Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSENAME	:	ELECTRONIC COMMUNICATION SYSTEM
COURSE CODE	:	BEB 31803
PROGRAMME	:	BEJ / BEV
EXAMINATION DATE	:	JUNE / JULY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	SECTION A: ANSWER **ALL** QUESTIONS. SECTION B: ANSWER **THREE (3)** QUESTIONS ONLY.

THIS QUESTION PAPER CONSISTS OF **FIFTEEN (15)** PAGES

SECTION A: ANSWER ALL QUESTIONS (40 MARKS)

Q1 (a) Differentiate between noise factor and noise figure.

(4 marks)

(b) Consider a non-ideal amplifier with the following parameters:

Input Signal Power = 2.5×10^{-10} W
Input Noise Power = 3.0×10^{-18} W
Power Gain = 1.5×10^{6}
Internal Noise = 6×10^{-12} W

Determine:

(i) the input signal to noise (S/N) power ratio (dB)

(2 marks)

(ii) the output signal to noise (S/N) power ratio (dB)

(2 marks)

(iii) the noise factor and noise figure.

(2 marks)

Q2 (a) Compare the difference between Double Sideband Full-Carrier (DSB-FC) and Single Sideband (SSB) with the aid of suitable diagrams.

(4 marks)

(b) For the AM envelope shown in **Figure Q2(b)**, determine the modulation index parameter.

(1 mark)

Q3 (a) Express the general angle modulation equation.

(1 mark)

(b) The difference between FM and PM is more easily understood by defining four terms with reference to equation in (c). Describe these four terms and its definition.

(4 marks)

Q4 (a) Contrast the advantage and disadvantage of digital transmission.

(4 marks)

(b) A pulse code modulation (PCM) system have the following parameters:

Maximum analog input frequency = 4 kHz
Maximum decoded voltage at the receiver = ±2.55 V
Minimum dynamic range = 46 dB

Determine;

(i) the minimum sample rate;

(1 mark)

(ii) the minimum number of bits used in the PCM;

(2 marks)

(iii) the resolution;

(1 mark)

(iv) the quantization error;

(1 mark)

(v) the coding efficiency.

(1 mark)

Q5 (a) The formation of standing wave is due to an improper termination of a transmission line system. If a transmission line is short circuited at the end of the line,

(i) analyze the formation of voltage standing wave on the transmission line,

(2 marks)

(ii) sketch the voltage standing wave pattern on the transmission line.

(2 marks)

(b) An isotropic radiator is a reference antenna used in the study of antenna.

(i) Describe the properties of an isotropic radiator.

(4 marks)

(ii) If the radiator is emitting 1 W of power, determine the power density 1 km away from the antenna.

(2 marks)

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

Q6 (a) Describe the thermal noise and show the related law.

(5 marks)

(b) A circuit consists of three resistors is shown in **Figure Q6(b)**.

(i) Analyze the circuit from first principle and show the equivalent noise resistance and rms noise voltage.

(10 mark)

(ii) Calculate the equivalent noise resistance and rms noise voltage at temperature of 27°C for the following values of resistors, R_1 = 20 Ω, R_2 = 50 Ω and R_3 = 40 Ω. The operating bandwidth is 10 kHz.

(5 marks)

Q7 (a) An AM radio station is given a transmission frequency band between 940 kHz and 960 kHz by the Malaysian Communication and Multimedia Commission (MCMC). The radio station will use the Double Sideband Full Carrier (DSB-FC) modulation in order to modulate a 15 V audio signal with modulation index of 70%.

(i) Draw and label the suitable basic block diagram for the AM transmitter system.

(2 marks)

(ii) Determine the carrier peak amplitude (V_c) and the carrier frequency (f_c) if the given bandwidth is only used for **1 (ONE)** AM channel only.

(2 marks)

(iii) Derive the possible AM signal ($V_{AM(t)}$) for the system.

(2 marks)

(iv) If the radio station want to accommodate more than **1 (ONE)** channel in the given bandwidth and more power efficient, suggest the changes that need to be made to the current transmitter system. Explain your answers with a suitable diagram

(4 marks)

(b) A Superheterodyne receiver as shown in **Figure Q7(b)** has received the DSB-FC AM signal, $V_{AM}(t) = 0.5\cos(1800\pi t) + 0.125\cos(1790\pi t) - 0.125\cos(1810\pi t)$. The Preselector, which consists of RF amplifier and filter, is tuned to the RF frequency of f_{RF} = 900 kHz with bandwidth of 10 kHz.

(i) Find the Q parameter of the filter in the Preselector.

(1 mark)

(ii) The mixer/converter uses high-side injection for RF-to-IF conversion. It has a Local Oscillator with frequency f_{LO} = 1355 kHz. Determine the IF carrier, the upper side frequency and the lower side frequency for the received RF signal $v_{AM}(t)$.

(5 marks)

(iii) Determine the image frequency, f_{image}, which is produced from RF-to-IF conversion.

(2 marks)

(iv) Calculate the image rejection ratio of the receiver in dB.

(2 marks)

Q8 The output signal of an Angle Modulator is

$$u(t) = 100\cos\left[\omega_c t + 4\sin(2000\pi t)\right]$$

where $\omega_c = 2\pi 10^7\ rad/s$.

(a) Determine the average transmitted power using Bessel function.

(2 marks)

(b) Determine the peak phase deviation.

(2 marks)

(c) Determine the peak frequency deviation.

(4 marks)

(d) Is this an FM or a PM signal? Explain your answer.

(4 marks)

(e) Draw the amplitude spectrum of the $u(t)$.

(5 marks)

(f) Calculate the bandwidth of the $u(t)$.

(3 marks)

Q9 (a) Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM) are three methods of transmitting information. Consider the input signal as shown in **Figure Q9(a)**. Illustrate your answer on the given graph that shows the unmodulated pulse train (dotted) if the signal below are transmitted using

(i) PAM;

(2 marks)

(ii) PWM; and

(2 marks)

(iii) PPM.

(2 marks)

(b) A companding system with $\mu = 150$ is used to compand -6V to 6V signal.

(i) Define the meaning of companding.

(2 marks)

(ii) Calculate the system output voltage for V_{in} = -6V, -3V, 3V, and 6V.

(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) (i) Construct a Binary Phase Shift Keying (BPSK) modulator block diagram.

(1.5 marks)

(ii) Prove an antipodal signal output with given of 0101 as input data.

(3.5 marks)

Q10 (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, and

(2 marks)

(iii) the velocity on the line.

(2 marks)

(b) Radio wave propagating in Earth's atmosphere space can be reflected and refracted. Identify the cause of the **TWO (2)** processes and their effects on wave propagation.

(4 marks)

(c) The Ministry of Education Malaysia has awarded a contract to your company to set up a direct line of sight communication link between a school in Batu Pahat and the ministry's regional office in Johor Bahru. The line of sight distance between the two sites is approximately 150 km. Your plan is to use an antenna with gain of 16 dB for both stations and you have been given the permission by the Malaysian Comission for Communication and Multimedia (MCMC) to operate at frequency of 1.2 GHz. The transmitter produces 10 W of power which is fed to the transmit antenna via a transmission cable that is 50 meter long with the following characteristic:

$Z_0 = 50\ \Omega$, attenuation at 1.2 GHz/100m = 10 dB.

Calculate

(i) the power at the input of the antenna assuming a matched load;

(4 marks)

(ii) the Effective Isotropic Radiated Power (EIRP) of the transmitter;

(2 marks)

(iii) the free space loss;

(2 marks)

(iv) the power density at the receiver antenna.

(2 marks)

- END OF QUESTIONS -

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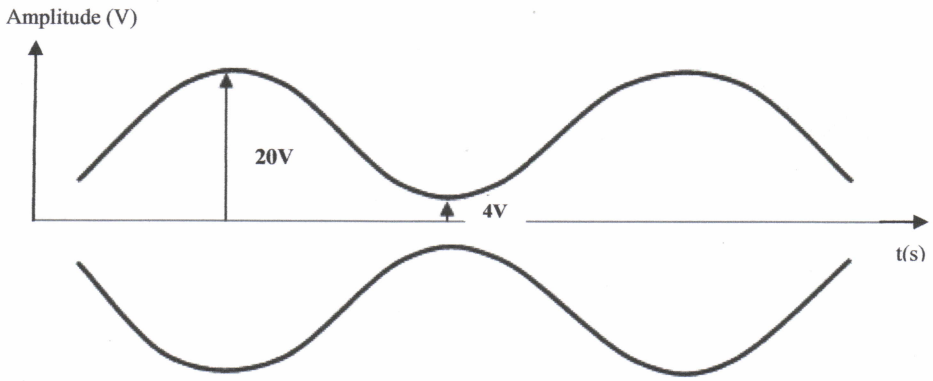

Figure Q2(b)

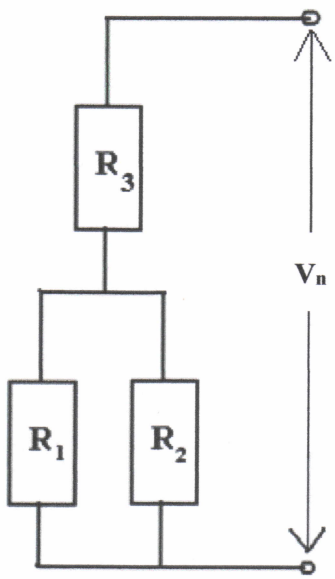

Figure Q6(b)

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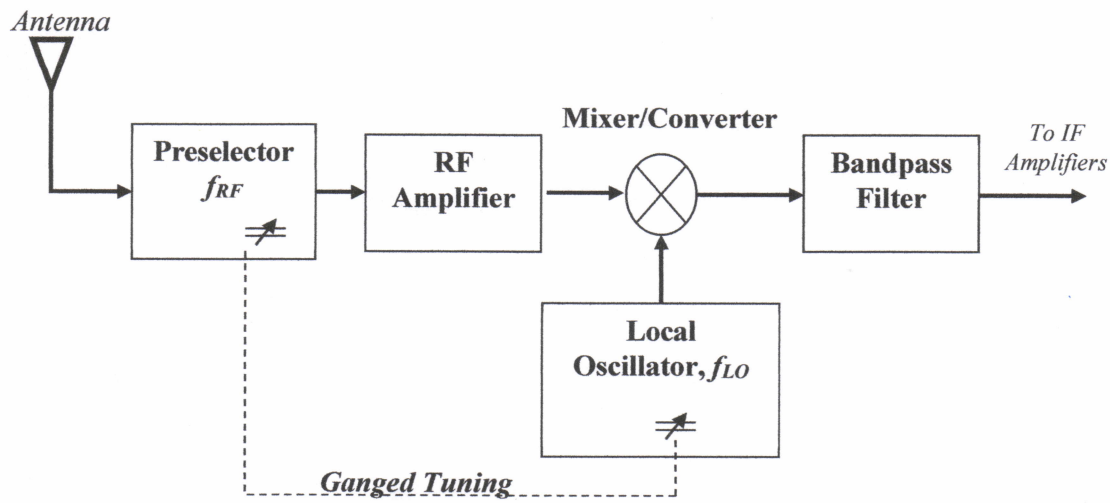

Figure 7(b)

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Please take off this page and attach together with your answer book.

Name: Matric No: Section:

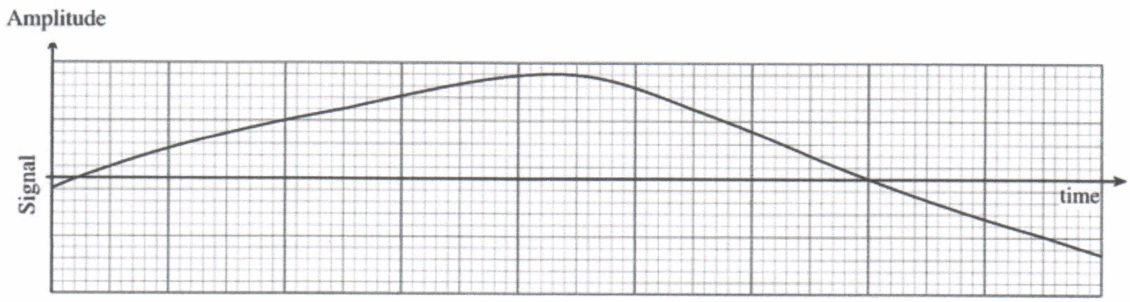
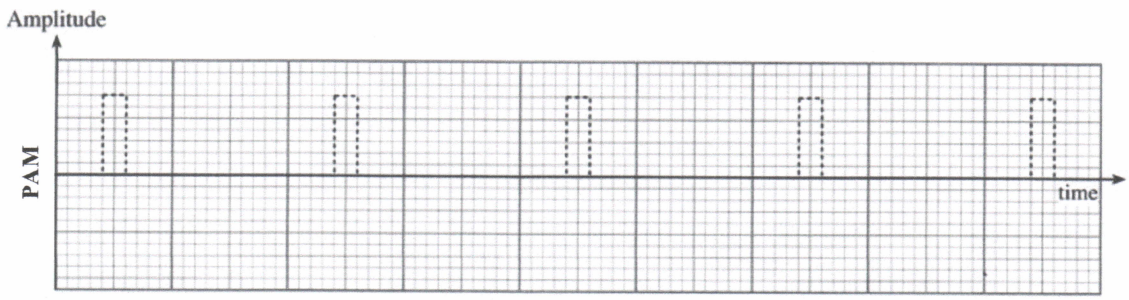
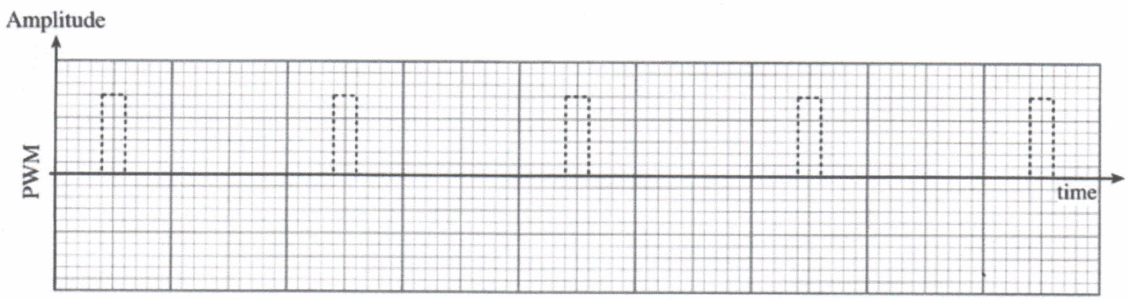
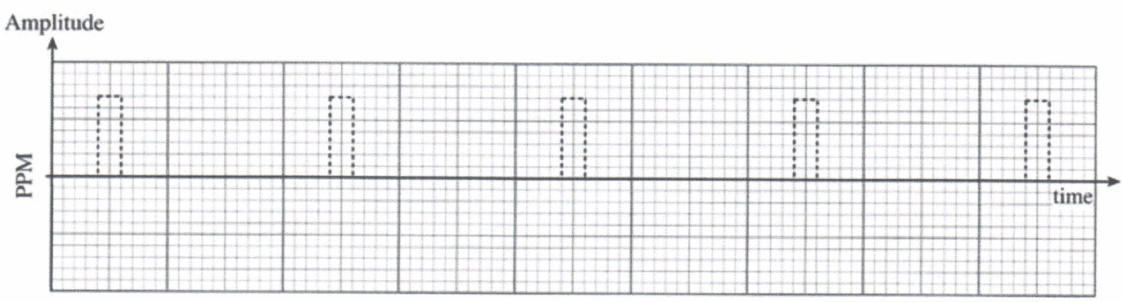


Figure Q9(a)







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Error Function Table

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

	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

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

	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/2015/2016 PROGRAMME: BEJ/BEV
COURSE NAME: ELECTRONIC COMMUNICATION SYSTEM COURSE CODE: BEB 31803

Miscellaneous Equations (1)

Trigonometry Identity

$sin(A + B) = sinAcosB + cosAsinB$
$sin(A - B) = sinAcosB - cosAsinB$
$cos(A + B) = cosAcosB - sinAsinB$
$cos(A - B) = cosAcosB + sinAsinB$
$sin(2A) = 2\ sinAcosA$
$cos(2A) = cos^2A - sin^2A$
$cos^2A=(1/2)[1+cos2A]$
$sin^2A=(1/2)[1-cos2A]$

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

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

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

SEMESTER/SESSION: SEMESTER II/2015/2016 PROGRAMME: BEJ/BEV
COURSE NAME: ELECTRONIC COMMUNICATION SYSTEM COURSE CODE: BEB 31803

Miscellaneous Equations (2)

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

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

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

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