INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**AIRCRAFT SYSTEMS**			
Course Code	**A62113**			
Regulation	**R15-JNTUH**			
Course Structure	**Lectures**	**Tutorials**	**Practical's**	**Credits**
	4	-	-	4
Course Coordinator	Ms. G Sravanthi, Assistant Professor, Department of Aeronautical Engineering			
Team of Instructors	Ms. G Sravanthi, Assistant Professor, Mr. R Suresh Kumar, Assistant Professor, Department of Aeronautical Engineering			

I. COURSE OVERVIEW

Aircraft Systems is a course of primary important to Aeronautical Engineering students. The aim is to impart the meaning of system in generic .The course covers, the main branching of Aircraft System Systems sub systems based on functionalities .These describes the working principles and their importance to aircraft. The course also gives basic knowledge of design procedures, failure severities Safety measures of system.

II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	5	Flight Mechanics

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. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. **Assignment** 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.	75	100

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. Explain the concept and meaning of system and classify the various systems required for aircraft and their contribution in order to fulfill the aircraft tasks.
II. Describe the various types of Electrical power generations and distribution in aircraft.
III. Impart the knowledge of pneumatic, hydraulic and environmental control system.
IV. Demonstrate different actuators and flight control system.
V. Give knowledge about the advanced engine control systems and fuel safety management.
VI. Discuss different levels system integration import the knowledge for the design of a aircraft system.

VI. COURSE OUTCOMES

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

1. Define the meaning of the system and its characteristics and identify different types of aircraft systems.
2. Describe the various electrical power generations in the aircraft and discover more electric aircraft.
3. Estimate the electrical power requirements and can optimize the load distribution.
4. Describe the importance of hydraulic systems and its components and develop hydraulic systems.
5. Illustrate the importance and criticality of landing gears.
6. Recognize the applications of pneumatic systems and the application of the bleed air.
7. Classify the various types of engine control system including advanced digital controls.
8. Identify important flight control operations and selects suitable flight control actuations.
9. Demonstrate the various levels of integration and describe the various design drivers and interfaces.
10. Identify the environmental control systems relating to aircraft systems.
11. Classify the types of hydraulic fluids applied in aircraft industry and advancement in it.
12. Estimate the flight control requirements including advanced controls.
13. Illustrate the importance of fly-by-wire technology in aircraft systems.
14. Describe the pneumatics systems and its components.
15. Estimate the various engine performances and their application in aircraft systems.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Knowledge in fundamentals of mathematics, science and engineering.	H	Lectures
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.	H	Assignments
PO3	**Design/development of solutions**: An ability to design and conduct experiments, analyze and interpret data related to various areas of Aeronautical Engineering.	S	Assignments,
PO4	**Conduct investigations of complex problems**: An ability in conducting investigations to solve problems using research based knowledge and methods to provide logical conclusions.	S	Assignments,

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 impact 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 environmental 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 team work**: An ability to work effectively as an individual and as a team member/leader in multidisciplinary areas.	S	projects
PO10	**Communication**: An ability to critique writing samples (abstract, executive summary, project report), and oral presentations.		
PO11	**Project management and finance:** The need of self education and ability to engage in life - long learning.		
PO12	**Life-long learning**: Knowledge of management principles and apply these to manage projects in multidisciplinary environments.	H	

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 innovative, dynamic and challenging environment for design and development of new products.	S	Seminars, Projects
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.	H	Lectures, Tutorials
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.	S	Projects
PSO4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats.	S	Seminars

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IX. SYLLABUS

UNIT – I

INTRODUCTION TO AIRCRAFT SYSTEMS AND INTEGRATION

Aircraft systems- airframe systems, vehicle systems, avionics systems, mission systems and their sub-systems. Specification of requirements- mission requirements, performance requirements. Operating environment conditions.

Interdependence of aircraft systems and need for integration- examples. Systems integration- the concept- examples. Levels of integration- component, system, process, function, information levels- examples. Enumeration of aircraft systems and some subsystems- purpose, brief description, aspects of safety/ integrity, integration, interfaces, design drivers

UNIT- II

ELECTRICAL SYSTEMS AND FLIGHT CONTROKL SYSTEMS

Electrical loads in aircraft. Electrical power generation and control- DC, AC- types. Power distribution-

primary, secondary. Power conversion and energy storage. Load protection. Electrical load management systems, variable speed constant frequency (VSCS) cycloconverter, 270 V DC systems.
Flight control systems- primary and secondary flight control- control linkages, actuation- types, description, and redundancy. Fly-by-wire control- control laws, implementation.

UNIT- III

HYDRAULIC SYSTEMS

Aircraft hydraulic systems- function, merits, application, system loads, design requirements. Principal components. Flight control actuation- importance, need for redundancy- types- description, applications. Advanced actuation implementations. The 'fly-by-wire' actuation, fly-by-wire control laws. Hydraulic fluid- required properties, operating fluid pressures, temperatures, and flow rates. Hydraulic piping, pumps, reservoir, accumulator. Landing gear and brake management systems.

UNIT- IV

PNEUMATICS AND ENVIRONMENAL CONTROL SYSTEMS

Engine as source of high pressure air- engine bleed air- user systems- environment control, windscreen, wing and engine anti-ice, engine start, hydraulic, pitot-static systems. Bleed air control- structure, components, operation. Need for controlled cabin environment. Principal heat sources in aircraft. Methods of cooling- ram air, engine bleed air, fuel cooling. Cooling systems- air cycle refrigeration- types- turbo fan, bootstrap, reverse bootstrap systems. Vapour cycle refrigeration. Humidity control. Air distribution systems, cabin pressurization, molecular-sieve oxygen concentrators, g tolerance and protection.

UNIT- V

ENGINE CONTROL AND FUEL SYSTEMS

Principle of operation of aircraft gas turbine engines. Engine- airframe interfaces. Control of fuel flow, air flow, exhaust gas flow- need, means, system parameters, basic inputs and outputs. Limited authority control systems, full authority control systems- examples. Engine monitoring- sensors, indicators. Power offtakes- need, types, effect on engine performance. Fuel systems- characteristics, components, operating modes. Fuel tank safety- fuel inerting system.

TEXT BOOKS:

1. Moir, I. and Sea bridge, A., Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, 3rd edn, John Wiley, 2008, ISBN 978-0-470-05996-8
2. Moir, I. and Sea bridge, A., Design and Development of Aircraft Systems- an Introduction, AIAA Education Series, AIAA, 2004.

REFERENCES:

1. Pallet, E.H.J., Aircraft Instruments and Integrated Systems, 10th edition., Longman Scientific &Technical, 1992.
2. Harris, D., Flight Instruments and Automatic Flight Control Systems, 6th edition, Ground Studies for Pilots, Blackwell Science, 2004, ISBN 0-632-05951-6.
3. Bolton, W., Pneumatic and Hydraulic Systems, Butterworth-Heinemann.

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	**Distinguish** various types of Systems and Explain their sub-systems	**UNIT-I INTRODUCTION TO AIRCRAFT SYSTEMS AND INTEGRATION** Aircraft systems- airframe systems, vehicle systems, avionics systems, mission systems and their sub-Systems.	T2:2.4
3-5	**Describe** Specifications of mission and performance	Specification of requirements- mission requirements, performance requirements	T2:2.5
6-8	**Discus** Operating environment conditions	Operating environment conditions.	T2:7.4

9-10	**Explain** Interdependence of aircraft systems and need for integration- examples	Interdependence of aircraft systems and need for integration- examples.	T2:6.2
11-13	**Discuss** Systems integration- the concept- examples. Levels of integration- component, system, process, function, information levels- examples.	Systems integration- the concept- examples. Levels of integration- component, system, process, function, information levels- examples.	T2:6.3
14-17	**Identify** Enumeration of aircraft systems and some subsystems- purpose, brief description, aspects of safety/ integrity, integration, interfaces, design drivers	Enumeration of aircraft systems and some subsystems- purpose, brief description, aspects of safety/ integrity, integration, interfaces, design drivers	T2:4.1
18-19	**Identify** The Electrical loads in aircraft, Distinguish Electrical power generation and control- DC, AC- types .	**UNIT-II ELECTRICAL SYSTEMS AND FLIGHT CONTROL SYSTEMS** Electrical loads in aircraft. Electrical power generation and control- DC, AC- types.	T1:3.1
20	**Explain** Power distribution- primary, secondary	Power distribution- primary, secondary	T1:3.2
21-22	**Discuss** various methods of Power conversion and energy storage. Load protection.	Power conversion and energy storage. Load protection.	T1:3.4
23-25	**Explain** various advanced- electrical systems	Advanced systems- electrical load management systems, variable speed constant frequency (VSCS) , Cycloconverter, 270 V DC systems,	T1:3.5
26-28	**Explain** Flight control systems- primary and secondary flight control- control linkages, actuation- types,	Flight control systems- primary and secondary flight control- control linkages, actuation- types, description,	T1:3.6
29-30	**Discuss** redundancy. Provision of trim and artificial feel. Explain Fly- by-wire control- control laws, implementation	Redundancy. Fly-by-wire control- control laws, implementation	T1:3.9
31-32	**State** Aircraft hydraulic systems- function, merits, application, system loads, design requirements.	**UNIT-III HYDRAULIC SYSTEMS** Aircraft hydraulic systems- function, merits, application, system loads, design requirements.	T1:5.1
33-34	**Describe** Aircraft hydraulic systems- Principal components	Principal components, description, applications.	T1:5.2
35	**Discuss** Flight control actuation	Flight control actuation - importance, need Redundancy – types - description, applications.	T1:5.3
36-37	**Explain** wind energy and its potential	Advanced actuation implementations. The 'fly-by-wire' actuation, fly-by-wire control laws.	T1:5.6
38-40	**Discuss** various types of windmills and their characteristics	Hydraulic fluid- required properties, operating fluid pressures, temperatures, and flow rates Hydraulic piping, pumps, reservoir, accumulator	T1:5.8
41-43	**Discuss** different types of Landing gear and brake management systems, Brake management systems	Landing gear and brake management systems, Brake management systems.	T1:5.9
44-46	**Explain** bleed air-and Use for systems- environment control, windscreen	**UNIT-IV PNEMATIC AND ENVIRONMENTAL CONTROL SYSTEMS** Engine as source of high pressure air- engine bleed air- user systems- environment control, windscreen.	T1:6.1
47-48	**Discuss** wing and engine anti-ice, engine start, hydraulic, pitot-static systems	wing and engine anti-ice, engine start, hydraulic, pitot-static systems	T1:6.2

49	**Discuss** the Need for controlled cabin environment; explain Bleed air control- structure, components, operation.	Bleed air control- structure, components, operation. Need for controlled cabin environment.	T1:6.3
50-53	**Identify** Principal heat sources in aircraft. Explain Methods of cooling- ram air, engine bleed air, fuel cooling	Principal heat sources in aircraft. Methods of cooling- ram air, engine bleed air, fuel cooling.	T1:6.5
54-56	**Discuss** various types of refrigeration techniques for aircraft cooling	Cooling systems- air cycle refrigeration- types- turbo fan, bootstrap, reverse bootstrap systems. Vapor cycle refrigeration.	T1:6.6
57-58	**Explain** Humidity control. Air distribution systems, cabin pressurization	Humidity control. Air distribution systems, cabin pressurization,	T1:6.7
59	**Describe** Molecular-sieve oxygen concentrators, g tolerance and protection.	Molecular-sieve oxygen concentrators, g tolerance and protection	T1:6.8
60	**Recall** Principle of operation of aircraft gas turbine engines. Explain the Engine- airframe interfaces	**UNIT-V ENGINE CONTROL AND FUEL SYSTEMS** Principle of operation of aircraft gas turbine engines. Engine- airframe interfaces	T1:9.1
61-63	**Explain** the Control of fuel flow, air flow, exhaust gas flow- need, means, system parameters, basic inputs and outputs	Control of fuel flow, air flow, exhaust gas flow- need, means, system parameters, basic inputs and outputs.	T1:9.2
64-65	**Define** Limited authority control systems, full authority control systems	Limited authority control systems, full authority control systems- examples. Engine monitoring- sensors, indicators.	T1:9.5
66-68	**Discuss** various types of power takeoffs and fuel system characteristics	Power off takes- need, types, effect on engine performance. Fuel systems- characteristics, components, operating modes.	T1:9.6
69-70	**Explain** Fuel tank safety- fuel inerting system	Fuel tank safety- fuel inerting system.	T1:9.7

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	H	S	H					S		H	H	H		S
II	S	S	H		S					S			H	H	S	
III	H			S	H	S	S			S			S	S		
IV	H														H	S
V			S									H				S
VI		S		H	H					S		H	S	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	H	H	S	H				S			H	S	H		
2	H				H											
3					H							H	S		S	S
4	H	H		H									H			H
5		S		H	H										S	S
6		S		H								S			H	
7		H		S	H							H				H
8												H				H
9	H												S		H	H
10	H												S			
11		S												H		
12				H									H			
13					S											S
14			H											H		
15		S													S	

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