INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**AVIONICS AND INSTRUMENTS SYSTEMS**			
Course Code	**A82129**			
Regulation	**R13 - JNTUH**			
Course Structure	**Lectures**	**Tutorials**	**Practical's**	**Credits**
	4	-	-	4
Course Coordinator	Mr. P. Anudeep, Assistant Professor, Department of Aeronautical Engineering.			
Team of Instructors	Mr. P. Anudeep, Assistant Professor, Ms. M. Mary Thraza, Assistant Professor, Mr. Naresh Eppakayala, Assistant Professor, Department of Aeronautical Engineering.			

I. COURSE OVERVIEW

The Avionics and Instruments course will enable the student to enhance his/her knowledge in the field of the instruments, sensors, communication techniques, and other equipment used onboard an aircraft. The course cover in detail about the evolution of the aviation electronics and moves further and discusses the important topics like navigation, communication systems, sensors and displays implemented in a civil aviation, later the military adaptation of the same will be discussed. The course will be discussing the topics like RADAR, GPS etc. which impart a thorough understanding of these modern-day technologies. The course will make the student realize the importance of electronics in the working of an aircraft.

II. PREREQUISITE(S)

Level	Credits	Periods / Week	Prerequisite
UG	4	5	Aircraft Systems, Electrical and Electronics Engineering

III. MARKS DISTRIBUTION

Session Marks	University End Exam Marks	Total Marks
Mid Semester Test There shall be two midterm examinations. Each midterm examination consists of essay paper, objective paper,and assignment. The essay paper is for 10 marks of 60 minutes duration and shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective paper is for 10 marks of 20 minutes duration. It consists of 10 multiple choice and 10 fill-in-the-blank questions, the student has to answer all the questions and each carries half mark. The first midterm examination shall be conducted for the first two and a half units of syllabus and second midterm examination shall be conducted for the remaining portion. **Assignment**	75	100

Five marks are marked for assignments. There shall be two assignments in every theory course. Assignments are usually issued at the time of commencement of the semester. These are of problem-solving in nature with critical thinking. Marks shall be awarded considering the average of two midterm tests in each course.		

IV. EVALUATION SCHEME

S No	Component	Duration	Marks
1	I Mid examination	80 minutes	20
2	I Assignment	--	05
3	II Mid examination	80 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES:

The course enables the students to:

I. Understand the core avionics concept in aircrafts.
II. Describes the Avionics classification based on theelectromagnetic spectrum.
III. Impart the knowledge of Communication, Navigation and Surveillance systems for Aircrafts.
IV. Illustrates the application of Avionics in Flight controlling
V. Impart the knowledge of Avionics used in Military aircrafts.

VI. COURSE OUTCOMES

At the end of the course the students are able to:

1. Describe the basic principles of operation of the avionics systems and their sub-systems that make up a typical integrated system.
2. Illustrate the Flight manage systems with controls and displays.
3. Describe the information required and generated by the sub-systems of avionics systems
4. Categorize requirement of the avionics systems and subsystem for military aircrafts.
5. Explain the basic operation of automatic flight control systems.
6. Discuss the functionalities of radars & antennas and their types for spacecraft applications.
7. Explain the operation of magnetic navigation equipment.
8. Analyze and discuss the baseline design-stability & control, performance,and constraint analysis.
9. Describe the terrain awareness systems and Traffic collision avoidance system.
10. Describe the system requirements for flight data recorders (FDR).

VII. HOW PROGRAM OUTCOMES AREASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Knowledge in fundamentals of mathematics, science,and engineering.	H	Assignments
PO2	**Problem analysis**: An ability to identify, formulate and solve problems in key areas of Aerodynamics, Structures, Propulsion, Flight Dynamics and Control, Design, Testing, Space and Missile Technologies and Aviation of Aeronautical Engineering discipline.	S	Lectures, Assignments
PO3	**Design/development of solutions**: An ability to design and conduct experiments, analyze and interpret data related to various areas of Aeronautical Engineering.	H	Lectures, Tutorials
PO4	**Conduct investigations of complex problems**: An ability in conducting investigations to solve problems using research-based knowledge and methods to	H	Lectures

	provide logical conclusions.		
PO5	**Modern tool usage:** Skills to use modern engineering and IT tools, software and equipment to analyze the problems in Aeronautical Engineering.	H	Lectures, Tutorials
PO6	**The engineer and society**: Understanding of theimpact of engineering solutions on the society to assess health, safety, legal, and social issues in Aeronautical Engineering.	--	--
PO7	**Environment and sustainability**: The impact of professional engineering solutions in anenvironmental context and to be able to respond effectively to the needs of sustainable development.	--	--
PO8	**Ethics:** The knowledge of Professional and ethical responsibilities.	--	--
PO9	**Individual and teamwork**: An ability to work effectively as an individual and as a team member/leader in multidisciplinary areas.	S	Discussions
PO10	**Communication**: An ability to critique writing samples (abstract, executive summary, project report), and oral presentations.	--	--
PO11	**Project management and finance:** The need forself-education and ability to engage in lifelong learning.	H	Seminars
PO12	**Life-long learning**: Knowledge of management principles and apply these to manage projects in multidisciplinary environments.	H	Guest lectures

S – Supportive **H – Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in theinnovative, dynamic and challenging environment for design and development of new products.	S	Seminars
PSO2	**Problem-solving skills:** Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles.	--	--
PSO3	**Practical implementation and testing skills:** Providing different types of in-house and training and industry practice to fabricate and test and develop the products with more innovative technologies.	--	--
PSO4	**Successful career and entrepreneurship:** To prepare the students with thebroad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats.	S	Guest Lectures

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IX. SYLLABUS

UNIT-I:

AVIONICS –INTRODUCTION-AVIONICS STANDARDS

Importance and role of avionics in modern aircraft-core avionics systems and interface with pilot-aircraft state sensor systems, outside world sensor systems-task automation systems. Requirements of avionics equipment and systems-environmental, weight, reliability

Standardization and specifications of avionics equipment and systems-the ARNC and MIL specifications. Electrical and optical data bus systems-integrated modular avionics architectures-avionics packaging

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UNIT-II:

DISPLAYS-MAN MACHINE INTERACTION AND COMMUNICATION SYSTEMS

Introduction to aircraft displays head up displays (HUD)-basic principles. Helmet mounted displays, head tracking systems. Head down displays-civil cockpit, military cockpit.Solid state standby display systems. Data fusion in displays-intelligent display management systems

Introduction to voice and data communication systems-HF, VHF, UHF and satellite communications-Data recorders-Audio management systems-in-flight entertainment systems-ACARS data communication systems.

UNIT-III:

INERTIAL SENSORS AND GLOBAL POSITIONING SYSTEMS

Basic principles of gyroscopes and accelerometers-Angular momentum gyros-dynamically tuned gyro-micro machined vibrating mass rate gyro.Introduction to optical gyroscopes-ring laser gyros-principles. Specific force measurements with accelerometers, torque balance pendulous accelerometers. Stable platform systems-strap down systems-errors in inertial systems and compensations.

Global Navigational satellite systems-the global positioning system (GPS)-description and basic principles-integration of GPS and INS-differential GPS –augmented satellite navigation systems.

UNIT-IV:

NAVIGATION RANGING AND LANDING SYSTEMS

Introduction and Basic principles of navigation-types of navigation systems- Radio-navigation systems-VHF Omnirange, distance measuring equipment, automatic direction finders.Attitude and heading reference systems. Inertial Navigation systems (INS)-platform axes angular rate corrections, acceleration correction, initial alignment and gyro-compassingstrap-down INS computing. Aided INS-Kalman filters.
Landing systems-localizer and glide slope-marker systems. Categories of instrument landing systems.

UNIT-V:

SURVEILLANCE SYSTEMS AND AUTOFLIGHT SYSTEMS

Traffic alert and collision avoidance systems (TCAS)-Enhanced ground proximity warning systems-Air traffic control systems-Mode S transponders-predictive wind shear warning systems-weather radar systems-Enhanced ground proximity warning systems

Longitudinal and lateral control and response of aircraft-powered flight controls-auto-stabilization systems. Autopilots-principles-height control-heading control-ILS coupled autopilot control-automatic landing systems-satellite landing guidance systems-speed control and autothrottle control systems. Flight management systems-principles-flight planning-navigation and guidance-flight path optimization and performance prediction-cost index.

TEXTBOOK

1. Collinson,R.P.G.,IntroductiontoAvionicsSystems,secondedition,Springer,2003,ISBN978-81-8489-795-1
2. Moir, I. and Sea bridge, A., Civil Avionics Systems, AIAA Education Series, AIAA, 2002, ISBN 1-56347589-8.
3. Moir, I., Sea bridge, A. & Jukes, M., Military Avionics Systems *(*Aerospace), Wiley, 2006, ISBN-10: 0470016329, ISBN-13: 9780470016329

REFERENCES

1. Kayton, M., & Fried, W.R., Avionics Navigation Systems, Wiley, 1997, ISBN 0-471-54795-6.
2. Helfrick, A., Principles of Avionics, Avionics Communications Inc. Leesburg, 2000, VA 20177, USA, ISBN 1-885544-10-3.
3. Moir, I. and Sea Bridge, A., AircraftSystems*:* Mechanical, Electrical and Avionics Subsystems Integration, AIAA Education Series, AIAA, 2001, ISBN 1-56347506-5.
4. Harris, D., Ground Studies for Pilots: Flight Instruments and Automatic Flight Control Systems, sixth edition, Blackwell Science, 2004, ISBN 0-632-05951-6.
5. Avionics Systems – Operation & Maintenance, 1994, Wasson, J. W., Jeppesen Sanderson Training Products, ISBN 0-89100-436-X.
6. Pallet, E.H.J., Aircraft Instruments & Integrated Systems, 1996, Longman scientific and technical.

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Course Learning Outcomes	Topics to be covered	Reference
1-2	**Describing** the important role of avionics in modern aircraft?	**UNIT-I: AVIONICS –INTRODUCTION-AVIONICS STANDARDS** Importance and role of avionics in modern aircraft	T1:1.1
3-4	**Explanation** of Core avionics systems	core avionics systems and interface with pilot-aircraft state sensor systems, outside world sensor systems-task automation systems	T1:1.2
5-6	**Explanation** of ARNC and MIL specifications	Requirements of avionics equipment and systems-environmental, weight, reliability	T1: 9.2.1.1
7-8	**Introduction** avionics equipment.	Standardization and specifications of avionics equipment and systems-the ARNC and MIL specifications	T1: 9.2.2
9-11	**Describe** Electrical and optical data bus systems	Electrical and optical data bus systems-integrated modular avionics architectures-avionics packaging	T1:9.2.3
12-14	**Introduction** about cockpit display units	**UNIT-II: DISPLAYS-MAN MACHINE INTERACTION AND COMMUNICATION SYSTEMS**	T1: 2.1
15-17	**Describing** the different types of aircraft displays.	Introduction to aircraft displays head up displays (HUD)-basic principles	T1:2.2
18-20	**Explanation** of head tracking systems	Helmet mounted displays, head tracking systems. Head down displays-civil cockpit, military cockpit.	T1:2.3-2.7
21-22	**Describing** intelligent display management systems	Solid state standby display systems. Data fusion in displays-intelligent display management systems	T1:2.8,2.9
23	**Explanation** of voice and data communication systems-HF, VHF, UHF	Introduction to voice and data communication systems-HF, VHF, UHF and SatelliteCommunication	T2:6.1
24-26	**Discuss** audio management systems in flight	Data recorders Audio management systemsin-flight entertainment systems	T2:6.2
27-28	**Explanation** of ACARS	ACARS data communication systems.	T2:6.3
29-30	**Explanation** of inertial sensors	**UNIT-III: INERTIAL SENSORS AND GLOBAL POSITIONING SYSTEMS**	T1:5.1
31-33	**Explanation** of Basic principles of gyroscopes and accelerometers	Basic principles of gyroscopes and accelerometers-Angular momentum gyros-dynamically tuned gyro-micro machined vibrating mass rate gyro.	T1:5.2
34-36	**Describing** the optical gyroscopes-ring laser gyros-principles	Introduction to optical gyroscopes-ring laser gyros-principles. Specific force measurements with accelerometers, torque balance pendulous accelerometers	T1:5.2
37-39	**Explain** Stable platform systems and strap down systems	Stable platform systems-strap down systems-errors in inertial systems and compensations.	T1:5.3
40	**Explain** the GPS and GNSS	Global Navigational satellite systems-the global positioning system (GPS)**.**	T1:6.5

41-43	**Explain** augmented satellite navigation systems	description and basic principles-integration of GPS and INS-differential GPS –augmented satellite navigation systems	T1:6.5
44-45	**Describing** navigation ranging	**UNIT-IV: NAVIGATION RANGING AND LANDING SYSTEMS**	T1:6.1
46-47	**Explain** Basic principles of navigation	Introduction and Basic principles of navigation-types of navigation systems- Radio-navigation systems	T1:6.1.2
48-50	**Explain** automatic direction finders.	VHF Omnirange, distance measuring equipment, automatic direction finders.	T1:6.2
51-53	**Analyze** Inertial Navigation systems (INS)	Attitude and heading reference systems. Inertial Navigation systems (INS)	T1:6.2
54	**Discuss** initial alignment and gyro-compassing	platform axes-angular rate corrections, acceleration correction, initial alignment and gyro compassing-strap down INS computing	T1:6.2.3
55-56	**Explain** instrument landing systems	Aided INS-Kalman filters. Landing systems-localizer and glide-slope marker systems. Categories of instrument landing systems	T1:6.3
57-59	**Discuss** autoflight systems	**UNIT-V: SURVEILLANCE SYSTEMS AND AUTOFLIGHT SYSTEMS**	T1:7.1
60-61	**Discuss** Traffic alert and collision avoidance systems	Traffic alert and collision avoidance systems (TCAS)-Enhanced ground proximity warning systems	T1:7.2
62-63	**Explain** Air traffic control systems	Air traffic control systems-Mode S transponders-predictive wind shear warning systems-weather radar systems	T1:7.3
65-66	**Discuss** auto-stabilization systems	Longitudinal and lateral control and response of aircraft-powered flight controls-auto-stabilization systems	T1:7.4
67-68	**Discuss** automatic landing systems	Autopilots-principles-height control-heading control-ILS coupled autopilot control-automatic landing systems	T1:8.2
69-70	**Explain** autothrottle control systems	Satellite landing guidance systems-speed control and autothrottle control systems.	T1:8.2.6
71-73	**Discuss** Flight management systems	Flight management systems-principles-flight planning-navigation and guidance	T1:8.3
74-76	**Discuss** flight path optimization	Flight path optimization and performance prediction-cost index.	T1:8.3.4

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Course Objectives	**Program Outcomes**												**Program Specific Outcomes**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
I	H	S			S								H			
II	H		S		S				S						S	

III	H	S	S								S		H			
IV	H	S			S								H		S	
V	H				S							S				

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XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	H			S									H			
2			S	H					S				S			
3		H		S												
4	H										S		S			
5				H	S											
6		H	H						S			S			S	
7	H			H											S	
8		H	H										S			
9		H	H								S		S			
10				H									H			H

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