## MISSILE GUIDANCE AND CONTROL

BAEB13         Elective         L         T         P         C         CIA         SEE           Jontact Classes: 45         Tutorial Classes: Nil         Practical Classes: Nil         Total Classes:           COURSE OVERVIEW:         Total classes: Nil         Total Classes:         Total Classes:           Itissile guidance refers to a variety of methods of guiding a missile or a guided bomb to its intend he missile's target accuracy is a critical factor for its effectiveness. Guidance systems improver curacy by improving its Probability of Guidance. These guidance technologies can generally be to a number of categories, with the broadest categories being "active," "passive" and "preset" his course deals with the introduction to missile system, airframe, autopilots and the guidance 1 eals with strategic missile systems used for the warfare and automatic delivery systems of th usisiles and aircrafts.           COURSE OBJECTIVES:         Total classes:           ne course should enable the students to:         Understand the advanced concepts of missile guidance and control.           Exposure on missile systems, missile airframes, autopilots, guidance laws.         Deploy these skills effectively in the understanding of missile guidance and control.           L         COURSE OUTCOMES:         Total classes:           Co 1         Understand the historical background of the development of the missile guidance and autopilot systems and trajectory characteristics         Apply the basic principles of Autopilot systems used in missile guidance and accuracy in avigation system         Appl     <	Course Code		Category	Hours / Week			Credits	Maximum Marks		
BAEB13       Elective       3       -       -       3       30       70         Contact Classes: 45       Tutorial Classes: Nil       Practical Classes: Nil       Total Classes:         COURSE OVERVIEW:       Inside guidance refers to a variety of methods of guiding a missile or a guided bomb to its intend he missile's target accuracy is a critical factor for its effectiveness. Guidance systems improcuracy by improving its Probability of Guidance. These guidance technologies can generally be of to a number of categories, with the broadest categories being "active," "passive" and "preset" his course deals with the introduction to missile system, airframe, autopilots and the guidance 1 eads with strategic missile systems used for the warfare and automatic delivery systems of th issiles and aircrafts.         COURSE OBJECTIVES:       Ecourse should enable the students to:       Understand the advanced concepts of missile guidance and control.       Exposure on missile systems, missile airframes, autopilots, guidance laws.         Deploy these skills effectively in the understanding of missile guidance and control.       Exposure on missile guidance system       Under         CO1       Understand the historical background of the development of the missile       Under         Co2       Apply the knowledge of the Equations of motions to solve the missile       Appl         Co3       Apply the basic principles of Autopilot systems used in missile guidance and accuracy in avigation system       Appl       Appl         Co4       Demonstrate the guidance laws and techniques	BAEB13			L	Т	Р	С	CIA	SEE	Tot
Ontact Classes: 45         Tutorial Classes: Nil         Practical Classes: Nil         Total Classes:           COURSE OVERVIEW:         Issile guidance refers to a variety of methods of guiding a missile or a guided bomb to its intend he missile's target accuracy is a critical factor for its effectiveness. Guidance systems improvementation of missile guidance technologies can generally be of to a number of categories, with the broadest categories being "active," "passive" and "preset" his course deals with the introduction to missile system, airframe, autopilots and the guidance the guidance technologies can generally be of the source deals with the introduction to missile guidance and automatic delivery systems of the issiles and aircrafts.           COURSE OBJECTIVES:         Ecourse should enable the students to:           Understand the advanced concepts of missile guidance and control.         Exposure on missile effectively in the understanding of missile guidance laws.           Deploy these skills effectively in the understanding of missile guidance and control.         Exposure on missile of the course, students will be able to:           CO 1         Understand the historical background of the development of the missile audiance system         Apply           CO 2         Apply the knowledge of the Equations of motions to solve the missile Appl audiance system         Appl           CO 3         Ist types         Appl         Appl           CO 4         Demonstrate the guidance laws and techniques of guidance and accuracy in avigation system         Appl           CO 4         Apply the concept of			Elective	3	-	-	3	30	70	100
COURSE OVERVIEW:         fissile guidance refers to a variety of methods of guiding a missile or a guided bomb to its intend he missile's target accuracy is a critical factor for its effectiveness. Guidance systems improver the analysis of a number of categories, with the broadest categories being "active," "passive" and "preset" his course deals with the introduction to missile system, airframe, autopilots and the guidance I eals with strategic missile systems used for the warfare and automatic delivery systems of the inscission of the students to:         COURSE OBJECTIVES:       COURSE OBJECTIVES:         ne course should enable the students to:       Understand the advanced concepts of missile guidance and control.         Exposure on missile systems, missile airframes, autopilots, guidance laws.       Deploy these skills effectively in the understanding of missile guidance and control.         It. COURSE OUTCOMES:       Inderstand the historical background of the development of the missile guidance system         CO 1       Understand the historical background of the development of the missile duidance system         CO 2       Apply the knowledge of the Equations of motions to solve the missile duidance and its types         CO 3       Apply the concept of Lamberts theorem, on missile guidance and accuracy in artategic missile         CO 4       Demonstrate the guidance laws and techniques of guidance systems and mavigation system         CO 6       Apply the concept of Lamberts theorem, on missile guidance and accuracy in systems         CO 6       Apply the concept of Lamberts theorem, on mis	ontact Cl	asses: 45	Tutorial Classes: Nil     Practical Classes: Nil     Total					Classes: 45		
The successful completion of the course, students will be able to:CO 1Understand the historical background of the development of the missile guidance systemUnderCO 2Apply the knowledge of the Equations of motions to solve the missile trajectory characteristicsApplCO 3Apply the basic principles of Autopilot systems used in missile guidance and its typesApplCO 4Demonstrate the guidance laws and techniques of guidance systems and navigation systemUnderCO 5Apply the concept of Lamberts theorem, on missile guidance and accuracy in strategic missileApplCO 6Analyze the weapon delivery systems with guided and unguided weapon systemsAnalyzeVLLABUS:NIT-IMISSILE SYSTEMS INTRODUCTIONClassical content is the principle of the principl	<ul> <li>he missile gui</li> <li>he missile</li> <li>ccuracy by</li> <li>ito a num</li> <li>'his course</li> <li>eals with</li> <li>nissiles and</li> <li>. COURS</li> <li>he course</li> <li>Unders</li> <li>Exposu</li> <li>[. Deploy</li> <li>I. COURS</li> </ul>	<ul> <li>target a y improving ber of cate e deals with strategic n d aircrafts.</li> <li>E OBJECT should ena tand the advire on missi these skills</li> <li>SE OUTCO</li> </ul>	rives: able the studer vanced concep le systems, mis	ritical fac y of Guida he broades ion to mis used for hts to: ts of missi ssile airfra the under	le guida mes, au	ance and topilots, g of miss	ctiveness. Gui lance technolo ing "active," " frame, autopil ad automatic of control. guidance laws	adance system gies can gene passive" and ots and the g delivery syst	ns impro erally be "preset" uidance i ems of th	ve mis divided guidar laws. A ne mod
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CO 3Apply the basic principles of Autopilot systems used in missile guidance and its typesApplCO 4Demonstrate the guidance laws and techniques of guidance systems and navigation systemUnderCO 5Apply the concept of Lamberts theorem, on missile guidance and accuracy in strategic missileApplCO 6Analyze the weapon delivery systems with guided and unguided weapon systemsAnalCULABUS:VIT-IMISSILE SYSTEMS INTRODUCTIONClass	CO 2	Apply th trajectory	e knowledge characteristics	of the Ec	quations	s of mo	tions to solve	e the missile	Ар	ply
CO 4       Demonstrate the guidance laws and techniques of guidance systems and navigation system       Under analyze the concept of Lamberts theorem, on missile guidance and accuracy in strategic missile       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 the weapon delivery systems with guided and unguided weapon       Analyze the weapon delivery systems with guided and unguided weapon         CO 6       MISSILE SYSTEMS INTRODUCTION       Classical delivery	CO 3	Apply the its types	e basic principl	es of Auto	opilot sy	ystems <mark>u</mark>	sed in missile	guidance and	Ар	ply
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       Anal         CULABUS:       MISSILE SYSTEMS INTRODUCTION       Classical desired in the factor is the desired in the	<b>CO 4</b>	Demonstration	rate the guida n system	ince laws	and te	chniques	of guidance	systems and	Under	rstand
CO 6       Analyze the weapon delivery systems with guided and unguided weapon systems       Analyze the weapon delivery systems with guided and unguided weapon       Analyze the weapon delivery systems with guided and unguided weapon         CO 6       Systems       Classifier of the delivery systems in the delivery systems with guided and unguided weapon       Analyze the weapon delivery systems with guided and unguided weapon       Analyze the weapon delivery systems         Classifier of the delivery systems in the delivery systems in the delivery systems       Classifier of the delivery systems in the delivery systems       Classifier of the delivery systems	CO 5	Apply the strategic r	e concept of La missile	mberts the	eorem,	on missi	le guidance an	d accuracy ir	Ар	ply
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NIT-I MISSILE SYSTEMS INTRODUCTION Class	YLLABU	S:								
	NIT-I	MISSILE	SYSTEMS II	NTRODU	CTION	N			Cla	sses: 0
story of guided missile for defence applications, classification of missiles, the generalized missile motion coordinate Systems, Lagrange's equations of or rotating coordinate systems rigid-body eq ption missile system elements, missile ground systems	story of g motion co	uided missi oordinate S	ile for defence ystems, Lagran	applicatio age"s equa	ons, clas tions of system	sification f or rotat	n of missiles, t ing coordinate	he generalize systems rigi	ed missile d-body ea	equati quations

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 autopilot design, pitch-yaw-roll autopilot design.

## UNIT-III MISSILE GUIDANCE LAWS

Classes: 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.

# UNIT-IV STRATEGIC MISSILES

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.

## UNIT-V WEAPON DELIVERY SYSTEMS

Classes: 08

Classes: 09

Weapon delivery requirements, factors influencing weapon delivery accuracy, unguided weapons, the bombing problem, guided weapons, integrated flight control in weapon delivery, missile launch envelope and mathematical considerations pertaining to the accuracy of weapon delivery computations.

## **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, 2<sup>nd</sup> Edition, 1990.
- 3. Eugene L. Fleeman, Tactical Missile Design, AIAA Education series, 1<sup>st</sup> Edition, 2001.

### **Reference Books:**

- 1. P. Garnell, "Guided Weapon Control Systems", Pergamon Press, 2<sup>nd</sup> Edition1980.
- 2. Joseph Ben Asher, Isaac Yaesh "Advances in Missile Guidance Theory" AIAA Education series, 1998.
- 3. Paul Zarchan, "Tactical and Strategic Missile Guidance" AIAA Education series, 2007.

### Web References:

 $1. \underline{http://www.sciencedirect.com/science/article/pii/S1000936108600217} \\ https://www.academia.edu/85$ 

- 21 925/Atmospheric\_re-entry\_vehicle\_mechanics
- 2. http://link.springer.com/article/10.1007/s11633-010-0563-z
- 3. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0471506516.html

### **E-Text Books:**

- 1. http://read.pudn.com/downloads165/doc/project/753314/Missile%20Guidance%20and%20Control%20Syst e ms.pdf
- 2. http://rahauav.com/Library/Stability-Control/Aircraft%20&%20Missile%20BLAKELOCK.pdf
- 3. https://info.aiaa.org/Regions/SE/CF/Meeting%20Minutes/AIAA%20Distinguished%20Lectur e- Missile%20Design%20and%20System%20Engineering-24%20Slides.pdf