# INSTITUTE OF AERONAUTICAL ENGINEERING

**(AUTONOMUS)**

Dundigal, Hyderabad - 500 043

## ELECTRONICS AND COMMUNICATION ENGINEERING

## COURSE DESCRIPTION FORM

| | | | | |
|---|---|---|---|---|
| **Course Title** | **INTRODUCTION TO AEROSPACE ENGINEERING** | | | |
| **Course Code** | **BAE701** | | | |
| **Regulation** | **R16** | | | |
| **Course Structure** | Lectures | Tutorials | Practicals | Credits |
| | 3 | - | - | 3 |
| **Course Coordinator** | Mr. R. Sabari vihar, Assistant Professor , | | | |
| **Course Faculty** | Mr. M. Vijay Kumar Assistant Professor<br>Mr. R. Sabari vihar, Assistant Professor<br>Ms. M.Snigdha, Assistant Professor | | | |

## I. COURSE OVERVIEW:

**Introduction to Aerospace engineering** covers the fundamental concepts, and approaches of aerospace Engineering, and are highlighted through lectures on aeronautics, astronautics, and design. Active learning aerospace modules make use of information technology. Student teams are immersed in a hands-on, lighter-than-air (LTA) vehicle design project, where they design, LTA vehicles. The connections between theory and practice are realized in the design exercises. The performance, weight, and principal characteristics of the LTA vehicles are estimated and illustrated using physics, mathematics, and chemistry known to freshmen, the emphasis being on the application of this knowledge to aerospace engineering and design rather than on exposure to new science and mathematics

## II. PREREQUISITE(S):

| Level | Course Code | Semester | Prerequisites | Credits |
|---|---|---|---|---|
| UG | BE701 | I | Introduction To Aerospace Engineering | 4 |

## III. MARKS DISTRIBUTION:

| Sessional Marks | University End Exam Marks | Total Marks |
|---|---|---|
| **Midterm Test**<br>There shall be two midterm examinations. Each midterm examination consists of essay paper and assignment.<br>The essay paper is for 25 marks of 120 minutes duration and shall contain 5<br>One mark compulsory questions in part-A and 4 questions in part-B.<br>The student has to answer any 4 questions out of five questions, each carrying 5 marks.<br>Marks are awarded by taking average of marks scored in two CIE exams.<br>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. Five marks are earmarked for technical seminar and term paper.<br>Two seminar presentations are conducted during I year I semester and II semester. For seminar, a student under the supervision of a concerned faculty member, shall identify a topic in each course and prepare the term paper with overview of topic. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations. | 70 | 100 |

## IV. EVALUATION SCHEME:

| S. No | Component | Duration | Marks |
|---|---|---|---|
| 1. | I Mid Examination | 120 minutes | 25 |
| 2. | I Assignment | - | 5 |
| 3. | II Mid Examination | 120 minutes | 25 |
| 4. | II Assignment | - | 5 |
| 5. | External Examination | 3 hours | 70 |

## V. COURSE OBJECTIVES:

**At the end of the course, the students will be able to:**

I. Outline different aspects of flight vehicles and their operational environment.
II. Description of flow behavior of one-dimensional incompressible and compressible flow, two-dimensional flow and finite wing.
III. Apprise about boundary layer effects, aerodynamic forces on airfoils, wings and high-lift systems.
IV. Analyze airplane performance, stability and control.

## VI. COURSE OUTCOMES:

**After completing this course the student must demonstrate the knowledge and ability to:**

I. Choose a concept or idea of technical real time problems to form solutions for the same.
II. Develop one- self to extend the outputs of research
III. Outline performance of the output of research, development, or design
IV. Identify, solve new problems and gain new knowledge
V. Understand about the performance parameters, performance in steady flight, cruise, climb, range, endurance, accelerated flight symmetric maneuvers, turns, sideslips, takeoff and landing
VI. Understand the theoretical knowledge behind the design and development of aircrafts
VII. Discuss the principle constituents of the transportation system involved in civil and commercial aircrafts and understanding the national and international regulations of the aviation organizations
VIII. Extend the outputs of earlier research and discover good ideas for new products or improving current products
IX. Gain knowledge about the anatomy of aircraft, helicopters, satellites and other air vehicles, and about the working importance of each component in an air vehicle
X. Ability to summarize the efficiency of the design in achieving the mission goal and safety of flight

## VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

| Program Outcomes | | Level | Proficiency assessed by |
|---|---|---|---|
| PO1 | **Engineering Knowledge** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems | H | Assignments, Tutorials |
| PO2 | **Problem Analysis** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences | S | Assignments |
| PO3 | **Design/Development of Solutions** Design solutions for complex meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations | S | Real time Applications |
| PO4 | **Conduct Investigations of Complex Problems** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions | S | Real time Applications |
| PO5 | **Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations | S | Projects |
| PO6 | **The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice | N | -- |
| PO7 | **Environment and Sustainability** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development | S | Assignments |
| PO8 | **Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice | N | -- |
| PO9 | **Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings | N | -- |
| PO10 | **Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions | S | Presentations |
| PO11 | **Project Management and Finance** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments | S | Seminars, Discussions |
| PO12 | **Life-long Learning** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change | H | Development of Prototype, Projects |

**N - None** **S - Supportive** **H - Highly Related**

## VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

| Program Specific Outcomes | | Level | Proficiency assessed by |
|---|---|---|---|
| PSO1 | **Professional Skills:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems. | H | Lectures, Assignments |
| PSO2 | **Problem-solving skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions. | S | Tutorials |
| PSO3 | **Successful career and Entrepreneurship:** An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur. | S | Seminars and Projects |

**N - None** **S - Supportive** **H - Highly Related**

## IX. SYLLABUS:

### UNIT-I INTRODUCTION TO AERONAUTICS AND ASTRONAUTICS

Historical perspective of aeronautics and astronautics, anatomy of the airplane, anatomy of a space vehicle, aerodynamic forces; Parameters affecting aerodynamic forces: Dimensional analysis; Theory and experiment, wind tunnels; Atmosphere: Properties of U.S. standard atmosphere, definitions of altitude.

### UNIT II: ONE DIMENSIONAL FLOW IN INCOMPRESSIBLE AND COMPRESSIBLE FLUIDS, TWO DIMENSIONAL FLOW AND FINITE WING

Continuity equation, Bernoulli's equation; Application of Bernoulli's equation: Airspeed indicators and wind tunnels, one dimensional compressible flow concepts, speed of sound, compressible flow equations in a variable-area stream tube, application to airspeed measurement, applications to channels and wind tunnels; Two dimensional flow and finite wing: Limitations of one dimensional flow equations; Theory of lift: circulation, Airfoil pressure distribution, Helmholtz vortex theorems, Simulating the wing with a vortex Line, downwash, elliptic lift distribution; Lift and drag: Momentum and energy, Slope of finite wing lift curve, verification of Prandtl wing theory, additional effects of wing vortices, search for reduced induced drag

### UNIT III: VISCOUS EFFECTS, DRAG DETERMINATION, AIRFOILS, WINGS AND HIGH- LIFT SYSTEMS

Boundary layer, boundary layer on bluff bodies, creation of circulation, laminar and turbulent boundary layers: skin friction, nature of Reynolds number, effect of turbulent boundary layer on separation; Total Incompressible drag: Parasite drag, drag due to lift, importance of aspect ratio; Compressibility drag: Prediction of drag divergence Mach number, sweptback wings, total drag; Supersonic flow: Shock waves and Mach waves, supersonic wing lift and drag, area rule, supersonic aircraft, airfoils.

Wings: early airfoil development, modern airfoils, supersonic airfoils, airfoil pitching moments, effects of sweepback on lift, airfoil characteristics, airfoil selection and wing design; High-lift Devices: Airfoil maximum lift coefficient, leading and trailing edge devices, effect of sweepback, deep stall, effect of Reynolds number, propulsive lift.

### UNIT IV: AIRPLANE PERFORMANCE, STABILITY AND CONTROL, AEROSPACE PROPULSION

Level flight performance, climb performance, range, endurance, energy-state approach to airplane performance, takeoff performance, landing performance; Static longitudinal stability; Dynamic longitudinal stability; Dynamic lateral stability; Control and manoeuvrability: Turning performance, control systems, active controls; Aerospace propulsion: Piston engines, gas turbines; Speed limitations of gas turbines: Ramjets, propellers, overall propulsion efficiency, rocket engines, rocket motor performance, propulsion-airframe integration.

**UNIT V: AIRCRAFT STRUCTURES, HYPERSONIC FLOWS, ROCKET TRAJECTORIES AND ORBITS**

Aircraft structures: Importance of structural weight and integrity, development of aircraft structures, importance of fatigue, materials, loads, weight estimation; Hypersonic flows: temperature effects, Newtonian theory; rocket trajectories, multistage rockets, escape velocity, circular orbital or satellite velocity, elliptical orbits, orbital maneuvers.

## Text Books:


1. Richard S. Shevell, Fundamentals of Flight, Pearson Education Publication, 2nd Edition, 1988
2. Newman D, "Interactive Aerospace Engineering and Design", McGraw-Hill, 1st Edition, 2002
3. Barnard R.H and Philpot. D.R, "Aircraft Flight", Pearson, 3rd Edition, 2004


## Reference Books:


1. John D. Anderson, "Introduction to Flight", Tata McGraw-Hill Publishing Company, Fifth Edition, Fifth Edition, 2007
2. A. C. Kermode, "Flight without Formulae", McGraw Hill, 4th Edition, 1997
3. P. J. Swatton, "Flight Planning", Blackwell Publisher, 6th Edition, 2002


## IX. COURSE PLAN:

**At the end of the course, the students are able to achieve the following course learning outcomes:**

| Lecture No. | CLO | Unit | Learning Objective | Topics to be covered | Reference |
|---|---|---|---|---|---|
| **Course Content Delivery --- Lecture Wise Break-up of Topics I SPELL** | | | | | |
| 1 | 1 | I | **Explain** history of aircraft. | Historical perspective of aeronautics and astronautics, anatomy of the airplane | T1,R1 |
| 2-3 | 2 | | **Explain** the anatomy of aircraft | Anatomy of a space vehicle, aerodynamic forces | T2 |
| 4-5 | 3 | | **Describe** aerodynamic forces and parameters affecting them | Parameters affecting aerodynamic forces: Dimensional analysis; | R1,T2 |
| 6 | 4 | | **Explain** aerodynamic forces | Theory and experiment, wind tunnels | R1 |
| 7-8 | 5 | | **Explain** about atmosphere and what is standard atmosphere | Atmosphere: Properties of U.S. standard atmosphere, definitions of altitude. | T2 |
| 9-10 | 6 | II | **Explain** different theories that define flow parameters | Continuity equation, Bernoulli's equation; Application of Bernoulli's equation: Airspeed indicators and wind tunnels, one dimensional compressible flow concepts | T1,R2 |
| 11-12 | 7 | | **Define** mach speed | speed of sound, compressible flow equations in a variable-area stream tube, application to airspeed measurement | T1,T2 |
| 13 | 8 | | **Describe** different equipment used in aerodynamics | applications to channels and wind tunnels; | T1,R2 |
| 14-15 | 9 | | **Describe** different wing configurations | Two dimensional flow and finite wing : Limitations of one dimensional flow equations; | T1 |

| | | | | | |
|---|---|---|---|---|---|
| 16-18 | 10 | | **Describe** how aircrafts obtain lift | Theory of lift: circulation, Airfoil pressure distribution, Helmholtz vortex theorems | T1 |
| 19-21 | 11 | | **Explain** different terms in flow over a wing | Simulating the wing with a vortex Line, downwash, elliptic lift distribution; | T1 |
| 22-24 | 12 | | **Describe** about lift and its affects | Lift and drag: Momentum and energy, Slope of finite wing lift curve | T2 |
| 25-28 | 13 | | **Explain** Prandtl wing theory | verification of Prandtl wing theory, additional effects of wing vortices, search for reduced induced drag | T1 |
| 29-31 | 14 | III | **Describe** about boundary layer | Boundary layer, boundary layer on bluff bodies, | T1, |
| 32-33 | 15 | | **Explain** theories behind flow conditions | creation of circulation, laminar and turbulent boundary layers skin friction, | T1,R2 |
| 34-35 | 16 | | **Define** Reynolds number | nature of Reynolds number, effect of turbulent boundary layer on separation; | T1,R2 |
| 36-37 | 17 | | **Explain** types of drag | Total Incompressible drag: Parasite drag, drag due to lift, importance of aspect ratio; Compressibility drag | T1,R2 |
| 38-40 | 18 | | **Explain** affects of mach number | Prediction of drag divergence Mach number, sweptback wings, total drag; Supersonic flow | T1,R2 |
| 41 | 19 | | **Explain** about shock waves and how they are produced | Shock waves and Mach waves, supersonic wing lift and drag, area rule, supersonic aircraft, airfoils. | T1,R2 |
| **Course Content Delivery --- Lecture Wise Break-up of Topics<br>II SPELL** | | | | | |
| 42-43 | 20 | III | **Discuss** about development of wing, aerofoil. | Wings: early airfoil development, modern airfoils, supersonic airfoils, airfoil pitching moments, effects of sweepback on lift, airfoil characteristics, airfoil selection and wing design | T1,T2 |
| 44 | 21 | | **Explain** about different high lift devices. | High-lift Devices: Airfoil maximum lift coefficient, leading and trailing edge devices | T1,T2 |
| 45 | 22 | | **Discuss** about the effect of sweep back wing | Effect of sweepback, deep stall, effect of Reynolds number, propulsive lift. | T1,T2 |
| 46-47 | 23 | | **Explain** about different flight conditions | Level flight performance, climb performance, range, endurance, energy-state approach to airplane performance, takeoff performance, landing | T1,T2 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | performance | |
| 48-49 | 24 | IV | **Explain** different stability conditions. | Static longitudinal stability; Dynamic longitudinal stability; Dynamic lateral stability | T1,R1 |
| 50 | 25 | | **Define** control and maneuverability. | Control and maneuvrability: Turning performance, control systems, active controls | T1,R1 |
| 51 | 26 | | **Discuss** about propulsive devices in aircrafts | Aerospace propulsion: Piston engines, gas turbines | T1,R1 |
| 52 | 27 | | **Discuss** about gas turbines | Speed limitations of gas turbines | T1,R1 |
| 53 | 28 | | **Explain** different engines. | Ramjets, propellers, overall propulsion efficiency, rocket engines | T1,R1 |
| 54 | 29 | | **Explain** about rocket motor performance. | rocket motor performance, propulsion-airframe integration | T1 |
| 55 | 30 | V | **Explain** about structures of aircraft | Aircraft structures: Importance of structural weight and integrity | T1 |
| 56-57 | 31 | | **Discuss** development of aircraft structures. | development of aircraft structures, importance of fatigue | T1,T2 |
| 58 | 32 | | **Discuss** about materials used in aircrafts | materials, loads, weight estimation | T1,T2 |
| 59 | 33 | | **Explain** different types of flows | Hypersonic flows: temperature effects, Newtonian theory | T1,T2 |
| 60 | 34 | | **Explain** about multi stage rocket | rocket trajectories, multistage rockets, escape velocity | T1,T2 |
| 61 | 35 | | **Discuss** about satellite terminologies | circular orbital or satellite velocity | T1,T2 |
| 63-64 | | | **Discuss** about different types of orbits and maneuvers | elliptical orbits, orbital maneuvers | T1,T2 |

:

## XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

| Course Objectives | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| 1 | S | S | | | | H | | | | | | S | | | H |
| 2 | H | | S | S | | | | | | | | S | | S | S |
| 3 | | S | | S | | | | | | | | S | | S | S |
| 4 | H | S | S | | | | | | | | | S | | S | S |

**S – Supportive** **H - Highly Related**

I. Analyze airplane performance, stability and control.

## XII. MAPPING COURSE OUTCOMES LEADING TO ACHIEVEMENT OF PROGRAM OUTCOMES:

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

**Prepared by:**

**R Sabari Vihar**

**Date: 24-Oct-2017**

**HOD,ECE**