Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2016

SUBJECT: ROCKETS AND MISSILES [AAE 320]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer any **FIVE FULL** questions.
- Missing data may be suitable assumed.

1A. Sketch & explain a typical 1-d model of combustion mechanism of a composite solid Propellants. Sketch the temperature profile in both the phases of the propellant. **(05)**

1B. Describe like-on-like and unlike propellant injectors. **(03)**

1C. With neat sketches distinguish between body up wash and body downwash in missile aerodynamics. **(02)**

2A. A rocket undergoes an inclined trajectory with constant pitch angle. The rocket develops constant thrust & its motion is in homogeneous gravitation field. Derive an expression for the burn out velocity & burn out altitude. Show that the vertical component of velocity is zero at culmination. Aerodynamic forces are negligible. **(05)**

2B. Determine the culmination altitude of i+1 stage rocket, ascending vertically in a homogenous gravitational field and in vacuum. **(03)**

2C. Explain secondary injection thrust vector control in a solid propellant motor. **(02)**

3A. What is thrust vector control? Explain the various methods of thrust vector control in a rocket. **(05)**

3B. What are the possible materials that can be used for nose/fore body, wings, &inter-stage couplings of short & long range ballistic missiles? Justify your answer. **(03)**

3C. What are the design requirements of Severance/ Release Mechanism systems? **(02)**

4A. What are the important design considerations in the selection of liquid rocket combustion chamber volume and shape? List out and explain them briefly. **(05)**

4B. Why are optical characteristics of materials of so much concern? **(03)**

4C. In designing separation mechanisms, what are the factors must be considered? **(02)**

5A. What are the various aerodynamic shaped for fore bodies of rockets and air breathing missiles? Sketch any two shapes and show typical pressure coefficient variation over the aerodynamic surfaces. What factors need to be considered for their selection? **(05)**

5B. A spacecraft's dry mass is 75,000 kg and the effective exhaust gas velocity of its main engine is 3,100 m/s. How much propellant must be carried if the propulsion system is to produce a total Δv of 700 m/s? **(03)**

5C. Derive an expression for the maximum ideal burn-out velocity of a two stage rocket of identical structural efficiencies. **(02)**

6A. List the factors (at least 6) on which the solid propellant ignitibility is dependent. **(03)**

6B. Derive the expression for the maximum ideal burn-out velocity of a multi-stage rocket of ‘n’ stages in free space. **(03)**

6C. A 5,000 kg spacecraft is in Earth orbit traveling at a velocity of 7,790 m/s. Its engine is burned to accelerate it to a velocity of 12,000 m/s placing it on an escape trajectory. The engine expels mass at a rate of 10 kg/s and an effective velocity of 3,000 m/s. Calculate the duration of the burn. **(02)**

6D. Explain: Mass ratio, Payload ratio, propellant ratio, and structural efficiency. **(02)**