衛星科技與工程導論 期中考

Midterm Exam for Introduction to Satellite Technology and Engineering

於 10/22 18:30 開始考試，請用 A4 空白紙或平板電腦**手寫**作答(避免去網路找資料來貼上)，
計算題請寫出計算過程，將作答結果拍照存檔。
考卷上、信件標題、檔名註明"衛星科技與工程導論 期中考 學校_學號_姓名"，
10/22 21:00 前寄到老師 albertlin2000@gmail.com，
及 交大助教 jimyuamg@gmail.com 或 中大助教 leo910429@gmail.com

Please write down the answers by hand on A4 paper or a tablet computer, then e-mail the files to the teacher and teaching assistants before 10/22 21:00

1. 請描述人造衛星包含哪些次系統及酬載？各有甚麼功能？各包含哪些元件？(20 分)
Describe the functions and components of the satellite subsystems and payloads.

2. 舉例說明衛星任務中，各系統參數的取捨(Trade-off)分析，並說明選擇的理由。 (20 分)
系統參數包含：任務種類、酬載、軌道高度、軌道傾角、衛星尺寸、衛星數量、通訊頻段、姿態控制方式…等項目的選擇。
Describe the trade-off analysis of the satellite system parameters, including: mission type, payload type, orbit altitude, orbit inclination angle, satellite size, satellite quantity, communication band, attitude control method,..etc.

3. 太陽能板電力計算： (20 分)
若一片 solar cell 發電的 Vmp=2.262 Volt, Imp=0.485 Amp， 電池充飽的最高電壓 33.6 Volt，
If one solar cell has Vmp=2.262 Volt, Imp=0.485 Amp, and the maximum voltage of one fully charged battery set is 33.6 Volt,

(1) 可使用多少片 solar cell 串接，以高於電池電壓來對電池充電？ (10 分)
How many solar cells in series to have larger voltage to charge the battery set?

(2) 若太陽能板需要發電 500 Watt 以上，需並聯幾組串聯的 solar cells? Watt=Volt*Amp (10 分)
How many solar cells in series and how many solar strings in parallel to generate power larger than 500W?

4. 舉例說明衛星指令與資料處理次系統的功能方塊圖，及描述各功能的用途。 (20 分)
Describe the functional block diagram of the satellite Command and Data Handling subsystem.

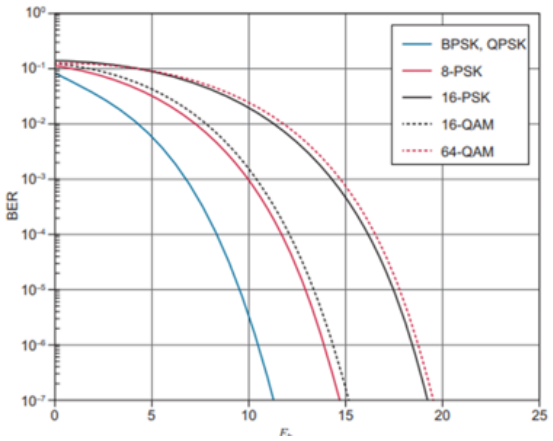
6. (加分題) 請說明自己在課堂計畫專題中所進行的工作及目前成果。 (10 分)
(Bonus) Please describe your job and status in the class project.

5. 以下表衛星 Downlink Budget 為例，計算各項目的值及說明其意思。 (20 分)

Calculate and describe the meaning of the satellite communication link budget, using the example below.

- **Satellite Downlink Budget Calculation**

  Satellite Altitude: 800Km
  Satellite Attitude: LVLH (nadir pointing)
  Downlink Frequency: 2.2 GHz
  Modulation: BPSK
  Transmitting Antenna Gain: 2 dB
  Bit Rate: 2 Mbps
  Ground Antenna G/T: 20 dB/K
  Ground Antenna Elevation Angle= 10 deg.
  Bit Error Rate: ≤ 10^{-6}



No	Parameter	Unit	Value	Remark
1	Data Rate	Mbps	**2.000**	
2	Carrier Frequency	GHz	2.200	
	BER & E_b/N_0 Related			
3	BER Required before error correction		1.0E-6	
4	Theoretical E_b/N_0	dB	10.50	NRZ-L BPSK
5	Implementation Loss	dB	0.00	
6	Coding Gain	dB	0.00	
7	Required E_b/N_0	dB	10.50	4-5-6
	Orbit Geometry			
8	Satellite altitude	km	**800.00**	
9	Ground elevation angles	degree	**10.00**	
10	Slant length	km	2366.87	
	Spacecraft EIRP Data			
9	Transmitter output power (Watts)	W	**1.00**	
10	Transmitter output power (dBW)	dBw	0.00	
11	On-Board loss	dB	-3.00	
12	Antenna Gain	dBi	2.00	
13	EIRP	dBW	-1.00	
	RF Link Loss in Space			
14	Polarization loss, Pointing loss	dB	-1.00	Estimated
15	Atmospheric and rain loss	dB	-2.00	Estimated
16	Space loss	dB	-166.78	
17	Received Power	dBWi	-170.78	

	Ground Station Data			
18	G/S G/T	dBi/K	20.00	
19	G/S carrier noise bandwidth	Hz	1000.00	
20	Required SNR	dB	15.00	Typical Value for GSTDN MFR
21	Boltzmann's Constant	dBw/Hz-K	-228.60	
22	Received C/N_0	dB-Hz	**77.82**	
	Carrier Margin Analysis			
	Carrier Modulation Loss	dB	-6.87	
23	Carrier Noise Bandwidth	dB-Hz	30.00	
24	Carrier SNR(Thermal Noise)	dB	**40.95**	
25	Carrier SNR(Data Modulation Noise)	dB	26.14	
26	Carrier SNR(Composite)	dB	26.00	
27	Required SNR	dB	15.00	Typical value
28	Carrier Margin	dB	11.00	
	Power Flux Density Analysis			
29	Received Power Flux Density	dBw/m^2	-136.92	
30	Allowable Power Flux Density	dBw/m^2	-151.50	
31	PFD margin	dBw/m^2	14.58	
	Data Link Margin Analysis			
32	Telemetry Modulation Loss	dB	0.00	
33	Received Telemetry E_b/N_0	dB	14.81	
34	Ground Implementation Loss	dB	-3.00	
35	Eb/No Achieved	dB	11.81	
36	Required Telemetry E_b/N_0	dB	10.50	
37	Margin	dB	**1.31**	

(1) 此例 Required Eb/No 值如何得出? (5 分)

(2) 以數據說明，調整上表那些參數，可以使 Telemetry Downlink Margin 增加? (15 分)