

Code.No: 37168

R05

SET-1

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**IV.B.TECH - I SEMESTER REGULAR EXAMINATIONS NOV/DEC, 2009**  
**ROCKETS AND MISSILES**  
**(AERONAUTICAL ENGINEERING)**

**Time: 3hours**

**Max.Marks:80**

**Answer any FIVE questions**  
**All questions carry equal marks**

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1. Sketch and explain pyrogen ignition system and mention its advantages over other systems. [16]
- 2.a) Describe the combustion chamber and nozzle of a liquid rocket engine.  
b) Describe like-on-like and unlike propellant injectors.  
c) Describe the ignition system for a liquid oxygen and liquid hydrogen system. [8+4+4]
- 3.a) Describe the aerodynamic forces, moments and longitudinal stability of a rocket with neat sketches.  
b) Describe the various types of drag acting on a rocket. In your opinion which is the largest contributor? [10+6]
- 4.a) Derive the rocket equation (Tsiolkovsky's equation).  
b) What is induced drag and how does it depend upon the aspect ratio?  
c) Set up the equations of motion of a rocket (assuming point mass system) in a gravity turn trajectory.  
d) Differentiate between free space and homogeneous gravity. [4+4+4+4]
5. Derive the expression for the culmination altitude of a two stage rocket. Make suitable assumptions, but do not assume vertical flight or free space. Mention all the assumptions very clearly. [16]
- 6.a) Explain with a neat sketch, thrust vector control of a solid propellant motor using a flexible nozzle. Mention clearly which part of the nozzle is flexible.  
b) Is it possible to have thrust vector control with fixed (non-moving) liquid engines? If so, explain using neat sketches. [10+6]
- 7.a) Sketch and explain separation of parallel stages.  
b) Are the systems for the separation of parallel stages and tandem stages similar or different? Explain.  
c) Set up equations of dynamics of separation for either parallel or tandem systems. [4+6+6]
8. What are the properties to be considered while selecting materials for different parts of a rocket? Explain in detail. [16]