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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSENAME	:	ELECTRONIC COMMUNICATION SYSTEM
COURSE CODE	:	BEB 31803
PROGRAMME	:	BEJ / BEV
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	SECTION A: ANSWER **ALL** QUESTIONS. SECTION B: ANSWER **THREE (3)** QUESTIONS ONLY.

THIS QUESTION PAPER CONSISTS OF **SIXTEEN (16)** PAGES

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SECTION A: ANSWER ALL QUESTIONS (40 MARKS)

Q1 (a) Differentiate between a positive and a negative decibel.

(4 marks)

(b) A three-stage system comprises of two amplifiers and one filter. The measured input power is $P_{in} = 0.1mW$. The absolute power gains are $A_{P_1} = 100$, $A_{P_2} = 40$ and $A_{P_3} = 0.25$. Determine:

(i) the input power in dBm,

(1 mark)

(ii) the output power in Watts and dBm,

(2 marks)

(iii) the dB gain of each of the three stages, and

(2 marks)

(iv) the overall gain in dB.

(1 mark)

Q2 (a) Basic communication systems consist of **THREE (3)** components; transmitters, channels and receivers. Draw the block diagram to illustrate the relationship between the components and describe them in relation to the information signals.

(4 marks)

(b) Consider a satellite receiver system which consists of an antenna, preamplifier and amplifier as shown in the **Figure Q2(b)**. The signal transmission bandwidth is set to 10 MHz. Determine:

(i) the total noise power at the output,

(2 marks)

(ii) the total noise figure of the system, and

(2 marks)

(iii) the input signal-to-noise ratio.

(2 marks)

Q3 (a) Criticise the fact that transmission amplitude modulation (AM) double side band full carrier (DSB-FC) signal is not efficient in term of power although it's simplicity.

(2 marks)

(b) For the AM envelope shown in **Figure Q3(b)**, determine:

(i) the modulation coefficient, and

(1 mark)

(ii) calculate the peak voltage of the modulating signal and peak voltage of the unmodulated carrier.

(2 marks)

(c) Angle Modulation is a class of modulation process that is widely used for analog signal transmission over the RF channel. It can divided into Frequency Modulation (FM) and Phase Modulation (PM).

(i) Define the term Frequency Modulation (FM).

(2 marks)

(ii) Specify **ONE (1)** difference between Indirect-FM and Direct-FM.

(2 marks)

(iii) Name **ONE (1)** Direct-FM modulator type that is commonly used to generate FM signal.

(1 marks)

Q4 (a) A compact disc (CD) records audio signal digitally by using pulse code modulation (PCM). Assume the audio signal bandwidth to be 15 kHz.

(i) Calculate the Nyquist rate.

(1 mark)

(ii) If the Nyquist samples are quantized into $L = 65{,}536$ levels and then binary coded, determine the number of binary digits required to encode a sample.

(1 mark)

(iii) Calculate the number of binary digits per second (bit/s) required to encode the audio signal.

(1 mark)

(iv) For practical reasons, signals are sampled at a rate well above the Nyquist rate. Practical CDs use 44,100 samples per second. If $L = 65{,}536$, determine the number of bits per second required to encode the signal.

(1 mark)

(b) List down **TWO (2)** types of antenna that commercially used for television broadcasting signals.

(2 marks)

(c) In a transmission system, the output of the final high-power amplifier is 500 W, and the line feeding its antenna has an attenuation of 20%. If the gain of the transmitting antenna is 60 dB, find the equivalent isotropic radiated power (EIRP) in dBW.

(4 marks)

SECTION B: ANSWER THREE (3) QUESTIONS ONLY (60 MARKS)

Q5 (a) Noise measurements involve with root mean square (RMS) and average values. Differentiate between RMS and average noise.

(4 marks)

(b) Consider a series of 10 noise values measured with a voltmeter as -0.3, 1.0, 0.2, 0.5, 0.6, -0.6, 0.3, 0.1, -0.15 and 0.9 V.

Determine,

(i) the RMS noise, and

(1 mark)

(ii) the average noise.

(1 mark)

(c) An engineer is given a choice of two amplifiers; parametric amplifier or erbium-doped fiber amplifier (EDFA), for application in optical communication systems. Both have the same gain but different noise figure. **Table Q5(c)** lists all the gain and noise figure parameters.
Select which amplifier should the engineer choose. Justify your answer in relation to communication systems.

(6 marks)

(d) A three-stage (A, B and C) cascaded amplifier for a radio receiver system is shown in **Figure Q5(d)**.

(i) In order to minimize the effect of noise, a suitable configuration for the cascaded system needs to be identified. In your opinion, which one of these amplifiers should be placed at the first stage? Justify your answer.

(3 marks)

(ii) Following the step in Q5(d)(i), suggest a new configuration for the above cascaded system. Justify why you have chosen that configuration.

(5 marks)

Q6 (a) A spectrum analyzer with an input impedance of 50 Ω is used to measure the power spectrum of an AM signal at the output of a preamplifier circuit. The AM signal has been modulated with a sine wave. The effective power P_C is 1000mW, P_{USB} and P_{LSB} is 250 mW. Calculate:

(i) the total effective power, P_T,

(2 marks)

(ii) the peak carrier voltage, Vc,

(2 marks)

(iii) the modulation index and percentage,

(2 marks)

(iv) the modulating voltage, V_m, and

(2 marks)

(v) the lower and upper sideband voltages, V_{LSB} and V_{USB}.

(2 marks)

(vi) Sketch the waveform that you would see with an oscilloscope if it were placed in parallel with the spectrum analyzer.

(2 marks)

(b) A superhetrodyne is one type of non-coherent AM receiver. Draw complete block diagram of a non-coherent superheterodyne receiver.

(2 marks)

(c) For an AM superhetrodyne receiver that uses high-side injection and has local oscillator frequency of 1355 kHz, determine:

(i) the intermediate frequency (IF) frequencies, if the carrier frequency, upper side band and lower sideband frequencies are 900 kHz, 905 kHz and 895 kHz,

(2 marks)

(ii) the image frequency that produces the same IF frequency, and

(1 marks)

(iii) the image rejection in decibels for carrier frequency assuming that the input filter of one-tuned circuit with a Q of 40.

(3 marks)

Q7 (a) List **TWO (2)** methods used for up-conversion used in the Frequency Modulation (FM) transmitter system.

(2 marks)

(b) Given the information signal, $V_m(t)$ and the resulting frequency modulation (FM) signal, $V_{FM}(t)$ equations as follows:

$$V_m(t) = 10\cos\left(10\pi \times 10^3\right)t \text{ V}$$

$$V_{FM}(t) = 100\cos\left(\left(100\pi \times 10^6\right)t + \theta(t)\right) \text{ V}$$

The output frequency is proportionally increased with the increment of the input voltage as shown in **Table Q7**.

(i) Calculate the frequency deviation, K_f in radian/s.

(2 marks)

(ii) Construct the complete expression of $V_{FM}(t)$.

(3 marks)

(iii) Sketch the frequency spectrum. Label the voltage amplitude (V) and frequency (Hz) of each spectrum component.

(6 marks)

(iv) Find the bandwidth using Bessel and Carson methods.

(2 marks)

(v) Determine the total dissipated power if $V_{FM}(t)$ is delivered through 50 Ω load. [Note: Use Bessel Table]

(3 marks)

(vi) If the FM signal in part Q7(b)(ii) is up-converted for transmission using frequency multiplier as shown in **Figure Q7(b)**, determine the output carrier frequency, $f_c(out)$ and information signal, $f_m(out)$.

(2 marks)

Q8 (a) Identify **THREE (3)** cases of sampling. Draw the frequency spectrum for each case and explain the effect on the output signal.

(6 marks)

(b) A companding system with $\mu = 100$ is used to compand -4V to 4V signal.

(i) Define the meaning of companding.

(2 marks)

(ii) Calculate the system output voltage for V_{in} = -4, -2, 2, and 4V.

(2 marks)

(iii) Plot the compression characteristic that will handle input voltage in the given range corresponds to the given μ.

(2 marks)

(c) State **THREE (3)** main digital bandpass modulation schemes and draw the waveforms with the given baseband data of 1010110.

(3 marks)

(d) You are planning to design a wide area network (WAN) which to encompass the local area networks (LANs) at two nearby office buildings. First vendor proposes the use of terrestrial radio band of 100 MHz and a SNR of 10 dB with a 4-bit per baud line encoding technique. Second vendor proposes running cable, with a bandwidth of 500 MHz, a 2-bit per baud line encoding, and a drastically lower SNR of only 1 dB. As a network engineer you need to identify which vendor you will choose for this project and justify your answer.

(5 marks)

Q9 (a) A lossless transmission line is 80 cm long and operates at a frequency of 600 MHz. The line parameters are $L = 0.25\mu H/m$ and $C = 100$ pF/m. Find,

(i) the characteristic impedance,

(2 marks)

(ii) the phase constant,

(2 marks)

(iii) the velocity on the line, and

(2 marks)

(iv) the input impedance for $Z_L = 100\Omega$.

(2 marks)

(b) Point out the importance of the Friis transmission equation in antenna system.

(2 marks)

(c) Consider the communication system shown in **Figure Q9(c)**, with all components properly matched. If power at the the transmitter, $P_{Tx} = 10$ W and frequency, $f = 6$ GHz,

(i) calculate the power density at the receiving antenna (assuming proper alignment of antennas),

(4 marks)

(ii) determine the received power, and

(2 marks)

(iii) If temperature system, Tsys = 1,000 K and the receiver bandwidth is 20 MHz, calculate the signal-to noise ratio in decibels.

(4 marks)

- END OF QUESTIONS -

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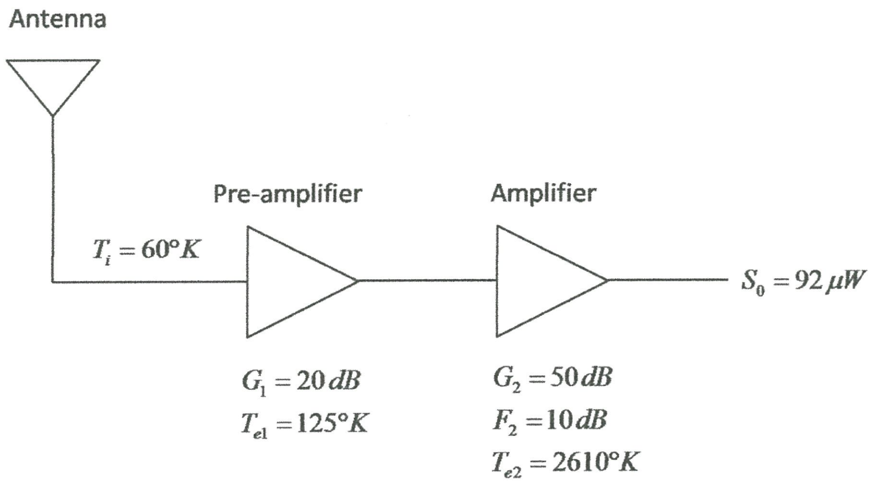

FIGURE Q2(b)

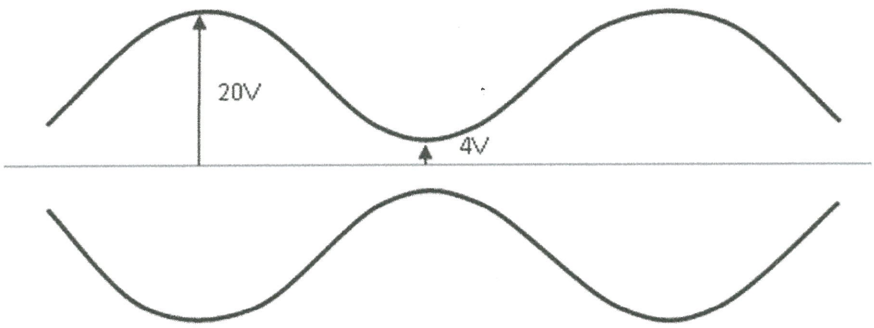

FIGURE Q3(b)

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TABLE Q5(c): Gain and Noise Figure of Parametric and Erbium-Doped Fiber Amplifier

Amplifier	Gain (dB)	Noise Figure (dB)
Parametric	20	5
EDFA	20	3

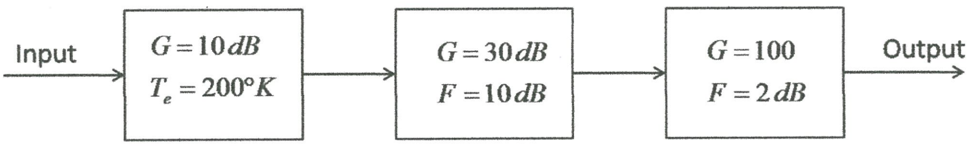

FIGURE Q5(d)

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TABLE Q7

Voltage (V)	0.25	0.5	0.75	1.0	1.25
Angular Frequency, ω (radian/s)	$0.25\pi \times 10^3$	$0.5\pi \times 10^3$	$0.75\pi \times 10^3$	$\pi \times 10^3$	$1.25\pi \times 10^3$

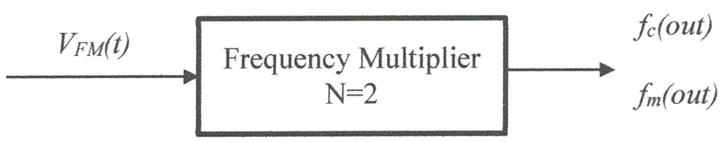

FIGURE Q7(b)

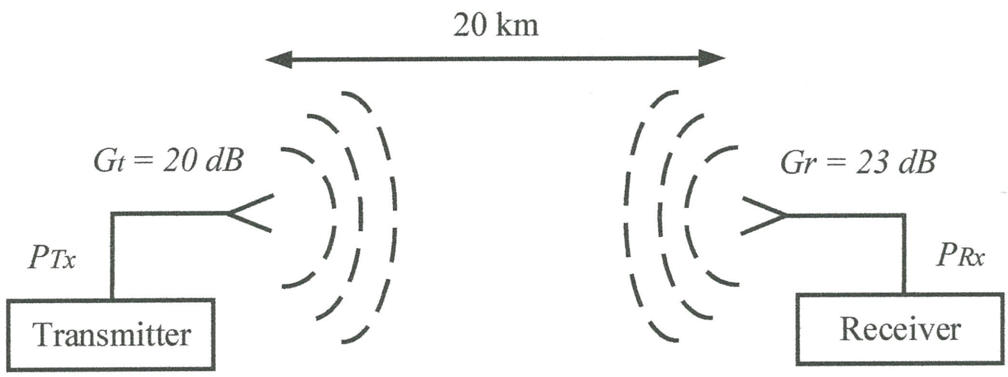

FIGURE Q9(c)

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Error Function Table

$$\mathrm{erf}(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$$

	Hundredths digit of x									
x	0	1	2	3	4	5	6	7	8	9
0.0	0.00000	0.01128	0.02256	0.03384	0.04511	0.05637	0.06762	0.07886	0.09008	0.10128
0.1	0.11246	0.12362	0.13476	0.14587	0.15695	0.16800	0.17901	0.18999	0.20094	0.21184
0.2	0.22270	0.23352	0.24430	0.25502	0.26570	0.27633	0.28690	0.29742	0.30788	0.31828
0.3	0.32863	0.33891	0.34913	0.35928	0.36936	0.37938	0.38933	0.39921	0.40901	0.41874
0.4	0.42839	0.43797	0.44747	0.45689	0.46623	0.47548	0.48466	0.49375	0.50275	0.51167
0.5	0.52050	0.52924	0.53790	0.54646	0.55494	0.56332	0.57162	0.57982	0.58792	0.59594
0.6	0.60386	0.61168	0.61941	0.62705	0.63459	0.64203	0.64938	0.65663	0.66378	0.67084
0.7	0.67780	0.68467	0.69143	0.69810	0.70468	0.71116	0.71754	0.72382	0.73001	0.73610
0.8	0.74210	0.74800	0.75381	0.75952	0.76514	0.77067	0.77610	0.78144	0.78669	0.79184
0.9	0.79691	0.80188	0.80677	0.81156	0.81627	0.82089	0.82542	0.82987	0.83423	0.83851
1.0	0.84270	0.84681	0.85084	0.85478	0.85865	0.86244	0.86614	0.86977	0.87333	0.87680
1.1	0.88021	0.88353	0.88679	0.88997	0.89308	0.89612	0.89910	0.90200	0.90484	0.90761
1.2	0.91031	0.91296	0.91553	0.91805	0.92051	0.92290	0.92524	0.92751	0.92973	0.93190
1.3	0.93401	0.93606	0.93807	0.94002	0.94191	0.94376	0.94556	0.94731	0.94902	0.95067
1.4	0.95229	0.95385	0.95538	0.95686	0.95830	0.95970	0.96105	0.96237	0.96365	0.96490
1.5	0.96611	0.96728	0.96841	0.96952	0.97059	0.97162	0.97263	0.97360	0.97455	0.97546
1.6	0.97635	0.97721	0.97804	0.97884	0.97962	0.98038	0.98110	0.98181	0.98249	0.98315
1.7	0.98379	0.98441	0.98500	0.98558	0.98613	0.98667	0.98719	0.98769	0.98817	0.98864
1.8	0.98909	0.98952	0.98994	0.99035	0.99074	0.99111	0.99147	0.99182	0.99216	0.99248
1.9	0.99279	0.99309	0.99338	0.99366	0.99392	0.99418	0.99443	0.99466	0.99489	0.99511
2.0	0.99532	0.99552	0.99572	0.99591	0.99609	0.99626	0.99642	0.99658	0.99673	0.99688
2.1	0.99702	0.99715	0.99728	0.99741	0.99753	0.99764	0.99775	0.99785	0.99795	0.99805
2.2	0.99814	0.99822	0.99831	0.99839	0.99846	0.99854	0.99861	0.99867	0.99874	0.99880
2.3	0.99886	0.99891	0.99897	0.99902	0.99906	0.99911	0.99915	0.99920	0.99924	0.99928
2.4	0.99931	0.99935	0.99938	0.99941	0.99944	0.99947	0.99950	0.99952	0.99955	0.99957
2.5	0.99959	0.99961	0.99963	0.99965	0.99967	0.99969	0.99971	0.99972	0.99974	0.99975
2.6	0.99976	0.99978	0.99979	0.99980	0.99981	0.99982	0.99983	0.99984	0.99985	0.99986
2.7	0.99987	0.99987	0.99988	0.99989	0.99989	0.99990	0.99991	0.99991	0.99992	0.99992
2.8	0.99992	0.99993	0.99993	0.99994	0.99994	0.99994	0.99995	0.99995	0.99995	0.99996
2.9	0.99996	0.99996	0.99996	0.99997	0.99997	0.99997	0.99997	0.99997	0.99997	0.99998
3.0	0.99998	0.99998	0.99998	0.99998	0.99998	0.99998	0.99998	0.99999	0.99999	0.99999
3.1	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999
3.2	0.99999	0.99999	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

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Complimentary Error Function Table

$$\mathrm{erfc}(x) = 1 - \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$$

	Hundredths digit of x									
x	0	1	2	3	4	5	6	7	8	9
0.0	1.00000	0.98872	0.97744	0.96616	0.95489	0.94363	0.93238	0.92114	0.90992	0.89872
0.1	0.88754	0.87638	0.86524	0.85413	0.84305	0.83200	0.82099	0.81001	0.79906	0.78816
0.2	0.77730	0.76648	0.75570	0.74498	0.73430	0.72367	0.71310	0.70258	0.69212	0.68172
0.3	0.67137	0.66109	0.65087	0.64072	0.63064	0.62062	0.61067	0.60079	0.59099	0.58126
0.4	0.57161	0.56203	0.55253	0.54311	0.53377	0.52452	0.51534	0.50625	0.49725	0.48833
0.5	0.47950	0.47076	0.46210	0.45354	0.44506	0.43668	0.42838	0.42018	0.41208	0.40406
0.6	0.39614	0.38832	0.38059	0.37295	0.36541	0.35797	0.35062	0.34337	0.33622	0.32916
0.7	0.32220	0.31533	0.30857	0.30190	0.29532	0.28884	0.28246	0.27618	0.26999	0.26390
0.8	0.25790	0.25200	0.24619	0.24048	0.23486	0.22933	0.22390	0.21856	0.21331	0.20816
0.9	0.20309	0.19812	0.19323	0.18844	0.18373	0.17911	0.17458	0.17013	0.16577	0.16149
1.0	0.15730	0.15319	0.14916	0.14522	0.14135	0.13756	0.13386	0.13023	0.12667	0.12320
1.1	0.11979	0.11647	0.11321	0.11003	0.10692	0.10388	0.10090	0.09800	0.09516	0.09239
1.2	0.08969	0.08704	0.08447	0.08195	0.07949	0.07710	0.07476	0.07249	0.07027	0.06810
1.3	0.06599	0.06394	0.06193	0.05998	0.05809	0.05624	0.05444	0.05269	0.05098	0.04933
1.4	0.04771	0.04615	0.04462	0.04314	0.04170	0.04030	0.03895	0.03763	0.03635	0.03510
1.5	0.03389	0.03272	0.03159	0.03048	0.02941	0.02838	0.02737	0.02640	0.02545	0.02454
1.6	0.02365	0.02279	0.02196	0.02116	0.02038	0.01962	0.01890	0.01819	0.01751	0.01685
1.7	0.01621	0.01559	0.01500	0.01442	0.01387	0.01333	0.01281	0.01231	0.01183	0.01136
1.8	0.01091	0.01048	0.01006	0.00965	0.00926	0.00889	0.00853	0.00818	0.00784	0.00752
1.9	0.00721	0.00691	0.00662	0.00634	0.00608	0.00582	0.00557	0.00534	0.00511	0.00489
2.0	0.00468	0.00448	0.00428	0.00409	0.00391	0.00374	0.00358	0.00342	0.00327	0.00312
2.1	0.00298	0.00285	0.00272	0.00259	0.00247	0.00236	0.00225	0.00215	0.00205	0.00195
2.2	0.00186	0.00178	0.00169	0.00161	0.00154	0.00146	0.00139	0.00133	0.00126	0.00120
2.3	0.00114	0.00109	0.00103	0.00098	0.00094	0.00089	0.00085	0.00080	0.00076	0.00072
2.4	0.00069	0.00065	0.00062	0.00059	0.00056	0.00053	0.00050	0.00048	0.00045	0.00043
2.5	0.00041	0.00039	0.00037	0.00035	0.00033	0.00031	0.00029	0.00028	0.00026	0.00025
2.6	0.00024	0.00022	0.00021	0.00020	0.00019	0.00018	0.00017	0.00016	0.00015	0.00014
2.7	0.00013	0.00013	0.00012	0.00011	0.00011	0.00010	0.00009	0.00009	0.00008	0.00008
2.8	0.00008	0.00007	0.00007	0.00006	0.00006	0.00006	0.00005	0.00005	0.00005	0.00004
2.9	0.00004	0.00004	0.00004	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00002
3.0	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00001
3.1	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
3.2	0.00001	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

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Table of Bessel Function

β	$J_0(\beta)$	$J_1(\beta)$	$J_2(\beta)$	$J_3(\beta)$	$J_4(\beta)$	$J_5(\beta)$	$J_6(\beta)$	$J_7(\beta)$	$J_8(\beta)$	$J_9(\beta)$	$J_{10}(\beta)$)
0.0	1.0000	–	–	–	–	–	–	–	–	–	–
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	0.2080	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

FINAL EXAMINATION

SEMESTER/SESSION: SEMESTER II/2014/2015 PROGRAMME: 3 BEJ/ 3 BEV
COURSE NAME: ELECTRONIC COMMUNICATION SYSTEM COURSE CODE: BEB 31803

Miscellaneous Equations (1)

Trigonometry Identity

$sin(A+B)$	$= sinA\ cosB + cosA\ sinB$
$sin(A-B)$	$= sinA\ cosB - cosA\ sinB$
$cos(A+B)$	$= cosA\ cosB - sinA\ sinB$
$cos(A-B)$	$= cosA\ cosB + sinA\ sinB$
$sin(2A)$	$= 2\ sinA\ cosA$
$cos(2A)$	$= cos^2A - sin^2A$
$Sin(A)\ Sin(B)$	$=1/2\ \{Cos(A-B) - Cos(A+B)\}$
$Cos(A)\ Cos(B)$	$=1/2\{Cos(A-B) + Cos(A+B)\}$
$Sin(A)\ Cos(B)$	$=1/2\{Sin(A-B) + Sin(A+B)\}$

Constants Table

Symbol	Constant	Value
c	Speed of light	3.0×10^8 m/s
k	Boltzmann constant	1.38×10^{-23} J/K

Friss Formula

$$F = F_1 + \frac{F_2 - 1}{A_1} + \frac{F_3 - 1}{A_1 A_2} + \cdots\cdots + \frac{F_n - 1}{A_1 A_2 \cdots A_n}$$

Modulation Index (AM)

$$m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

Total Power (AM)

$$P_t = P_c\left(1 + \frac{m^2}{2}\right) \quad W$$

Image Frequency Rejection Ratio (IFRR)

$$IFRR = \sqrt{1 + Q^2\rho^2}$$

Modulation Index (FM)

$$\beta_f = \frac{K_f V_m}{\omega_m}$$

Total Power (FM)

$$P_t = P_0 + 2(P_1 + P_2 + P_3 + \cdots\cdots + P_n)$$

FINAL EXAMINATION

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Miscellaneous Equations (2)

Thermal Noise Power

$$P_n = kTB \quad \text{W}$$

Equivalent Noise Temperature

$$T_e = T(F-1) \quad \text{K}$$

μ Law: Output Voltage

$$V_{out} = \frac{V_{\max} \ln(1+\mu \, V_{in}/V_{\max})}{\ln(1+\mu)}$$

Free Space Loss

$$FSL(dB) = 20\log\left(\frac{4\pi d}{\lambda}\right)$$

Receive Power at Receiver

$$P_R = \left(\frac{P_T G_T G_R}{\left(\frac{4\pi d}{\lambda}\right)^2}\right) \times \frac{1}{L_t L_r} \qquad W$$

Power Density

$$P_d = \frac{EIRP}{4\pi d^2} \quad W/m^2$$

Reflection Coefficient

$$\Gamma = \frac{VSWR-1}{VSWR+1}$$

Characteristic Impedance

$$Z_0 = \sqrt{\frac{L}{C}}$$

Input Impedance

$$Z_{in} = Z_0\left[\frac{Z_L \cos\beta l + jZ_0 \tan\beta l}{Z_0 \cos\beta l + jZ_L \tan\beta l}\right]$$

Propagation Constant

$$\gamma = \alpha + j\beta = \sqrt{(R+j\omega L)(G+j\omega C)}$$