SINGAPORE POLYTECHNIC **ET0930**

SAMPLE SEMESTER EXAMINATION

Diploma in Electrical & Electronic Engineering (DEEE)
3rd Year FT

Instructions to Candidates:

1. The Singapore Polytechnic examination rules are to be complied with.

2. This paper consists of **TWO** sections:
   Section A: 5 short questions, 12 marks each
   Section B: 2 Long Questions, 20 marks each

3. **ALL** questions are **COMPULSORY**.

4. All questions are to be answered in the answer booklet.
   Start each question on a new page.

5. Fill in the Question Number, in the order that it was answered, in the boxes found on the front cover of the answer booklet under the column "Question Answered".

6. This paper consists of **10** pages, including 2 pages of Formula List and 4 pages of Complementary Error Function Table.

7. The question paper must be submitted together with the answer booklet at the end of this exam session.

SECTION A (5 Short Questions, 60 marks)

A1. A 2 V_{peak}, 15 kHz sinusoidal signal is fed into a frequency modulator with carrier of 200 kHz. The FM signal generated has a peak frequency deviation of 30 kHz.

(a) Determine the modulation index. (4 marks)

(b) Determine the conversion gain of the FM modulator. (4 marks)

(c) Using Carson's rule, find the bandwidth of the FM signal. (4 marks)

A2. The bandlimited signal f(t) is ideally sampled at 200 samples per second as shown in FigureA2, where f(t) = 100sinc 100t.

(a) Sketch the amplitude spectrum of f(t). (4 mark)

(b) Sketch the amplitude spectrum of the sampled signal $f_p(t)$ over -300Hz < f < 300Hz. (8 mark)

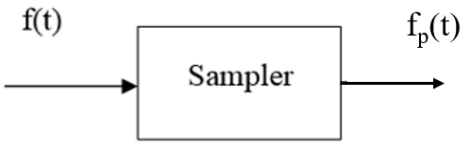


Figure A2

A3. A uniform mid-riser 3-bit quantiser has maximum and minimum inputs from +2.8V to -2.8V respectively.

(a) Calculate its step size, q. (2 marks)

(b) Draw the input-output characteristic of the quantiser. (5 marks)

(c) Calculate its signal-to-quantisation noise ratio (in dB). (3 marks)

(d) Determine the quantised voltage for a dc input of -1.6 V. (2 marks)

A4. A baseband digital communication system transmits random equiprobable binary signals. The transmission channel is affected by additive white Gaussian noise (AWGN) of rms values of 1 mV. The receiver is a simple comparator circuit. Assume that the line code used is of the form shown in Figure A4.

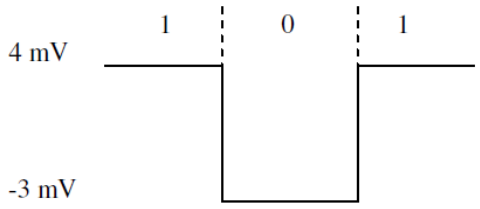


Figure A4

(a) Determine the value of the threshold voltage V_T to minimize the probability of bit error. (2 marks)

(b) Calculate the probability of bit error. (5 marks)

(c) If 10^5 bits are transmitted in each block of message, on average how many error bits will be received per block? (3 marks)

(d) What are the two main causes of signal degradation in the communication channel of a digital communication system? (2 marks)

A5. A baseband digital communication system transmits logic '1' as $s_2(t)$ and logic '0' as $s_1(t)$ as shown in Figure A5.1. The system uses an Integrate-and-Dump Correlation receiver shown in Figure A5.2.

(a) Sketch the waveform at A, B and C for a sequence of 1100. (6 marks)

(b) Assume that the input signal to the receiver has an amplitude of 12 mV with a bit rate of of 9000 bits/sec and that the binary bits of the input signal are independent and equiprobable. Calculate the probability of bit error if the single-sided power spectral density of the AWGN channel is 2×10^{-9} watt/Hz. (6 marks)

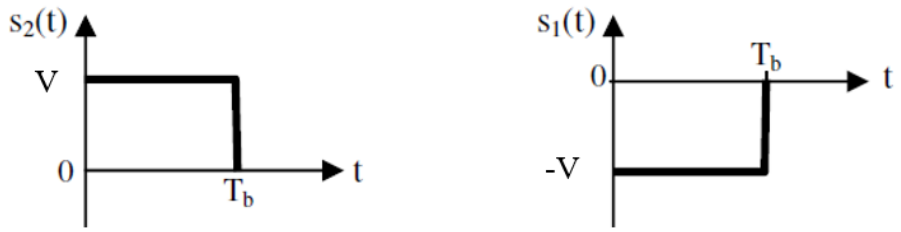


Figure A5.1

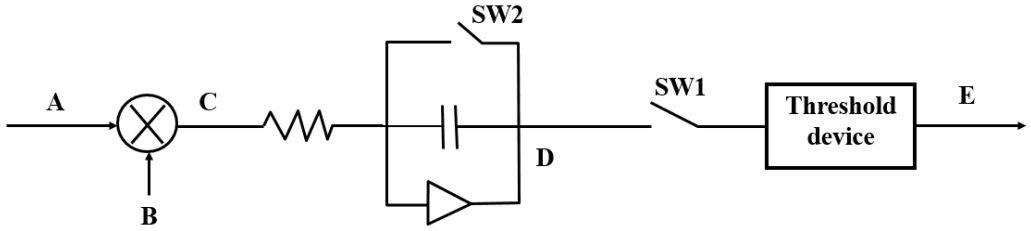


Figure A5.2

SECTION B (2 Long Questions, 40 marks)

B1. One voice signal, one music signal and a data signal are transmitted by a PCM-TDM system in which 8-bit uniform quantisers is employed. The voice signal is bandlimited to 4 kHz and the music signal is bandlimited to 10 kHz while the data signal is bandlimited to 9 kHz. The system requires synchronisation information.

(a) Sketch the PCM-TDM commutator system capable of handling these four signals. Ensure that uniform sampling is achieved. (10 marks)

(b) Determine the commutator speed. (2 marks)

(c) Calculate the gross output bit rate. (5 marks)

(d) Determine the minimum transmission bandwidth required if NRZ format is used. (3 marks)

B2. Binary data at rate 4 kb/s is transmitted over a passbank channel using BPSK. The carrier amplitude at the receiver is 10 mV, and the double-sided power spectral density of the channel AWGN is 1 nanowatt/Hz.

(a) Sketch a clearly labelled diagram of a BPSK transmitter. (4 marks)

(b) If the carrier frequency is 8 kHz, draw the BPSK waveform at the transmitter for a bit sequence of 101011. (10 marks)

(c) Calculate the bit error rate at the receiver, assuming that an integrate-and-dump correlation receiver is used. (6 marks)

**** End of the Paper ****

Formula List

$P_n = kTB$ $\quad E_n = \sqrt{4kTBR}$

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

Room Temperature, $T_0 =$ 290 K

$$F_t = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \frac{F_4 - 1}{G_1 G_2 G_3} + \cdots + \frac{F_n - 1}{G_1 G_2 G_3 \cdots G_{(n-1)}}$$

Velocity of light in free space, c = 3 x 10^8 m/s

$\cos A \cos B = \frac{1}{2}\cos(A+B) + \frac{1}{2}\cos(A-B)$

Positive envelope = $\left[V_c + v_s(t)\right]$ Negative envelope = $-\left[V_c + v_s(t)\right]$

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

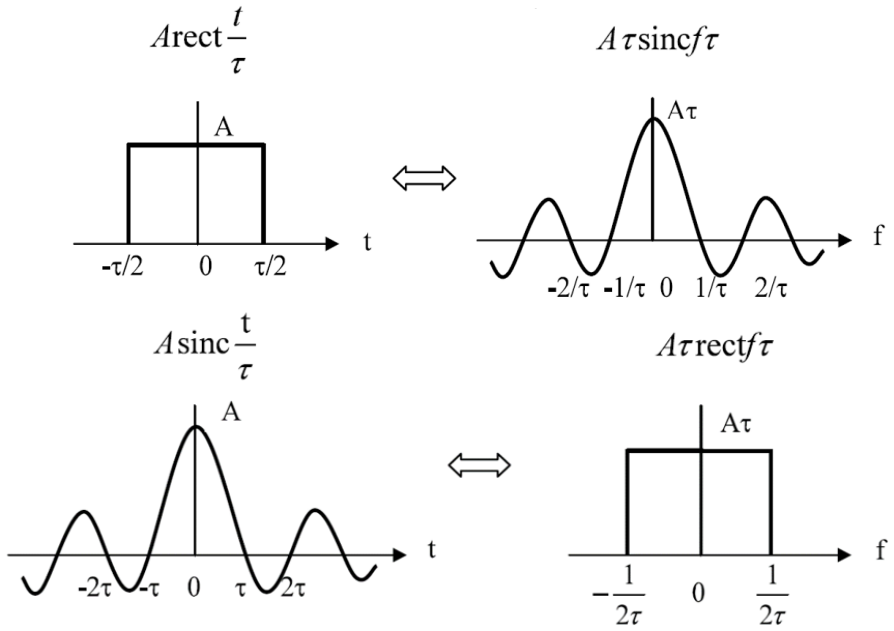
$B_{FM} = 2(m_f + 1)f_s$, for integer values of m_f.

$B_{FM} = 2(m_{f_H} + 1)f_H$

Component Amplitude: $C_n = \frac{A\tau}{T}\text{sinc}\frac{n\tau}{T}$

FT of impulse train: $x(t) = \sum_{n=-\infty}^{\infty}\frac{1}{T}e^{jn\omega_0 t} \Leftrightarrow X(f) = \frac{1}{T}\sum_{n=-\infty}^{\infty}\delta(f - nf_0)$

Common Fourier Transforms:



Step size for mid-riser quantiser: $\mathbf{q} = 2\,X_{max} / 2^B$

Quantisation noise power: $N_q = \frac{q^2}{12}$

Signal-to-noise ratio (dB) for quantiser: $\left[\frac{S}{N_q}\right] = 1.76 + 6B$, $\left[\frac{S}{N_q}\right] = 1.76 + 6B + 20log_{10}\frac{V_x}{V}$

Gross output bit rate, R = commutator speed × no. of inputs × no. of bits per symbol

Probability that AWGN exceeds T volts: $P(n>T) = \frac{1}{2} erfc\left[\frac{T}{\sqrt{2}\sigma}\right]$

Probability of bit error for a simple comparator receiver: $P_e = \frac{1}{2} erfc\left[\frac{R}{\sqrt{2}\sigma}\right]$

Noise margin: $\frac{V_{\min}}{V_{\max}} \times 100\%$

ISI degradation: $20\log_{10}\left(\frac{V_{\max}}{V_{\min}}\right) dB$

Jitter(%): $\frac{\Delta T}{T} \times 100\%$

Impulse response of a matched filter: $h(t) = s_2(T_b - t) - s_1(T_b - t)$

Probability of bit error for matched filter receiver: $P_e = \frac{1}{2} erfc(\frac{\gamma}{2\sqrt{2}})$

$$where\ \gamma^2 = \frac{2}{\eta}\int_0^{T_b}[s_2(t) - s_1(t)]^2 dt$$

Probability of bit error for matched filter receiver with polar NRZ inputs: $P_e = \frac{1}{2} erfc\left[\sqrt{\frac{V^2 T_b}{\eta}}\right]$

Probability of bit error for BPSK: $P_e = \frac{1}{2} erfc\left[\sqrt{\frac{V^2 T_b}{2\eta}}\right]$

Probability of bit error for DPSK: $P_e = \frac{1}{2} exp\left[\frac{-V^2 T_b}{2\eta}\right] = e^{-\left(\frac{V^2 T_b}{2\eta}\right)}$

Table **Complementary Error Function**

Z	erfc(Z)	Z	erfc(Z)	Z	erfc(Z)	Z	erfc(Z)
0.00	1.000000	0.40	0.571608	0.80	0.257899	1.20	0.896860D-01
0.01	0.988717	0.41	0.562031	0.81	0.251997	1.21	0.870445D-01
0.02	0.977435	0.42	0.552532	0.82	0.246189	1.22	0.844661D-01
0.03	0.966159	0.43	0.543113	0.83	0.240476	1.23	0.819499D-01
0.04	0.954889	0.44	0.533775	0.84	0.234857	1.24	0.794948D-01
0.05	0.943628	0.45	0.524518	0.85	0.229332	1.25	0.770999D-01
0.06	0.932378	0.46	0.515345	0.86	0.223900	1.26	0.747540D-01
0.07	0.921142	0.47	0.506255	0.87	0.218560	1.27	0.724864D-01
0.08	0.909922	0.48	0.497250	0.88	0.213313	1.28	0.702658D-01
0.09	0.898719	0.49	0.488332	0.89	0.208157	1.29	0.681014D-01
0.10	0.887537	0.50	0.479500	0.90	0.203092	1.30	0.659920D-01
0.11	0.876377	0.51	0.470756	0.91	0.198117	1.31	0.639369D-01
0.12	0.865242	0.52	0.462101	0.92	0.193232	1.32	0.619348D-01
0.13	0.854133	0.53	0.453536	0.93	0.188436	1.33	0.599850D-01
0.14	0.843053	0.54	0.445061	0.94	0.183729	1.34	0.580863D-01
0.15	0.832004	0.55	0.436677	0.95	0.179109	1.35	0.562378D-01
0.16	0.820988	0.56	0.428384	0.96	0.174576	1.36	0.544386D-01
0.17	0.810008	0.57	0.420184	0.97	0.170130	1.37	0.526876D-01
0.18	0.799064	0.58	0.412077	0.98	0.165768	1.38	0.509840D-01
0.19	0.788160	0.59	0.404063	0.99	0.161492	1.39	0.493267D-01
0.20	0.777297	0.60	0.396144	1.00	0.157299	1.40	0.477149D-01
0.21	0.766478	0.61	0.388319	1.01	0.153190	1.41	0.461476D-01
0.22	0.755704	0.62	0.380589	1.02	0.149162	1.42	0.446238D-01
0.23	0.744977	0.63	0.372954	1.03	0.145216	1.43	0.431427D-01
0.24	0.7343	0.64	0.365414	1.04	0.141350	1.44	0.417034D-01
0.25	0.723674	0.65	0.357971	1.05	0.137564	1.45	0.403050D-01
0.26	0.7131	0.66	0.350623	1.06	0.133856	1.46	0.389465D-01
0.27	0.702582	0.67	0.343372	1.07	0.130227	1.47	0.376271D-01
0.28	0.69212	0.68	0.336218	1.08	0.126674	1.48	0.363459D-01
0.29	0.681716	0.69	0.32916	1.09	0.123197	1.49	0.351021D-01
0.30	0.671373	0.70	0.322199	1.10	0.119795	1.50	0.338949D-01
0.31	0.661092	0.71	0.315334	1.11	0.116467	1.51	0.327233D-01
0.32	0.650874	0.72	0.308567	1.12	0.113212	1.52	0.315865D-01
0.33	0.640721	0.73	0.301896	1.13	0.110029	1.53	0.304838D-01
0.34	0.630635	0.74	0.295322	1.14	0.106918	1.54	0.294143D-01
0.35	0.620618	0.75	0.288844	1.15	0.103876	1.55	0.283773D-01
0.36	0.610670	0.76	0.282463	1.16	0.100904	1.56	0.273719D-01
0.37	0.600794	0.77	0.276178	1.17	0.979996D-01	1.57	0.263974D-01
0.38	0.590990	0.78	0.26999	1.18	0.951626D-01	1.58	0.254530D-01
0.39	0.581261	0.79	0.263897	1.19	0.923917D-01	1.59	0.245380D-01

(cont'd)

Table **Complementary Error Function**

Z	erfc(Z)	Z	erfc(Z)	Z	erfc(Z)	Z	erfc(Z)
1.60	0.236516D-01	2.00	0.467773D-02	2.40	0.688514D-03	2.80	0.750132D-04
1.61	0.227932D-01	2.01	0.447515D-02	2.41	0.653798D-03	2.81	0.706933D-04
1.62	0.219619D-01	2.02	0.428055D-02	2.42	0.620716D-03	2.82	0.666096D-04
1.63	0.211572D-01	2.03	0.400365D-02	2.43	0.589197D-03	2.83	0.627497D-04
1.64	0.203782D-01	2.04	0.391419D-02	2.44	0.559174D-03	2.84	0.591023D-04
1.65	0.196244D-01	2.05	0.374190D-02	2.45	0.530580D-03	2.85	0.556563D-04
1.66	0.188951D-01	2.06	0.357654D-02	2.46	0.503353D-03	2.86	0.524012D-04
1.67	0.181896D-01	2.07	0.341785D-02	2.47	0.477434D-03	2.87	0.493270D-04
1.68	0.175072D-01	2.08	0.326559D-02	2.48	0.452764D-03	2.88	0.464244D-04
1.69	0.168474D-01	2.09	0.311954D-02	2.49	0.429288D-03	2.89	0.436842D-04
1.70	0.162095D-01	2.10	0.297947D-02	2.50	0.406952D-03	2.90	0.410979D-04
1.71	0.155930D-01	2.11	0.284515D-02	2.51	0.365705D-03	2.91	0.386573D-04
1.72	0.149972D-01	2.12	0.271639D-02	2.52	0.365499D-03	2.92	0.363547D-04
1.73	0.144215D-01	2.13	0.259298D-02	2.53	0.346286D-03	2.93	0.341828D-04
1.74	0.138654D-01	2.14	0.247471D-02	2.54	0.328021D-03	2.94	0.321344D-04
1.75	0.133283D-01	2.15	0.236139D-02	2.55	0.310660D-03	2.95	0.302030D-04
1.76	0.128097D-01	2.16	0.225285D-02	2.56	0.294163D-03	2.96	0.283823D-04
1.77	0.123091D-01	2.17	0.214889D-02	2.57	0.278489D-03	2.97	0.266662D-04
1.78	0.118258D-01	2.18	0.204935D-02	2.58	0.263600D-03	2.98	0.250491D-04
1.79	0.113594D-01	2.19	0.195406D-02	2.59	0.249461D-03	2.99	0.235256D-04
1.80	0.109095D-01	2.20	0.186285D-02	2.60	0.236034D-03	3.00	0.220905D-04
1.81	0.104755D-01	2.21	0.177556D-02	2.61	0.223289D-03	3.01	0.207390D-04
1.82	0.100568D-01	2.22	0.169205D-02	2.62	0.211191D-03	3.02	0.194664D-04
1.83	0,965319D-02	2.23	0.161217D-02	2.63	0.199711D-03	3.03	0.182684D-04
1.84	0.926405D-02	2.24	0.153577D-02	2.64	0.188819D-03	3.04	0.171400D-04
1.85	0.888897D-02	2.25	0.146272D-02	2.65	0.178488D-03	3.05	0.160798D-04
1.86	0.852751D-02	2.26	0.139288D-02	2.66	0.168689D-03	3.06	0.150816D-04
1.87	0.817925D-02	2.27	0.132613D-02	2.67	0.159399D-03	3.07	0.141426D-04
1.88	0.784378D-02	2.28	0.126234D-02	2.68	0.150591D-03	3.08	0.132595D-04
1.89	0.752068D-02	2.29	0.120139D-02	2.69	0.142243D-03	3.09	0.124292D-04
1.90	0.720957D-02	2.30	0.114318D-02	2.70	0.134333D-03	3.10	0.116487D-04
1.91	0.691006D-02	2.31	0.108758D-02	2.71	0.126838D-03	3.11	0.109150D-04
1.92	0.662177D-02	2.32	0.102449D-02	2.72	0.119738D-03	3.12	0.102256D-04
1.93	0.634435D-02	2.33	0.983805D-03	2.73	0.113015D-03	3.13	0.957795D-05
1.94	0.607743D-02	2.34	0.935430D-03	2.74	0.106649D-03	3.14	0.896956D-05
1.95	0.582066D-02	2.35	0.889267D-03	2.75	0.100622D-03	3.15	0.839821D-05
1.96	0.557372D-02	2.36	0.845223D-03	2.76	0.949176D-04	3.16	0.786174D-05
1.97	0.533627D-02	2.37	0.803210D-03	2.77	0.895197D-04	3.17	0.735813D-05
1.98	0.510800D-02	2.38	0.763142D-03	2.78	0.844127D-04	3.18	0.688545D-05
1.99	0.488859D-02	2.39	0.724936D-03	2.79	0.795818D-04	3.19	0.644190D-05

(cont'd)

Table **Complementary Error Function**

Z	erfc(Z)	Z	erfc(Z)	Z	erfc(Z)	Z	erfc(Z)
3.20	0.602576D-05	3.60	0.355863D-06	4.00	0.154173D-07	4.40	0.489171D-09
3.21	0.563542D-05	3.61	0.330251D-06	4.01	0.141969D-07	4.41	0.446950D-09
3.22	0.526935D-05	3.62	0.306423D-06	4.02	0.130707D-07	4.42	0.408293D-09
3.23	0.492612D-05	3.63	0.284259D-06	4.03	0.120314D-07	4.43	0.372906D-09
3.24	0.460435D-05	3.64	0.263647D-06	4.04	0.110726D-07	4.44	0.340520D-09
3.25	0.430278D-05	3.65	0.244483D-06	4.05	0.101882D-07	4.45	0.310886D-09
3.26	0.402018D-05	3.66	0.226667D-06	4.06	0.937269D-08	4.46	0.283775D-09
3.27	0.375542D-05	3.67	0.210109D-06	4.07	0.862073D-08	4.47	0.258978D-09
3.28	0.350742D-05	3.68	0.194723D-06	4.08	0.792756D-08	4.48	0.236302D-09
3.29	0.327517D-05	3.69	0.180429D-06	4.09	0.728870D-08	4.49	0.215568D-09
3.30	0.305771D-05	3.70	0.167151D-06	4.10	0.670003D-08	4.50	0.196616D-09
3.31	0.285414D-05	3.71	0.154821D-06	4.11	0.615769D-08	4.51	0.179295D-09
3.32	0.266360D-05	3.72	0.143372D-06	4.12	0.565816D-08	4.52	0.163467D-09
3.33	0.248531D-05	3.73	0.132744D-06	4.13	0.519813D-08	4.53	0.149008D-09
3.34	0.231850D-05	3.74	0.122880D-06	4.14	0.477457D-08	4.54	0.135801D-09
3.35	0.216248D-05	3.75	0.113727D-06	4.15	0.438468D-08	4.55	0.123740D-09
3.36	0.201656D-05	3.76	0.105236D-06	4.16	0.402583D-08	4.56	0.112729D-09
3.37	0.188013D-05	3.77	0.973591D-07	4.17	0.369564D-08	4.57	0.102677D-09
3.38	0.175259D-05	3.78	0.900547D-07	4.18	0.339186D-08	4.58	0.935034D-10
3.39	0.163338D-05	3.79	0.832821D-07	4.19	0.311245D-08	4.59	0.851326D-10
3.40	0.152199D-05	3.80	0.770039D-07	4.20	0.285549D-08	4.60	0.774960D-10
3.41	0.141793D-05	3.81	0.711851D-07	4.21	0.261924D-08	4.61	0.705306D-10
3.42	0.132072D-05	3.82	0.657933D-07	4.22	0.240207D-08	4.62	0.641787D-10
3.43	0.1229940-05	3.83	0.607981D-07	4.23	0.220247D-08	4.63	0.583874D-10
3.44	0.114518D-05	3.84	0.561711D-07	4.24	0.201907D-08	4.64	0.531083D-10
3.45	0.106605D-05	3.85	0.518863D-07	4.25	0.185057D-08	4.65	0.482970D-10
3.46	0.992201D-06	3.86	0.4791890-07	4.26	0.169581D-08	4.66	0.439130D-10
3.47	0.923288D-06	3.87	0.442464D-07	4.27	0.155369D-08	4.67	0.399191D-10
3.48	0.8589950-06	3.88	0.408473D-07	4.28	0.142319D-08	4.68	0.362814D-10
3.49	0.799025D-06	3.89	0.377021D-07	4.29	0.130341D-08	4.69	0.329687D-10
3.50	0.743098D-06	3.90	0.347922D-07	4.30	0.119347D-08	4.70	0.299526D-10
3.51	0.690952D-06	3.91	0.321007D-07	4.31	0.109259D-08	4.71	0.272071D-10
3.52	0.642341D-06	3.92	0.296117D-07	4.32	0.100005D-08	4.72	0.247084D-10
3.53	0.597035D-06	3.93	0.273103D-07	4.33	0.915161D-09	4.73	0.224348D-10
3.54	0.554816D-06	3.94	0.251829D-07	4.34	0.837317D-09	4.74	0.203664D-10
3.55	0.515484D-06	3.95	0.232167D-07	4.35	0.765944D-09	4.75	0.184850D-10
3.56	0.478847D-06	3.96	0.213999D-07	4.36	0.700518D-09	4.76	0.167742D-10
3.57	0.444728D-06	3.97	0.197214D-07	4.37	0.640556D-09	4.77	0.152187D-10
3.58	0.412960D-06	3.98	0.181710D-07	4.38	0.585612D-09	4.78	0.138048D-10
3.59	0.383387D-06	3.99	0.167392D-07	4.39	0.535276D-09	4.79	0.125198D-10

(cont'd)

Table **Complementary Error Function**

Z	erfc(Z)	Z	erfc(Z)	Z	erfc(Z)	Z	erfc(Z)
4.80	0.113521D-10	5.10	0.549382D-12	5.40	0.222766D-13	5.70	0.756621D-15
4.81	0.102914D-10	5.11	0.495122D-12	5.41	0.199585D-13	5.71	0.673885D-15
4.82	0.932791D-11	5.12	0.446133D-12	5.42	0.178779D-13	5.72	0.600078D-15
4.83	0.845298D-11	5.13	0.401912D-12	5.43	0.160110D-13	5.73	0.534249D-15
4.84	0.765861D-11	5.14	0.362004D-12	5.44	0.143363D-13	5.74	0.475548D-15
4.85	0.693754D-11	5.15	0.325994D-12	5.45	0.128342D-13	5.75	0.423213D-15
4.86	0.628312D-11	5.16	0.293508D-12	5.46	0.114873D-13	5.76	0.376564D-15
4.87	0.568932D-11	5.17	0.264208D-12	5.47	0.102797D-13	5.77	0.334990D-15
4.88	0.515062D-11	5.18	0.237786D-12	5.48	0.919719D-14	5.78	0.297948D-15
4.89	0.466202D-11	5.19	0.213964D-12	5.49	0.822708D-14	5.79	0.264949D-15
4.90	0.421893D-11	5.20	0.192491D-12	5.50	0.735785D-14	5.80	0.235559D-15
4.91	0.381721D-11	5.21	0.173138D-12	5.51	0.657916D-14	5.81	0.209387D-15
4.92	0.345307D-11	5.22	0.155701D-12	5.52	0.588172D-14	5.82	0.186087D-15
4.93	0.312304D-11	5.23	0.139992D-12	5.53	0.525717D-14	5.83	0.165347D-15
4.94	0.282401D-11	5.24	0.125844D-12	5.54	0.469802D-14	5.84	0.146889D-15
4.95	0.255311D-11	5.25	0.113103D-12	5.55	0.419751D-14	5.85	0.130466D-15
4.96	0.230774D-11	5.26	0.101632D-12	5.56	0.374959D-14	5.86	0.115856D-15
4.97	0.208554D-11	5.27	0.913067D-13	5.57	0.334880D-14	5.87	0.102862D-15
4.98	0.188437D-11	5.28	0.820141D-13	5.58	0.299027D-14	5.88	0.913078D-16
4.99	0.170226D-11	5.29	0.736527D-13	5.59	0.266959D-14	5.89	0.810352D-16
5.00	0.153746D-11	5.30	0.661308D-13	5.60	0.238284D-14	5.90	0.719040D-16
5.01	0.138834D-11	5.31	0.593654D-13	5.61	0.212646D-14	5.91	0.637892D-16
5.02	0.125343D-11	5.32	0.532816D-13	5.62	0.189730D-14	5.92	0.565791D-16
5.03	0.113141D-11	5.33	0.478119D-13	5.63	0.169250D-14	5.93	0.501740D-16
5.04	0.102107D-11	5.34	0.428952D-13	5.64	0.150951D-14	5.94	0.444852D-16
5.05	0.921310D-12	5.35	0.384766D-13	5.65	0.134604D-14	5.95	0.394336D-16
5.06	0.831132D-12	5.36	0.345063D-13	5.66	0.120003D-14	5.96	0.349488D-16
5.07	0.749634D-12	5.37	0.309396D-13	5.67	0.106965D-14	5.97	0.309679D-16
5.08	0.675994D-12	5.38	0.277362D-13	5.68	0.953249D-15	5.98	0.274350D-16
5.09	0.609469D-12	5.39	0.248595D-13	5.69	0.849347D-15	5.99	0.243004D-16