# AE 450
# Individual Design Project
# Mars Entry Probe Parachute Design

You are to design a parachute system for a probe entering Mars' atmosphere. The parachute system is to decelerate the probe to a velocity less than or equal to 60 m/s by the time it reaches an altitude of 100 m. The probe itself has a mass of 300 kg and a circular cross section with a projected area of 3.14 square meters. **At a minimum, you must determine the altitude at which the parachute is to be deployed and the size of the parachute.** You also should attempt to include an estimate of the mass of the parachute and the materials to be used in its construction. It is desirable for the parachute to be as light as feasible.

At a first pass design, you may consider only the drag on the parachute and model the parachute and the probe as a lumped system. You must develop a numerical model to predict the trajectory of the system. You must develop a numerical model to predict the trajectory of the system after the parachute deployment. It is advisable to start your project by doing background research on previous Mars probes and the recovery systems that were used on those missions (Pathfinder, Viking, etc.).

Your report should include discussions of the performance requirements, the methodology you used to develop your model of the system, your final design, and the reasoning that went into your design selections. **There is not a single solution for the problem, but many combinations may meet the basic requirements.** Therefore, address the reasons for your specific selections.

The trajectory of the probe *without a parachute* is listed below. Any point in this trajectory can, at your discretion, be used as the deployment time for the parachute and the starting time for your simulation routine.

# MARS ATMOSPHERIC PROBE ENTRY TRAJECTORY

| t(s) | Alt(m) | Vel(m/s) | Gamma | Den(kg/m^3) |
|---|---|---|---|---|
| 0.0 | 125000.00 | 7101.2 | -16.00 | 0.6310E-08 |
| 1.0 | 122981.98 | 7102.2 | -15.91 | 0.7799E-08 |
| 2.0 | 120974.67 | 7103.2 | -15.82 | 0.9281E-08 |
| 3.0 | 118978.08 | 7104.1 | -15.73 | 0.1352E-07 |
| 4.0 | 116992.23 | 7104.1 | -15.64 | 0.2035E-07 |
| 5.0 | 115017.15 | 7106.0 | -15.55 | 0.2714E-07 |
| 6.0 | 113052.85 | 7107.0 | -15.47 | 0.3390E-07 |
| 7.0 | 111099.36 | 7107.9 | -15.38 | 0.4062E-07 |
| 8.0 | 109156.69 | 7108.9 | -15.29 | 0.5406E-07 |
| 9.0 | 107224.87 | 7109.8 | -15.20 | 0.7620E-07 |
| 10.0 | 105303.93 | 7110.7 | -15.11 | 0.9822E-07 |
| 11.0 | 103393.87 | 7111.6 | -15.02 | 0.1201E-06 |
| 12.0 | 101494.73 | 7112.4 | -14.93 | 0.1419E-06 |
| 13.0 | 99606.53 | 7113.3 | -14.84 | 0.1708E-06 |
| 14.0 | 97729.29 | 7114.1 | -14.75 | 0.2271E-06 |
| 15.0 | 95863.03 | 7115.0 | -14.66 | 0.2831E-06 |
| 16.0 | 94007.78 | 7115.7 | -14.57 | 0.3671E-06 |
| 17.0 | 92163.57 | 7116.5 | -14.48 | 0.4752E-06 |
| 18.0 | 90330.43 | 7117.1 | -14.39 | 0.5826E-06 |
| 19.0 | 88508.38 | 7117.8 | -14.30 | 0.7714E-06 |
| 20.0 | 86697.48 | 7118.3 | -14.20 | 0.9772E-06 |
| 21.0 | 84897.74 | 7118.7 | -14.11 | 0.1193E-05 |
| 22.0 | 83109.23 | 7119.0 | -14.02 | 0.1594E-05 |
| 23.0 | 81332.00 | 7119.1 | -13.93 | 0.1992E-05 |
| 24.0 | 79566.10 | 7119.0 | -13.84 | 0.2480E-05 |
| 25.0 | 77811.60 | 7118.6 | -13.75 | 0.3249E-05 |
| 26.0 | 76068.59 | 7117.9 | -13.66 | 0.4012E-05 |
| 27.0 | 74337.16 | 7116.9 | -13.57 | 0.5043E-05 |
| 28.0 | 72617.44 | 7115.2 | -13.48 | 0.6505E-05 |
| 29.0 | 70909.57 | 7113.0 | -13.39 | 0.7957E-05 |
| 30.0 | 69213.72 | 7110.0 | -13.29 | 0.9999E-05 |
| 31.0 | 67530.08 | 7106.0 | -13.20 | 0.1272E-04 |
| 32.0 | 65858.91 | 7100.7 | -13.11 | 0.1541E-04 |
| 33.0 | 64200.49 | 7094.2 | -13.02 | 0.1921E-04 |
| 34.0 | 62555.16 | 7085.8 | -12.93 | 0.2418E-04 |
| 35.0 | 60923.38 | 7075.2 | -12.84 | 0.2911E-04 |
| 36.0 | 59305.57 | 7062.4 | -12.74 | 0.3569E-04 |
| 37.0 | 57702.33 | 7046.2 | -12.65 | 0.4445E-04 |
| 38.0 | 56114.38 | 7026.3 | -12.56 | 0.5312E-04 |