

UCL Mechanical Engineering 2021/2022

MECH0024 Coursework

RFLH9

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Part I

SpaceX rocket engine essay

SpaceX has been developing rocket engines for nearly two decades. The two primary engine families in use today are the Merlin series and the Raptor series. The Draco and SuperDraco series of engines have also been developed by SpaceX, however their role as Reaction Control System (RCS) thrusters and Launch Abort System engines respectively leave them to be not considered in this essay. SpaceX has developed these rocket engines to power a variety of booster rockets, including the Falcon 9, Falcon Heavy and Starship. The roles of these rockets include delivering crew and cargo to space, as well as interplanetary travel. SpaceX places a strong emphasis on reusability and a reduction of ‘cost to launch’. Hence, the engines powering these flights must be efficient, powerful and reliable to facilitate multiple missions.

The Merlin series of engines power the Falcon 9 and Falcon Heavy rocket boosters. These are two-stage rockets, primarily designed to place cargo and crew into earth orbit. The first stage is powered by nine Merlin ‘sea level’ engines and the second stage is powered by one Merlin ‘vacuum’ engine. There have been a variety of developments over the past years and the current generation of Merlin engines are the Merlin 1D. The Merlin 1D uses Rocket Propellant 1 (RP-1) and liquid oxygen for combustion in a gas-generator staged combustion cycle.

Part II

Sea Level and Vacuum Merlin 1D rocket engines analysis

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- 1.1 Estimation of ideal OF ratio & comparison with typical value
- 1.2 Estimation of isentropic index γ
- 1.3 Estimation of molecular weight of combustion products M_g
- 1.4 Estimation of heat capacity c_p
- 1.5 Estimation of the adiabatic flame temperature of the combustion product in the combustion chamber

2 Determination of mass flux through both rocket engines

3 Estimation of exit velocity of jet exhaust in both cases

4 Estimation of exit pressure of the exhaust in both cases

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6.1 At sea level

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7 Description of other technologies (and their working principles), which accommodate the change in back-pressure on thrust performance