital Video Broadcasting (DVB) satellite that provides regional television coverage for people living in South East Asia. The satellite is located approximately 36,000 km away from an Earth's based receiver is able to provide continuous satellite coverage due to its position in the geosynchronous orbit.

(i) Discuss the term geosynchronous orbit and its advantage in global satellite coverage.
(ii) Approximate the free space loss between the satellite and the receiver if the downlink frequency is set at 11.4 GHz.
(iii) Given the input to the satellite's antenna is 30dBW, transmitting and receiving antenna gain are 20dB and 15dB respectively, calculate the power at the output of the receiving antenna.
(iv) The South East Asia region is associated with heavy rainfall. Discuss the effect of rain on the communication link between the satellite and receiver.

(10 marks)

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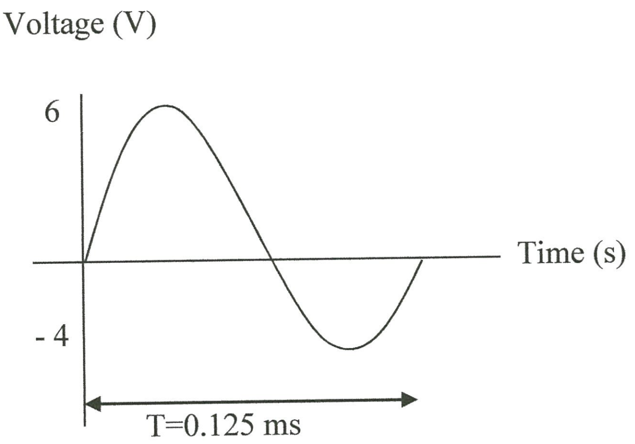

FIGURE Q4 (b)

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Table of Bessel Function

β	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta)$	$J_0(\beta))$
0.0	1	–	–	–	–	–	–	–	–	–	–
0.1	0.9975	0.0499	0.0012	–	–	–	–	–	–	–	–
0.2	0.9900	0.0995	0.0050	0.0002	–	–	–	–	–	–	–
0.3	0.9776	0.1483	0.0112	0.0006	–	–	–	–	–	–	–
0.4	0.9604	0.1960	0.0197	0.0013	0.0001	–	–	–	–	–	–
0.5	0.9385	0.2423	0.0306	0.0026	0.0002	–	–	–	–	–	–
0.6	0.9120	0.2867	0.0437	0.0044	0.0003	–	–	–	–	–	–
0.7	0.8812	0.3290	0.0588	0.0069	0.0006	–	–	–	–	–	–
0.8	0.8463	0.3688	0.0758	0.0102	0.0010	0.0001	–	–	–	–	–
0.9	0.8075	0.4059	0.0946	0.0144	0.0016	0.0001	–	–	–	–	–
1.0	0.7652	0.4401	0.1149	0.0196	0.0025	0.0002	–	–	–	–	–
1.1	0.7196	0.4709	0.1366	0.0257	0.0036	0.0004	–	–	–	–	–
1.2	0.6711	0.4983	0.1593	0.0329	0.0050	0.0006	–	–	–	–	–
1.3	0.6201	0.5220	0.1830	0.0411	0.0068	0.0009	0.0001	–	–	–	–
1.4	0.5669	0.5419	0.2074	0.0505	0.0091	0.0013	0.0002	–	–	–	–
1.5	0.5118	0.5579	0.2321	0.0610	0.0118	0.0018	0.0002	–	–	–	–
1.6	0.4554	0.5699	0.2570	0.0725	0.0150	0.0025	0.0003	–	–	–	–
1.7	0.3980	0.5778	0.2817	0.0851	0.0188	0.0033	0.0005	0.0001	–	–	–
1.8	0.3400	0.5815	0.3061	0.0988	0.0232	0.0043	0.0007	0.0001	–	–	–
1.9	0.2818	0.5812	0.3299	0.1134	0.0283	0.0055	0.0009	0.0001	–	–	–
2.0	0.2239	0.5767	0.3528	0.1289	0.0340	0.0070	0.0012	0.0002	–	–	–
2.1	0.1666	0.5683	0.3746	0.1453	0.0405	0.0088	0.0016	0.0002	–	–	–
2.2	0.1104	0.5560	0.3951	0.1623	0.0476	0.0109	0.0021	0.0003	–	–	–
2.3	0.0555	0.5399	0.4139	0.1800	0.0556	0.0134	0.0027	0.0004	–	–	–
2.4	0.0025	0.5202	0.4310	0.1981	0.0643	0.0162	0.0034	0.0006	0.0001	–	–
2.5	-0.0484	0.4971	0.4461	0.2166	0.0738	0.0195	0.0042	0.0008	0.0001	–	–
2.6	-0.0968	0.4708	0.4590	0.2353	0.0840	0.0232	0.0052	0.0010	0.0002	–	–
2.7	-0.1424	0.4416	0.4696	0.2540	0.0950	0.0274	0.0065	0.0013	0.0002	–	–
2.8	-0.1850	0.4097	0.4777	0.2727	0.1067	0.0321	0.0079	0.0016	0.0003	–	–
2.9	-0.2243	0.3754	0.4832	0.2911	0.1190	0.0373	0.0095	0.0020	0.0004	0.0001	–
3.0	-0.2601	0.3391	0.4861	0.3091	0.1320	0.0430	0.0114	0.0025	0.0005	0.0001	–
3.1	-0.2921	0.3009	0.4862	0.3264	0.1456	0.0493	0.0136	0.0031	0.0006	0.0001	–
3.2	-0.3202	0.2613	0.4835	0.3431	0.1597	0.0562	0.0160	0.0038	0.0008	0.0001	–
3.3	-0.3443	0.2207	0.4780	0.3588	0.1743	0.0637	0.0188	0.0047	0.0010	0.0002	–
3.4	-0.3643	0.1792	0.4697	0.3734	0.1892	0.0718	0.0219	0.0056	0.0012	0.0002	–
3.5	-0.3801	0.1374	0.4586	0.3868	0.2044	0.0804	0.0254	0.0067	0.0015	0.0003	0.0001
3.6	-0.3918	0.0955	0.4448	0.3988	0.2198	0.0897	0.0293	0.008	0.0019	0.0004	0.0001
3.7	-0.3992	0.0538	0.4283	0.4092	0.2353	0.0995	0.0336	0.0095	0.0023	0.0005	0.0001
3.8	-0.4026	0.0128	0.4093	0.4180	0.2507	0.1098	0.0383	0.0112	0.0028	0.0006	0.0001
3.9	-0.4018	-0.0272	0.3879	0.4250	0.2661	0.1207	0.0435	0.0130	0.0034	0.0008	0.0002
4.0	-0.3971	-0.0660	0.3641	0.4302	0.2811	0.1321	0.0491	0.0152	0.0040	0.0009	0.0002
4.1	-0.3887	-0.1033	0.3383	0.4333	0.2958	0.1439	0.0552	0.0176	0.0048	0.0011	0.0002
4.2	-0.3766	-0.1386	0.3105	0.4344	0.3100	0.1561	0.0617	0.0202	0.0057	0.0014	0.0003
4.3	-0.3610	-0.1719	0.2811	0.4333	0.3236	0.1687	0.0688	0.0232	0.0067	0.0017	0.0004
4.4	-0.3423	-0.2028	0.2501	0.4301	0.3365	0.1816	0.0763	0.0264	0.0078	0.0020	0.0005
4.5	-0.3205	-0.2311	0.2178	0.4247	0.3484	0.1947	0.0843	0.0300	0.0091	0.0024	0.0006
4.6	-0.2961	-0.2566	0.1846	0.4171	0.3594	0.208	0.0927	0.0340	0.0106	0.0029	0.0007
4.7	-0.2693	-0.2791	0.1506	0.4072	0.3693	0.2214	0.1017	0.0382	0.0122	0.0034	0.0008
4.8	-0.2404	-0.2985	0.1161	0.3952	0.3780	0.2347	0.1111	0.0429	0.0141	0.0040	0.0010
4.9	-0.2097	-0.3147	0.0813	0.3811	0.3853	0.2480	0.1209	0.0479	0.0161	0.0047	0.0012
5.0	-0.1776	-0.3276	0.0466	0.3648	0.3912	0.2611	0.1310	0.0534	0.0184	0.0055	0.0015

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The Complete Smith Chart