# GUIDANCE AND CONTROLS

**II Semester:** AE

| Course Code | Category | Hours /Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAEC15 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes:45 | Tutorial Classes: Nil | Practical Classes: Nil | | | | Total Classes:45 | | |

## I. COURSE OVERVIEW:

Missile guidance refers to a variety of methods of guiding a missile or a guided bomb to its intended target. The missile's target accuracy is a critical factor for its effectiveness. Guidance systems improve missile accuracy by improving its Probability of Guidance. These guidance technologies can generally be divided up into a number of categories, with the broadest categories being "active," "passive" and "preset" guidance. This course deals with the introduction to missile system, airframe, autopilots and the guidance laws. Also deals with strategic missile systems used for the warfare and automatic delivery systems of the modern missiles and aircrafts.

## II. COURSE OBJECTIVES:

**The students will try to learn:**

I. The advanced concepts of missile guidance and control.
II. Exposure on missile systems, missile airframes, auto pilots, guidance laws.
III. Skills effectively in the understanding of missile guidance and control.

## III. COURSE OUTCOMES:

**After successful completion of the course, students will be able to:**

| | | |
|---|---|---|
| **CO 1** | **Understand** the historical background of the development of the missile guidance system | **Understand** |
| **CO 2** | **Apply** the knowledge of the Equations of motions to solve the missile trajectory characteristics | **Apply** |
| **CO 3** | **Apply** the basic principles of Autopilot systems used in missile guidance and its types | **Apply** |
| **CO 4** | **Demonstrate** the guidance laws and techniques of guidance systems and navigation system | **Understand** |
| **CO 5** | **Apply** the concept of Lamberts theorem, on missile guidance and accuracy in strategic missile | **Apply** |
| **CO 6** | **Analyze** the weapon delivery systems with guided and unguided weapon systems | **Analyze** |

## IV. SYLLABUS:

**MODULE-I: MISSILE SYSTEMS INTRODUCTION (08)**

History of guided missile for defence applications, classification of missiles, the generalized missile equations of motion coordinate Systems, Lagrange‟s equations of or rotating coordinate systems rigid-body equations of motion missile system elements, missile ground systems.

**MODULE-II: MISSILE AIR FRAMES, AUTO PILOTS AND CONTROL (10)**

Missile aerodynamics: Force equations, moment equations, phases of missile flight; Missile control configurations; Missile mathematical model; Autopilots: Definitions, types of autopilots, example applications, open-loop autopilots; Inertial instruments and feedback; Autopilot response, stability and agility-pitch auto pilot design, pitch-yaw-roll auto pilot design.

**MODULE-III: MISSILE GUIDANCE LAWS (10)**
Tactical guidance intercept techniques, derivation of the fundamental guidance equations, explicit, proportional navigation, augmented proportional navigation, beam riding, bank to turn missile guidance.

Three-dimensional proportional navigation, comparison of guidance system performance, application of optimal control of linear feedback systems.

**MODULE-IV: STRATEGIC MISSILES (09)**
Introduction, the two-body problem, Lambert's theorem, first order motion of a ballistic missile , correlated velocity and velocity-to-be-gained concepts, derivation of the force equation for ballistic missiles, atmospheric re-entry, ballistic missile intercept, missile tracking equations of motion, introduction to cruise missiles, the terrain contour matching concept.

**MODULE-V: WEAPON DELIVERY SYSTEMS (08)**
Dynamic Performance of Spacecraft: Equations of Motion of Launch Vehicles with respect to a rotating planet, Motion of Spacecraft with respect to a rotating planet. Dynamic Performance-Atmospheric Entry: Equation of motion, Approximate analysis of gliding entry into a planetary atmosphere.

## V. TEXT BOOKS:


1. G.M.Siouris, "Missile Guidance and Control Systems", Springer, 2003.
2. J.H.Blakelock, "Automatic Control of Aircraft and Missiles", John Wiley & Sons, 2nd Edition, 1990.
3. Eugene L.Fleeman, "Tactical Missile Design", AIAA Education series, 1st Edition, 2001.


## VI. REFERENCE BOOKS:


1. P. Garnell, "Guided Weapon Control Systems", Pergamon Press, 2nd Edition, 1980.
2. Joseph Ben Asher, IsaacYaesh, "Advances in Missile Guidance Theory", AIAA Education series, 1998.
3. Paul Zarchan, "Tactical and Strategic Missile Guidance", AIAA Education series, 2007.


## VII. WEB REFERENCES:

1. http://www.sciencedirect.com/science/article/pii/S1000936108600217
2. https://www.academia.edu/8521925/Atmospheric_re-entry_vehicle_mechanics
3. http://link.springer.com/article/10.1007/s11633-010-0563-
4. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0471506516.html

## VIII. E-TEXT BOOKS:

1. http://read.pudn.com/downloads165/doc/project/753314/Missile%20Guidance%20and%20Control%20Systems.pdf
2. http://rahauav.com/Library/Stability-Control/Aircraft%20&%20Missile%20BLAKELOCK.pdf