



Space Mission Assignment



Preamble

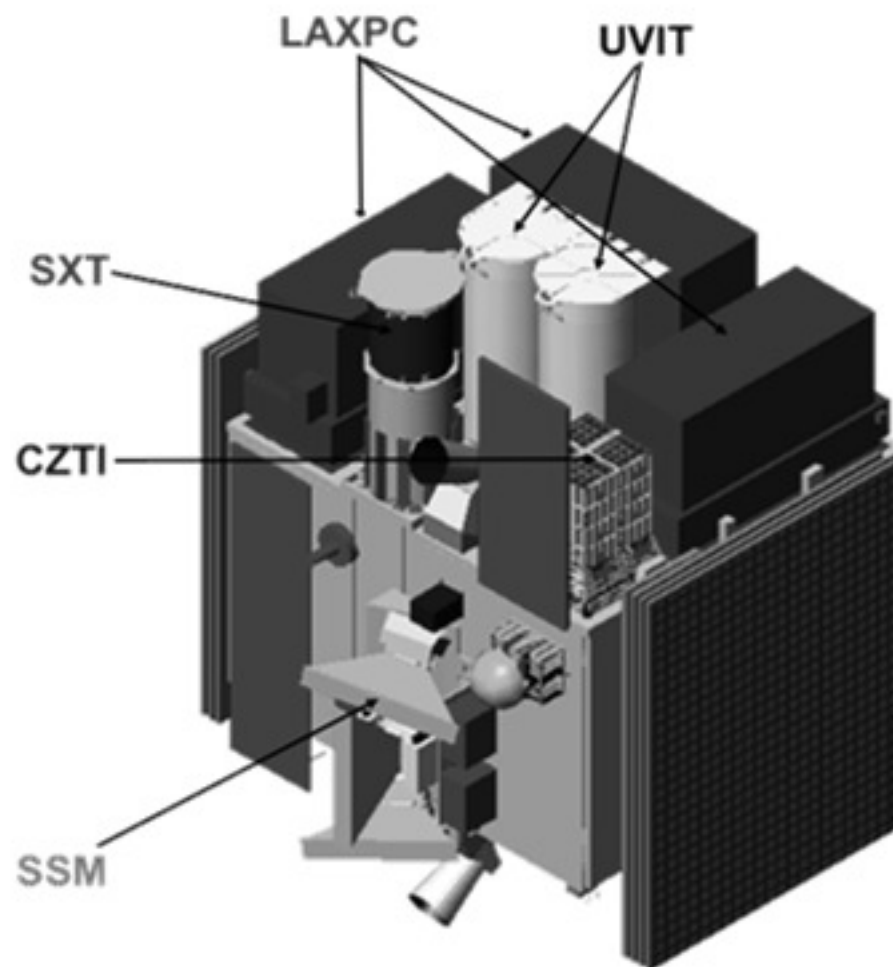
Space mission **assignment** aims to provide an **opportunity** to have a hands-on **experience** of various **tools** that help **create** a complete space mission **profile**.

The above **exercise** is set up through a process of **recreating** an existing **mission**, as closely as possible.

An example of **ASTROSAT** is taken to show the **information** / process applicable for such **missions**.



ASTROSAT – Schematic





ASTROSAT – Launch Objectives

"The satellite is planned to be launched during the second half of 2015 by PSLV C-34 to a 650 km near equatorial orbit around the Earth."



ASTROSAT – General Information

Launch date: 28 September 2015

Launch site: Satish Dhawan Space Centre, SHAR

Launch vehicle: PSLV-XL

Mission length: 5 years

Mass: 1,650 kg

Type of orbit: Near-equatorial Circular Orbit

Height: 650 km (400 mi)

Orbit period: 1h38m



PSLV-XL – Schematic



Height 44 metres (144 ft)

Diameter 2.8 metres (9 ft 2 in)

Mass 320,000 kg

Stages 4



PSLV-XL Propulsion Details

No. boosters 6 Thrust 719 kN each Specific impulse 262 s, Burn time 49 seconds.

First Stage Engines Thrust 4,800 kN Specific impulse 237s (sea level), 269 s (vacuum), Burn time 105 seconds.

Second Stage Engines Thrust 799 kN Specific impulse 293 s, Burn time 158 seconds.

Third Stage Engines Thrust 240 kN Specific impulse 295 s, Burn time 83 seconds

Fourth Stage Engines Thrust 15.2 kN Specific impulse 308 s, Burn time 425 seconds.

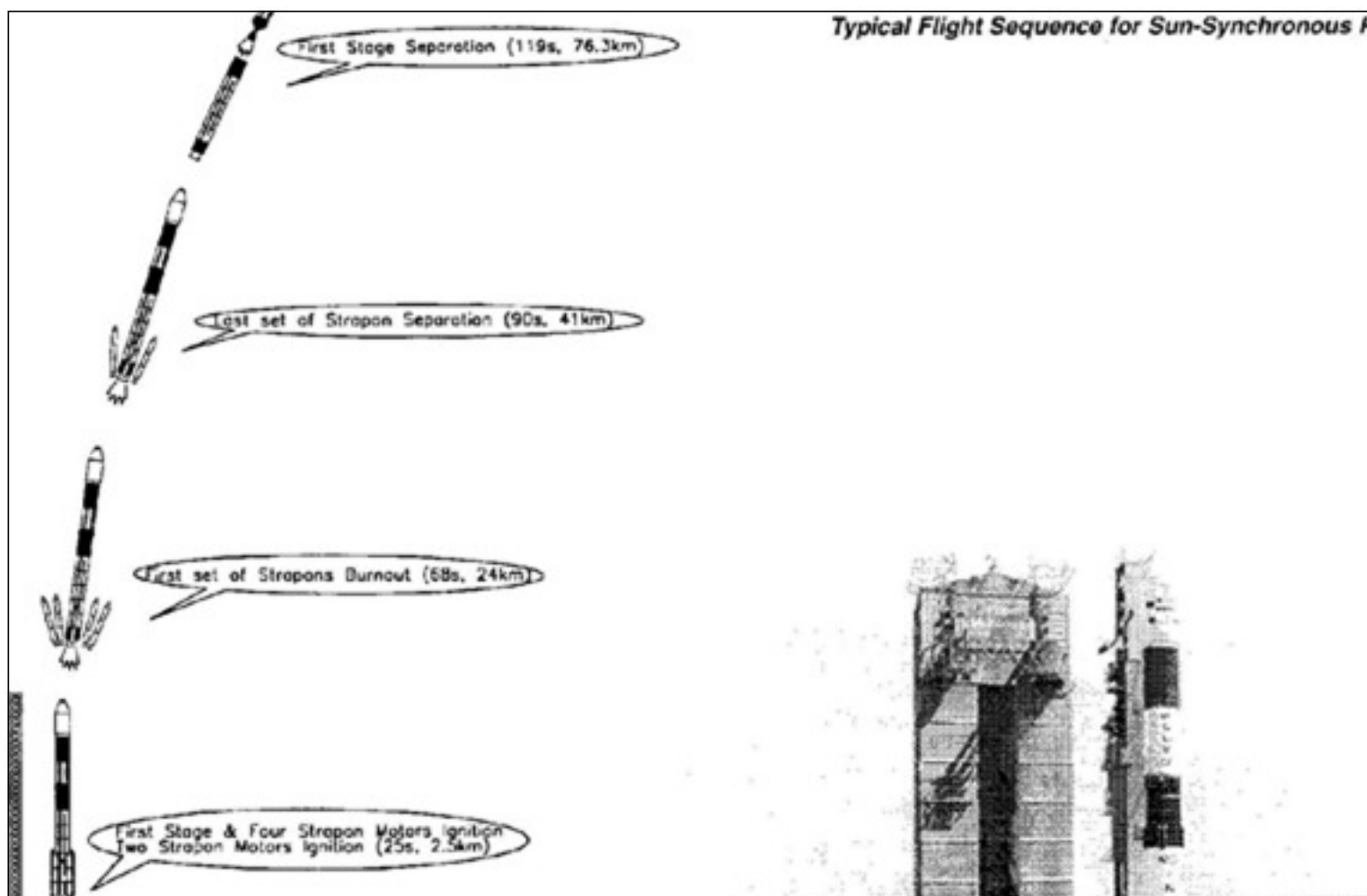


PSLV-XL Mass Configuration

	Boosters (PSOM, S9)	(PS1, S138)	(PS2, PL-40)	(HP53, S7)	(PS4, L2)
Dimensions					
Length	11.3 m (37 ft)	20 m (66 ft)	12.5 m (41.0 ft)	3.5 m (11.5 ft)	2.9 m (9.5 ft)
Diameter	1.0 m (3.3 ft)	2.8 m (9.2 ft)	2.8 m (9.2 ft)	2.0 m (6.6 ft)	2.0 m (6.6 ft)
Mass					
Propellant Mass	9.0 t (19.8 kbm) each	138.0 t (304 kbm)	40.5 t (89.3 kbm)	7600 kg (16,750 lbm)	2500 kg (5500 lbm)
Inert Mass	2.0 t (4.4 kbm)	30.0 t (66.1 kbm)	5.3 t (11.7 kbm)	940 kg (2068 lbm)	830 kg (1826 lbm)
Gross Mass	11.0 t (24.3 kbm)	168.0 t (370.2 kbm)	45.8 t (101 kbm)	8500 kg (18,700 lbm)	3330 kg (7326 lbm)
Propellant Mass Fraction	0.81	0.82	0.88	0.88	0.73
Structure					
Type	Monocoque	Monocoque	Tanks: monocoque Interstage: skin-stringer	Filament-wound monocoque	Monocoque
Material	Steel	M250 Steel	Aluminum alloy	Polyaramid fiber/epoxy	Tanks: titanium Structures: composite
Propulsion					
Engine Designation	PSOM (ISRO)	PS1 (ISRO)	Vikas (ISRO)	HPM (ISRO)	PS4 (ISRO)
Number of Engines	6 (3 segments each)	1 (5 segments)	1	1	2
Propellant	HTPB	HPTS	N_2O_4/UDS	HTPB	MON-3MMH
Average Thrust (Vacuum)	677 kN (152 kbf) each	4430 kN (995 kbf)	804 kN (180.7 kbf)	260 kN (58.5 kbf)	2x7.4 kN (1.7 kbf)
Ign (Vacuum)	262 s	269 s	293 s	295 s	305 s
Chamber Pressure	?	?	58 bar (841 psi)	60.4 bar (876 psi)	8.5 bar (123 psi)
Nozzle Expansion Ratio	8:1	8:1	31:1	69:1	60:1
Propellant Feed System	—	—	Gas generator turbopump	—	Pressure fed
Mixture Ratio (O/F)	—	—	1.7:1	—	1.6:1
Throttling Capability	No	No	No	No	No
Restart Capability	No	No	No	No	1 restart
Tank Pressurization	—	—	Helium	—	Helium
Attitude Control					
Pitch, Yaw	Controlled by Stage 1	SITVC	Nozzle gimbal ± 4 deg	Flexural nozzle gimbal ± 2 deg	Electromechanical nozzle gimbal ± 4 deg
Roll	SITVC	Roll control thrusters	Hot gas RCS	Stage 4 RCS	50 N (11 lbf) bipropellant RCS
Staging					
Nominal Burn Time	44.2 s	105 s	147 s	115 s	500 s



PSLV-XL Flight Sequence (Partial)





Mission Allocation Format

Missions will be allocated **individually** to each student through an **allocation** table, as per **sample** below.

Space Mission
Delta II 7320-10, WISE Spacecraft
Saturn V SA-512, Apollo 17 Mission
M-V-6, Suzaku Satellite

In this **column**, 1st entry is the launch **vehicle**, while the second entry is the **spacecraft** mission definition.



Tasks to be Carried Out

Gather information regarding the mission.

Determine spacecraft orbit / trajectory & find key events, including applicable manoeuvre components.

Determine connection between orbit & objectives.

Design nominal rocket trajectory for spacecraft initial conditions.

Design nominal burn profiles for all stages of the launch vehicle.



Submission Requirements

Assignment should contain **relevant** solution details, including **assumptions** made, along with **justifications**.

Be **concise** and to the point, **without** leaving gaps or ignoring **important** results.

In case any **software tool** (e.g. matlab, scilab etc.) is used, **submission** must include code soft **copy** (or workspace command history or other evidence), for **verification**.



Copying Criteria & Penalties

It is **expected** to be an **individual's** own effort.

Use of **same** solution format, method and/or **same** document format, etc. will be treated as **copying**.

More than 30% common **content** on any one of the above counts will be deemed to satisfy **copying criteria**.

Zero marks will be **given** to all those assignments **found** to satisfy copying **criterion**.

Clarification should be **sought** only from **instructor**.



Evaluation Scheme

Consists of both **moodle** submission (PDF only) & **viva**.

Marking Scheme

12 marks are for submission, **8** marks are for viva.

Moodle **solution** will be evaluated on (1) **completeness** and (2) **correctness** (6 marks each). **Part** marking will be based on the **extent** of completion and correctness.

Viva will be based on **submitted** solution & expectations.



Submission & Evaluation Timelines

Submission deadline is Friday 23rd April **midnight**.

Further, **viva** for the assignment will be **conducted** during 24th and 25th April, as per the mutual **convenience** of students and **TAs**.

Students have the option to **submit** and get their **viva** conducted **earlier** than the deadline, if so **desired**.