Assignment 2 AE330/708

Due date: 15-09-2020 11:59 pm

(Kindly follow the instructions provided in the first assignment)

1) A satellite is launched from a circular equatorial parking orbit at an altitude of 160 km into a coplanar circular synchronous orbit by using a Hohmann transfer ellipse. Assume a homogeneous spherical earth with a radius of 6374 km. Determine the velocity increments for entering the transfer ellipse and for achieving the synchronous orbit at 42,200 km altitude.

2) A research space vehicle in gravity-free and drag-free outer space launches a small spacecraft. The 2 kg instrument package of this spacecraft (25 kg total mass) limits the maximum acceleration to no more than 50 m/s^2. It is launched by solid rocket (Is = 260 sec and propellant mass fraction = 0.88). Determine the allowable burn time and the maximum velocity.

3) Consider a single stage rocket having total initial mass 100000 kg, structural mass of 9975 kg and payload mass of 1025 kg. The specific impulse of the rocket is 400 sec. Determine the velocity imparted to the payload. Further, if we want to configure the two stage rocket with same total initial mass, structural mass and payload mass, determine the increment in the payload velocity. (Assume identical stages and similar engines power both the stages with specific impulse of 400 sec)

4) A four-stage rocket is used to put up a satellite of 40 kg mass in a low earth orbit. The approximate stage details are as below:

STAGE	I	II	III	IV
Propellant mass (kg)	9000	3500	1700	260
Structural mass (kg)	1500	550	250	40
Effective exhaust velocity (m/s)	2200	2400	2500	2750

Determine: Mass ratios of different stages and total velocity imparted to the satellite. If the first stage fires for a period of 50 sec and the rate of propellant flow is assumed constant, what would be the acceleration of the rocket at take-off.

5) Derive the expressions for burn-out altitude and maximum altitude of a single stage sounding rocket assuming drag-free environment. The expressions must be expressed in terms of propellant loading (η) and burn time (t_b). Apply your results for a take-off from moon's surface (where the gravitational acceleration is 1/6th of earth's gravitational acceleration) using a sounding rocket with vacuum specific impulse of 180 seconds and propellant loading of 0.8 that burns for 25 seconds. (Caution: Specific impulse is generally determined on the earth)