Durham University

EXAMINATION PAPER

Examination Session:	Year:	Exam Code:
May/June	2018	ENGI4121-WE01

Title: **MEng Engineering (Part III)**

Communication Systems Paper 1

Time Allowed:	2 hours	
Additional Material provided:	None.	
Materials Permitted:	None.	
Calculators Permitted:	Models Permitted:	You are permitted to use only two models of calculator (Casio fx-83 GTPLUS or a Casio fx-85 GTPLUS).
Visiting Students may use dictionaries:	Yes	

Instructions to Candidates:	Answer ALL questions. All relevant workings must be shown.

Revision:	

Question 1

(a) Discuss the different types of pulse analogue modulation and compare their performance in the presence of additive white Gaussian noise.

[40%]

(b) Discuss the following

(i) The necessary properties for codes used in synchronous data transmission.

[10%]

(ii) Land usage factor and the degree of urbanisation factor.

[15%]

(c) Binary information is transmitted using baseband signals of the form shown in Figure Q.1. Design a correlation detector and find the probability of bit error assuming that the additive white Gaussian noise has a single sided power density equal to 1×10^{-3} watts/Hz.

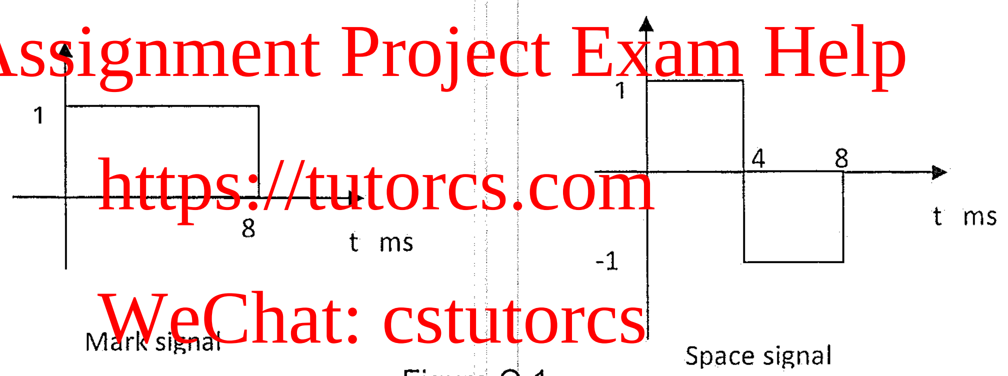

Figure Q.1

Use can be made of the following relationships:

$$P_e = \frac{1}{2} erfc \sqrt{\frac{E(1-\rho)}{2N_o}}$$

$$\rho = \frac{\int_0^T s_{mark}(t) s_{space}(t) dt}{\sqrt{\int_0^T s(t)^2_{mark} dt \int_0^T s(t)^2_{space} dt}}$$

[35%]

Question 2

(a) Discuss the three basic forms of bandpass digital modulation methods: ASK, PSK, and FSK.

[15%]

(b) Discuss the synchronisation requirements for the coherent detector for FSK, showing how these requirements can be achieved.

[10%]

continued

(c) Explain the diffraction mechanism of propagation.

[15%]

(d) For the geometry of Figure Q.2.a show that the excess phase $\Delta\phi$, caused by the obstruction, with respect to the line of sight can be written in terms of the Fresnel-Kirchhoff diffraction parameter, ν, which is equal to

$$\nu = h\sqrt{\frac{2(d_1+d_2)}{\lambda d_1 d_2}} \quad \text{where } \lambda \text{ is the wavelength}$$

Assume h << d_1, d_2.

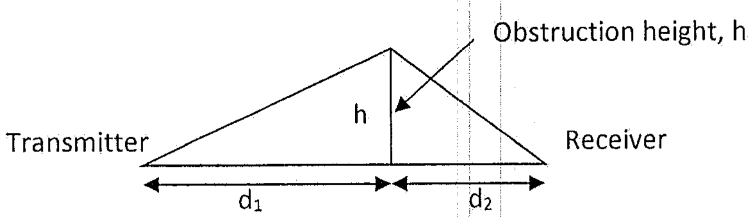

Figure Q. 2.a

Use can be made of the relationship $\sqrt{1+\epsilon} \cong 1+\frac{1}{2}\epsilon$ for $\epsilon \ll 1$

[30%]

(e) For the geometry of Figure Q.2.b compute the diffraction loss coefficient ν, using the Bullington method for a 900 MHz carrier frequency.

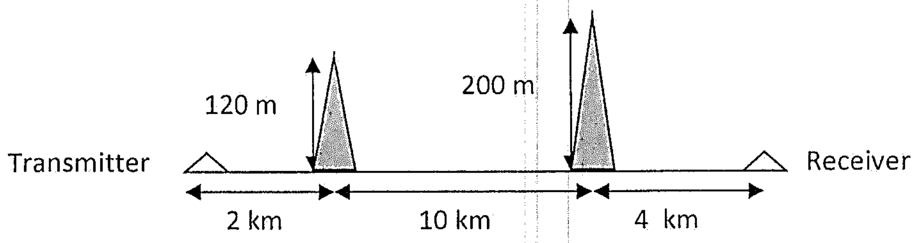

Figure Q. 2.b

[30%]

Error function and the complementary error function

$$\mathrm{erf}(x) = \frac{2}{\sqrt{\pi}}\int_0^x e^{-u^2}\,du \qquad \mathrm{erfc}(x) = \frac{2}{\sqrt{\pi}}\int_x^\infty e^{-u^2}\,du$$

continued

Table of Error function and complementary error function

x	erf(x)	erfc(x)	x	erf(x)	erfc(x)
0.00	0.0000000	1.0000000	1.30	0.9340079	0.0659921
0.05	0.0563720	0.9436280	1.40	0.9522851	0.0477149
0.10	0.1124629	0.8875371	1.50	0.9661051	0.0338949
0.15	0.1679960	0.8320040	1.60	0.9763484	0.0236516
0.20	0.2227026	0.7772974	1.70	0.9837905	0.0162095
0.25	0.2763264	0.7236736	1.80	0.9890905	0.0109095
0.30	0.3286268	0.6713732	1.90	0.9927904	0.0072096
0.35	0.3793821	0.6206179	2.00	0.9953223	0.0046777
0.40	0.4283924	0.5716076	2.10	0.9970205	0.0029795
0.45	0.4754817	0.5245183	2.20	0.9981372	0.0018628
0.50	0.5204999	0.4795001	2.30	0.9988568	0.0011432
0.55	0.5633234	0.4366766	2.40	0.9993115	0.0006885
0.60	0.6038561	0.3961439	2.50	0.9995930	0.0004070
0.65	0.6420293	0.3579707	2.60	0.9997640	0.0002360
0.70	0.6778012	0.3221988	2.70	0.9998657	0.0001343
0.75	0.7111556	0.2888444	2.80	0.9999250	0.0000750
0.80	0.7421010	0.2578990	2.90	0.9999589	0.0000411
0.85	0.7706681	0.2293319	3.00	0.9999779	0.0000221
0.90	0.7969082	0.2030918	3.10	0.9999884	0.0000116
0.95	0.8208908	0.1791092	3.20	0.9999940	0.0000060
1.00	0.8427008	0.1572992	3.30	0.9999969	0.0000031
1.10	0.8802051	0.1197949	3.40	0.9999985	0.0000015
1.20	0.9103140	0.0896860	3.50	0.9999993	0.0000007

END