AA 236: Spacecraft Design
Problem Set 1

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Problem 1

(a) After World War Two, America and the Soviet Union were locked in a cold war. The Soviet Union decided that they wanted to launch satellites and then move on to manned spaceflight. Wernher von Braun, a Nazi engineer who came to the states with his team after the war to be able to pursue spaceflight, wanted to begin development in the USA. The first obstacles to space exploration was the USA's governments desire to focus on missile development. At the same time the Soviet program, led by Korolev, was beginning to take form. Von Braun turns to Disney to help increase interest in a space program by getting the general public interested in it. America decides to run a satellite program secretly for spy satellites. Von Braun looses the contract to the US Navy while the Russians complete a scale mock up of the R7 Semyorka. The R7 was designed for warheads but the team was given the go ahead to use it to launch a satellite, named Object D. Von Braun successfully launches a Jupiter-C rocket with no satellites on board. Things in the Soviet Union are starting to look bad when the R7 test explodes and parts for the object D are coming in sized wrong. Despite that, they were still making steady progress until they experience many failures in flight test. The over-sized object D was redesigned and slimmed down into the Sputnik while the R7 has a successful test flight. The Soviet Union beats America to space by launching their Sputnik satellite into orbit by the R7 rocket. The Russians decide to continue their progress by launching a cute dog into space. In response the US government gives von Braun the go ahead to launch a satellite right after the Nave attempts. The Navy's rocket fails on launch after rising 3ft. Shortly after von Braun successfully launches his satellite.

(b) Object D was scraped and redesigned because the different parts were being delivered sized wrong and it was ending up overweight because of all of the experiments on board. It ended up being too complex. An Interface Control Document could have helped the program by ensuring cohesion for the systems onboard and prevented redundancy.

(c) Sputnik 1 had a fan in it's temperature regulation system. Did the Sputnik 1 have a fan. This cooling system used the fan to keep the sattalite within the safe operating area of the electronics on board.

The "Traitorous Eight" left Shockley Semiconductor Laboratory to form Fairchild Semiconductor in Mountain View CA. They brought silicon to "Silicon Valley" in order to make transistors. They went on to invent the integrated circuits which help the ability to design light satellites.

(d) The Redstone was a descendant of the V2 rocket, with an upgraded engine with higher thrust.

(e) Table:

	R7	Redstone
Thrust	8000,000lbf	78,000 pounds-force
class	ICBM	SRBM
payload	KB-11 warhead ($\tilde{1}$2,000lb)	W39 warhead (6,900lb)
data rate	20.005–40.002 MHz	108.03 MHz
ICs?	Vacuum Tubes	uses ICs

Problem 2

(a) – done –

(b) – done –

Problem 3

(a) Two Line Elements (TLEs) were originally developed as a way to predict the location of Earth orbiting satellites with minimal amount of data elements. The original model was developed by Max Lane in the 1960s and an improved version became TLE format in the 1970s. It was originally developed for use on punch cards but is now formatted into a text file. TLEs are still used and useful today for describing the trajectories and locations of Earth orbiting items.

(b) Beginings of a TLE reader

(i) My TLE file:

```
ISS (ZARYA)
1 25544U 98067A   21020.73928083 -.00000437  00000-0  21336-6 0  9991
2 25544  51.6446 352.0168 0000410 314.0614 106.8284 15.49300430265749
KESTREL EYE IIM (KE2M)
1 42982U 98067NE  21020.34479427  .00027274  00000-0  14742-3 0  9993
2 42982  51.6324 247.7774 0003818 193.2461 166.8441 15.79895238185238
DELLINGR (RBLE)
1 43021U 98067NJ  21020.31781189  .00035075  00000-0  17032-3 0  9999
2 43021  51.6303 244.6421 0003355 158.9585 201.1556 15.82092661181044
TEMPEST-D
1 43547U 98067NV  21020.46056417  .00017990  00000-0  14022-3 0  9999
2 43547  51.6344 291.5848 0006267 141.2688 218.8761 15.71767240143513
RADSAT-G
1 43553U 98067PB  21019.70651218  .00063592  00000-0  25764-3 0  9995
2 43553  51.6356 264.8415 0005745 174.3942 185.7127 15.85640382144236
AEROCUBE 12A
1 43556U 18046C   21020.52077132  .00002004  00000-0  78317-4 0  9990
2 43556  51.6410 141.9221 0007821 356.3931   3.6992 15.30838287140616
AEROCUBE 12B
1 43557U 18046D   21020.49947023  .00001173  00000-0  51525-4 0  9990
2 43557  51.6419 143.2581 0007880 355.9702   4.1213 15.30385996140544
LEMUR-2-VU
1 43558U 18046E   21020.60423100  .00003555  00000-0  12299-3 0  9999
2 43558  51.6403 135.8770 0006873   1.2966 358.8032 15.32551271140696
LEMUR-2-ALEXANDER
1 43559U 18046F   21020.61167735  .00003052  00000-0  10662-3 0  9994
2 43559  51.6403 135.1947 0006854   1.1781 358.9215 15.32744782140481
LEMUR-2-YUASA
1 43560U 18046G   21020.50184291  .00002461  00000-0  88887-4 0  9998
2 43560  51.6409 136.6877 0007169  13.9236 346.1942 15.32501158140678
LEMUR-2-TOMHENDERSON
1 43561U 18046H   21020.48717115  .00001847  00000-0  70313-4 0  9995
2 43561  51.6406 137.3289 0007364  13.9347 346.1837 15.32179814140225
1998-067PN
1 43638U 98067PN  21020.46299597  .00019854  00000-0  15307-3 0  9996
2 43638  51.6337 288.5566 0003417 129.4294 230.7007 15.71962071130717
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1998-067PP
1 43639U 98067PP  21020.56468460  .00109790  00000-0  37799-3 0  9993
2 43639  51.6273 265.7779 0005729 162.0634 198.0574 15.88744100131028
STARS-ME
1 43640U 98067PQ  21019.96420598  .00035760  00000-0  22746-3 0  9998
2 43640  51.6308 283.6183 0005054 134.4845 225.6569 15.76079075130732
ISS DEB (SEDA-AP)
1 43870U 98067PU  21020.11522524  .00005078  00000-0  67479-4 0  9996
2 43870  51.6372 318.6278 0004599 128.8248 231.3157 15.60143765118452
CATSAT-2
1 44029U 98067PV  21019.96507292  .00071544  00000-0  35992-3 0  9994
2 44029  51.6388 289.8325 0004244 162.8595 197.2551 15.81010896112552
DELPHINI
1 44030U 98067PW  21020.13748814  .00094368  00000-0  36829-3 0  9993
2 44030  51.6285 283.9315 0005667 158.6825 201.4416 15.86260516112619
UNITE
1 44031U 98067PX  21020.49382834  .00020031  00000-0  17957-3 0  9996
2 44031  51.6374 303.8816 0003494 144.6628 215.4601 15.68299211112388
CATSAT-1
1 44033U 98067PZ  21020.02832685  .00067643  00000-0  34027-3 0  9998
2 44033  51.6387 289.5145 0003879 163.4629 196.6500 15.81036507112476
ISS DEB
1 44303U 98067QA  21020.57338348  .00006807  00000-0  99374-4 0  9997
2 44303  51.6412 334.5874 0005968  61.3700 298.7891 15.56937260 93554
ISS DEB
1 44304U 98067QB  21020.50478864  .00093013  00000-0  46060-3 0  9997
2 44304  51.6345 305.4834 0005777 108.0601 252.1031 15.81239845 93945
ISS DEB
1 44305U 98067QC  21017.99978115  .07702457  12184-4  93942-3 0  9998
2 44305  51.6090 302.5059 0006259 207.7361 152.3330 16.35437524 93752
ISS DEB
1 44306U 98067QD  21020.57536360  .00008034  00000-0  11487-3 0  9996
2 44306  51.6398 334.5170 0007095  57.5604 302.6073 15.57207924 93568
RAAVANA-1
1 44329U 98067QE  21020.25196836  .00022921  00000-0  22946-3 0  9999
2 44329  51.6376 322.6169 0006596  95.2715 264.9033 15.65436194 90860
UGUISU
1 44330U 98067QF  21020.21770325  .00021019  00000-0  21262-3 0  9995
2 44330  51.6353 323.0809 0006573  94.4164 265.7582 15.65234548 90831
NEPALISAT-1
1 44331U 98067QG  21020.24323934  .00021861  00000-0  21928-3 0  9993
2 44331  51.6352 322.5030 0006588  96.9206 263.2539 15.65419290 90857
SPOOQY-1
1 44332U 98067QH  21020.52578715  .00024723  00000-0  25022-3 0  9993
2 44332  51.6362 321.4091 0005843 100.0269 260.1386 15.65115919 90850
RED-EYE 1 (PINOT)
1 44364U 98067QJ  21020.59007413  .00008133  00000-0  11796-3 0  9997
2 44364  51.6412 335.4328 0007361  56.9054 303.2643 15.56796855 89135
IOD-1 GEMS
1 44385U 98067QK  21020.52074404  .00081159  00000-0  49771-3 0  9990
2 44385  51.6357 311.6620 0004974 104.4200 255.7352 15.76559516 88507
SWIATOWID
1 44426U 98067QL  21020.53892361  .00103053  00000-0  50184-3 0  9995
2 44426  51.6373 307.6022 0006219 122.4693  47.9850 15.81557616 88567
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KRAKSAT
1 44427U 98067QM  21020.29540057  .00012483  00000-0  15109-3 0  9995
2 44427  51.6435 330.1611 0004164  63.2003  90.1888 15.61088781 88286
VCC A
1 44428U 98067QN  21020.54592452  .00024181  00000-0  25214-3 0  9996
2 44428  51.6387 323.8888 0003947  80.4962 279.6479 15.64384651 88391
ENTRYSAT
1 44429U 98067QP  21020.53600797  .00034268  00000-0  31371-3 0  9996
2 44429  51.6350 319.9920 0003951  84.8917 275.2531 15.67448215 88445
VCC C
1 44430U 98067QQ  21020.51679231  .00049083  00000-0  36739-3 0  9999
2 44430  51.6344 315.3550 0004309  99.1439 261.0047 15.72149526 87336
VCC B
1 44431U 98067QR  21020.14980700  .00020257  00000-0  21089-3 0  9999
2 44431  51.6363 325.6929 0004110  78.1062 282.0394 15.64545855 88279
ISS DEB
1 44788U 98067QT  21020.57600927  .00056531  00000-0  48628-3 0  9993
2 44788  51.6379 329.2900 0006537  92.2060 267.9685 15.68733278 67296
ISS DEB
1 44789U 98067QU  21020.14696255  .00041436  00000-0  38830-3 0  9998
2 44789  51.6375 333.2014 0007228  89.2563 270.9261 15.66755860 67198
RWASAT-1
1 44790U 98067QV  21020.31957553  .00010611  00000-0  15478-3 0  9994
2 44790  51.6438 342.2854 0008710 101.7714  49.0428 15.56250295 66355
AQT-D
1 44791U 98067QW  21020.59040147  .00010518  00000-0  15342-3 0  9993
2 44791  51.6424 341.4677 0007497  77.2794 282.9035 15.56271231 66390
NARSSCUBE-1
1 44792U 98067QX  21020.16641120  .00015593  00000-0  20061-3 0  9997
2 44792  51.6397 340.0730 0006056  92.5695 267.5991 15.59242779 66371
STPSAT-4
1 45043U 98067QY  21020.34051366  .00004689  00000-0  83688-4 0  9993
2 45043  51.6423 350.9739 0006277  87.1309 273.0400 15.52134464 55488
HARP
1 45256U 98067QZ  21020.29625832  .00010266  00000-0  15794-3 0  9998
2 45256  51.6428 347.7171 0007897  81.9486 278.2401 15.54832969 52190
1998-067RA
1 45257U 98067RA  21020.32495599  .00007929  00000-0  12602-3 0  9995
2 45257  51.6419 347.8835 0008463  83.4698 276.7256 15.54302323 52198
PHOENIX
1 45258U 98067RB  21020.31372129  .00006949  00000-0  11383-3 0  9994
2 45258  51.6416 348.5455 0006756  67.1368 293.0335 15.53696731 52152
1998-067RC
1 45259U 98067RC  21020.19050464  .00012623  00000-0  18382-3 0  9998
2 45259  51.6408 346.9849 0007811  81.5648 278.6229 15.56099486 52199
CRYOCUBE
1 45260U 98067RD  21020.29755155  .00015006  00000-0  21712-3 0  9999
2 45260  51.6407 346.2020 0008470  82.3706 277.8247 15.56097411 52221
AZTECHSAT-1
1 45261U 98067RE  21020.17891750  .00016306  00000-0  22218-3 0  9995
2 45261  51.6403 345.4071 0008222  81.8639 278.3286 15.57652047 52210
RADSAT-U
1 45262U 98067RF  21020.17661766  .00008406  00000-0  13221-3 0  9994
2 45262  51.6431 348.4162 0007172 111.7800 248.3954 15.54507618 52187
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QARMAN
1 45263U 98067RG  21020.16664863  .00013027  00000-0  19069-3 0  9996
2 45263  51.6409 347.5727 0007827  78.5084 281.6785 15.55924775 52215
SORTIE
1 45264U 98067RH  21020.60603538  .00006059  00000-0  10358-3 0  9997
2 45264  51.6430 348.2694 0008115  88.8818 271.3101 15.52752141 52212
ICS-EF (ISS DEB)
1 45265U 98067RJ  21020.29376109  .00002823  00000-0  55263-4 0  9994
2 45265  51.6428 352.1547 0006110  87.6937 272.4752 15.51143175 51812
PROGRESS-MS 14
1 45595U 20026A   21019.40295723  .00000872  00000-0  23712-4 0  9999
2 45595  51.6468 358.6249 0000255 279.1625 243.4938 15.49302954265537
G-SAT
1 45597U 98067RK  21020.18229811  .00008488  00000-0  13529-3 0  9998
2 45597  51.6421 349.9388 0005122 129.6015 230.5429 15.54131356 41520
QUETZAL-1
1 45598U 98067RL  21020.18806342  .00011832  00000-0  18213-3 0  9991
2 45598  51.6425 349.9742 0002701 137.0479 223.0723 15.54666718 41457
RED-EYE 2 (MERLOT)
1 45800U 98067RM  21020.37105148  .00004321  00000-0  79240-4 0  9997
2 45800  51.6430 351.9362 0001992  99.2169 260.9046 15.51570261 33684
RED-EYE 3 (CABERNET)
1 45809U 98067RN  21020.37163286  .00004351  00000-0  79743-4 0  9994
2 45809  51.6430 351.9404 0002228  91.0917 269.0328 15.51568025 32669
DEMI
1 45916U 98067RP  21020.17521634  .00011496  00000-0  18198-3 0  9990
2 45916  51.6427 351.3888 0003062  46.3480 313.7764 15.53921426 29644
TECHEDSAT 10
1 45917U 98067RQ  21020.59076000  .00129187  00000-0  10075-2 0  9991
2 45917  51.6354 341.3805 0007980  88.1853 272.0059 15.70735801 29769
PROGRESS-MS 15
1 45937U 20050A   21019.40295723  .00000872  00000-0  23712-4 0  9996
2 45937  51.6468 358.6249 0000255 279.1625 243.4938 15.49302954265537
CYGNUS NG-14
1 46530U 20069A   21020.73929850  .00002253  00000-0  94558-4 0  9990
2 46530  51.6416 354.2275 0010644 337.0536  82.7912 15.27811863 16977
SOYUZ-MS 17
1 46613U 20072A   21019.40295723  .00000872  00000-0  23712-4 0  9992
2 46613  51.6468 358.6249 0000255 279.1625 243.4938 15.49302954265539
CREW DRAGON 1
1 46920U 20084A   21019.40295723  .00000872  00000-0  23712-4 0  9996
2 46920  51.6468 358.6249 0000255 279.1625 243.4938 15.49302954265530
SPOC
1 46921U 98067RR  21020.32345052  .00006955  00000-0  12289-3 0  9991
2 46921  51.6441 353.1239 0001159 231.6847 128.4039 15.51549976 11841
BOBCAT-1
1 46922U 98067RS  21020.31191849  .00009221  00000-0  15765-3 0  9995
2 46922  51.6442 353.0493 0000680 231.3485 128.7444 15.52038045 11807
NEUTRON-1
1 46923U 98067RT  21020.19912651  .00006475  00000-0  11536-3 0  9994
2 46923  51.6441 353.7926 0000993 260.3518  99.7359 15.51447767 11852
1998-067RU
1 46924U 98067RU  21020.16509533  .00014286  00000-0  23289-3 0  9990
2 46924  51.6436 353.5652 0001056 356.8432   3.2551 15.52876122 11821
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LEMUR-2-BAXTER-OLIVER
1 46925U 98067RV  21020.22268771  .00015016  00000-0  24234-3 0  9997
2 46925  51.6441 353.2046 0001160 345.8670  14.2287 15.53111457 11798
LEMUR-2-DJARA
1 46926U 98067RW  21020.29182299  .00013883  00000-0  22587-3 0  9994
2 46926  51.6440 352.9156 0000270   4.2141 355.8852 15.52958214 11821
DESCENT
1 46927U 98067RX  21020.33052309  .00006839  00000-0  12156-3 0  9992
2 46927  51.6439 353.1694 0001268 303.6383  56.4485 15.51414996 11786
```

(ii) – cloned to local drive –

(iii) – Done –

(iv) – Done –

(v) – Done –

(vi) – Done –

(vii) See Figures 1 and 2

Figure 1: Ground Station Display

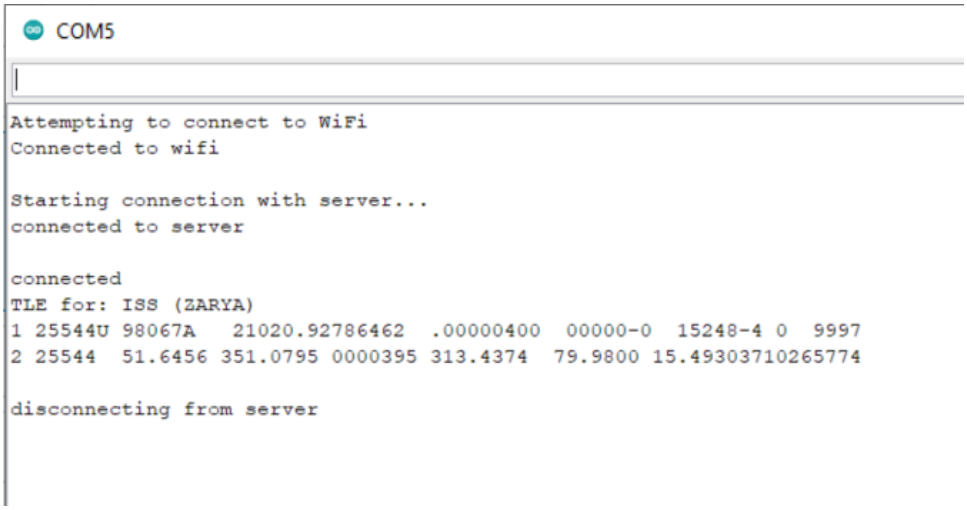

Figure 2: Serial Monitor

(viii) https://github.com/gypsyinagirl/SpacecraftDesignSchneider

(ix) (BONUS)

Problem 4

(a) See Figure 3

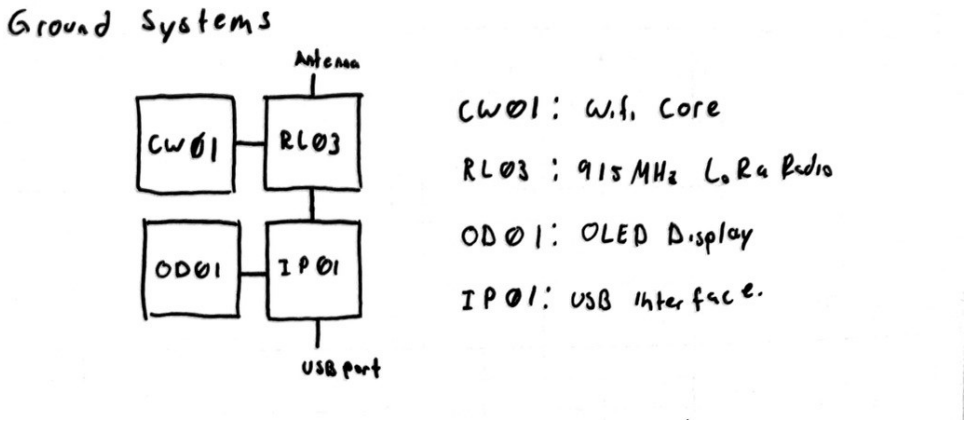

Figure 3: Ground Station

(b) See Figure 4
I2C: multi-master, multi slave packet switched communication bus
SPI: single master slave communcation bus
UART: sends data by bits one-by-one

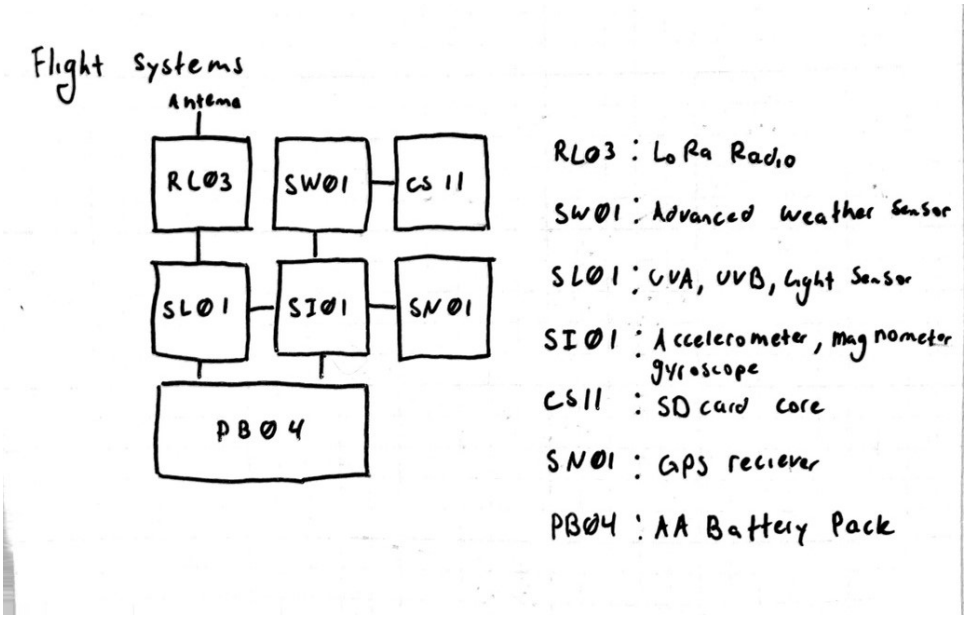

Figure 4: Flight Station