

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institution of Manipal University

## V SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

## **END SEMESTER EXAMINATIONS, NOV/DEC 2016**

SUBJECT: AERODYNAMICS OF ROCKETS & MISSILES [AAE 4001]

## REVISED CREDIT SYSTEM (29/11/2016)

Time: 3 Hours

MAX. MARKS: 50

## Instructions to Candidates:

- ✤ Answer ALL the questions.
- ✤ Missing data may be suitable assumed.
- **1A.** Explain the classification of missiles based on range, launch platform, **(04)** guidance and method of launching
- **1B.** Explain the following with their definitions, advantages and disadvantages of **(04)** their designs.
  - a) wing controlled
  - b) canard controlled
  - c) tail controlled
  - d) body extension
- 1C. Consider a rocket baseline (reference diameter=0.35m) with 12% nose tip (02) bluntness, rocket nose bluntness ratio 2.7 at Mach 2.2. If then calculate the zero lift drag for wave with blunt nose.
- 2A. Explain the design features of Ogival nose section, Cylindrical mid-section (04) and Boattail of a missile. Also, write down the equation for aerodynamic center based on slender body theory.
- **2B.** Derive and prove that normal force coefficient is inversely proportional to **(04)** Mach number with the help of linearized theory. Also, derive the equation for diamond wedge airfoil the coefficient of drag is proportional to deflection angle of the airfoil.
- **2C.** Write down the two main approaches which we use for the prediction of **(02)** normal force on the surface of missiles.

- **3A.** How is flow field around an aircraft under pitch, yaw and side forces affecting **(03)** the air launch of a missile. (Use proper sketches to illustrate your answer)
- **3B.** With a neat sketch, explain the working of fragmentation warheads. (02)
- **3C.** What is conformal transformation? Name and Illustrate the transformation that results in an airfoil in the transformed plain.
- (05)

(04)

- **4A.** What is launch boundary for an air launched missile? How is it determined? **(03)**
- **4B.** What are the re-entry bodies design considerations used in ballistic missile to **(02)** reduce free- flight dispersion?
- **4C.** 'Guidance can be thought as the brain of a missile'. Give the processes **(05)** involved during guidance. Write a brief note on missile homing guidance system with classifications.
- **5A.** Write a brief note on:
  - i. Gyroscopic rigidity and precession.
  - ii. Propulsion system for BrahMos Missiles
  - iii. Sources of dispersion during launch phase of a missile
  - iv. Elliptic and Circular probable error
- **5B.** How is propellant and nozzle length determined for a missile using power- **(04)** plant design considerations.
- **5C.** What are the aerodynamic issues to be taken care during ground launch of a **(02)** missile?