| AVIONICS AND SYSTEMS | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE701** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:2:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory + 8-10 Lab slots | Total Marks | 100 |
| Credits | 04 | Exam Hours | 3 |
| Examination nature (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Understand the aircraft control systems.
- Understand the aircraft systems.
- Acquire the knowledge of avionics systems.
- Analyse analog /digital conversions and use microprocessors.
- Understand the functioning of MIL-STD-1553B Data Bus

**Teaching-Learning Process (General Instructions)**

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**MODULE-1**

**Airplane Control Systems:** Conventional Systems, power assisted and fully powered systems, Power actuated systems, Modern control systems, Digital fly by wire systems, Auto pilot system.

**Aircraft Systems:** Hydraulic systems, components, Pneumatic systems and components, Brake system, Landing Gear systems, Classification.

**MODULE-2**

**Engine Systems**: Fuel systems for Piston and jet engines, Components of multi engines. lubricating systems - Starting and Ignition systems.

**Auxiliary System:** Basic Air cycle systems, Vapour Cycle systems, oxygen & pressurization systems, Fire protection systems, De-icing and anti-icing systems.

**MODULE-3**

**Aircraft Instruments:** Flight Instruments, Gyroscope, Accelerometers, Air speed Indicators, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles.

**MODULE-4**

**Power Distribution System:** Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilization-typical application to avionics. Need for Avionics in civil and military aircraft.

**MODULE-5**

**Flight Deck and Cockpits**: Control and display technologies CRT, LED, LCD, EL and plasma panel, Touch screen, Direct voice input (DVI), MFDS, HUD, MFK, HOTAS.

**Avionics Systems Integration**: Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Electronic Warfare, and fire control system, Data buses, MIL–STD 1553 B.

**PRACTICAL COMPONENT OF IPCC** *(May cover all / major modules)*

| Sl.NO | Experiments |
|---|---|
| 1 | Realise basic logic functions using universal gates(7400, 7402, 7408, 7432, 7486, 7404, 7411,7410,7420) |
| 2 | Design half adder and full adder using basic logic gates and verify the truth table |
| 3 | Design half subtractor and full subtractor using basic logic gates and verify the truth table. |
| 4 | Design and implement the encoder and decoder and to verify the truth table. |
| 5 | Design and implement multiplexer and demultiplexer and to verify the truth table. |
| 6 | Realize the following shift registers using IC7474/7495 (i) SISO (ii) SIPO (iii)) PISO(iv) )PIPO (v) Ring (vi) Johnson counter |
| 7 | Compute Indicated Airspeed for Pitot-Static Airspeed Indicator for cessana aircraft by using MATLAB |
| 8 | Six-DOF mathematical modelling and simulation of an aircraft and avionics integration |
| 9 | Study of MIL-STD-1553 B Data Bus |
| 10 | Study of Pulse Amplitude Modulation (PAM) and Demodulation. |
| 11 | Study of HAM Radio |
| 12 | Study of Flip flops |

**Course outcomes (Course Skill Set):**

At the end of the course, the student will be able to:

- Distinguish the conventional and modern control systems.
- Categorize different types of aircraft systems and instruments.
- Identify the use of avionics systems.
- Perform analog /digital conversions and use microprocessors.
- Handle functioning of MIL-STD-1553B Data Bus

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**CIE for the theory component of the IPCC (maximum marks 50)**

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.

- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

**CIE for the practical component of the IPCC**

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

**SEE for IPCC**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scoredby the student shall be proportionally scaled down to 50 Marks

**The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component**.

**Suggested Learning Resources:**

**Text Books**


1. Ian Moir and Allan Seabridge, 'Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration', Wiley India Pvt Ltd, 3rd edition, 2012, ISBN-13: 978-8126535217.
2. Pallet, E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific and Technical, 1996.
3. R.P.G. Collinson., "Introduction to Avionics Systems", Springer,3rd edition, 2011, ISBN-13: 978-9400707078


**Reference Books**


1. Lalit Gupta and OP. Sharma, 'Aircraft Systems (Fundamentals of Flight Vol. IV)', HimalayanBooks;2006.
2. Treager. S, "Gas Turbine Technology", McGraw-Hill, 3rd edition,2013, ISBN-13: 978- 1259064876.
3. R.W. Sloley and W.H. Coulthard, 'The aircraft Engineers Handbook, No 4, Instruments', 6th Edition, 2005, ISBN-13: 978-8175980518.
4. SR. Majumdar, 'Pneumatic Systems', Tata McGraw Hill Publishing Co,1st Edition, 2001, ISBN-13: 978-0074602317.
5. William A Neese, 'Aircraft Hydraulic Systems', Himalayan Books, 2007.
6. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989, ISBN-13: 978-0582018815.


**Web links and Video Lectures (e-Resources):**

- **https://nptel.ac.in/courses/101104071**
- **https://www.iist.ac.in/departments/avionics-lab**

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

1. Experimentation – gathering knowledge through experience through lab.
2. Exploration – gathering knowledge and attaining skills through active investigation.
3. Expression – encouraging students to express their views through visual presentations.

| COMPUTATIONAL FLUID DYNAMICS | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE702/BAS702** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:2:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory + 8-10 Lab slots | Total Marks | 100 |
| Credits | 04 | Exam Hours | 3 |
| Examination nature (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Know the basic equations of fluid dynamics, boundary layer and discretization.
- Understand the source and vortex panel method.
- Know about FDM, FVM and FEM.
- Acquire the knowledge of types of meshing.
- Understand the basics of flow and stress analysis.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**MODULE-1**

**Introduction:** CFD Applications. Need for Parallel Computers in CFD algorithms. Models of flows. Substantial derivative, Divergence of velocity. Continuity, Momentum, and Energy Equations-Derivation in various forms. Integral versus Differential form of equations. Comments on governing equations. Physical boundary conditions. Forms of equations especially suitable for CFD work. Shock capturing, and shock fitting.

**MODULE-2**

**Mathematical Behaviour of Partial Differential Equations:** Classification of partial differential equations. Cramer Rule and Eigen value methods for classification. Hyperbolic, parabolic, and elliptic forms of equations. Impact of classification on physical and computational fluid dynamics. Case studies: steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, and unsteady thermal conduction, steady subsonic inviscid flow.

**MODULE-3**

**Grid Generation and Adaptive Grids:** Need for grid generation and Body-fitted coordinate system. Structured Grids-essential features. Structured Grid generation techniques- algebraic and numerical methods. Unstructured Grids-essential features. Unstructured Grid generation techniques- Delaunay-Voronoi diagram, advancing front method. Surface grid generation, multi-block grid generation, and meshless methods. Grid quality and adaptive grids. Structured grids adaptive methods and unstructured grids adaptive methods.

**MODULE-4**

| |
|---|
| **Discretisation & Transformation:**<br>**Discretisation:** Finite differences methods, and difference equations. Explicit and Implicit approaches. Unsteady Problem -Explicit versus Implicit Scheme. Errors and stability analysis. Time marching and space marching. Reflection boundary condition. Relaxation techniques. Alternating direction implicit method. Successive over relaxation/under relaxation. Second order Lax-Wendroff method, mid-point Leap frog method, upwind scheme, numerical viscosity, and artificial viscosity.<br>**Transformation:** Transformation of governing partial differential equations from physical domain to computational domain. Matrices and Jacobians of transformation. Example of transformation. Generic form of the Governing flow equations in Strong Conservative form in the Transformed Space. |
| **MODULE-5** |
| **Finite Volume Technique and Some Applications:** Spatial discretisation- cell centered and cell vertex techniques (overlapping control volume, duel control volume). Temporal discretisation- Explicit time stepping, and implicit time stepping. Time step calculation. Upwind scheme and high resolution scheme. Flux vector splitting, approximate factorisation. Artificial dissipation and flux limiters. Unsteady flows and heat conduction problems. Upwind biasing. |

**PRACTICAL COMPONENT OF IPCC***(May cover all / major modules)*

| Sl.NO | Experiments |
|---|---|
| 1 | Modeling of Symmetrical/Cambered Aerofoil Geometry, and Generation of Body Fitting Adaptive Mesh. |
| 2 | Modeling of 2-D Incompressible and Invisicd Flow over Symmetrical/Cambered Aerofoil, and Plotting of Pressure distribution and Velocity vectors for Subsonic/Supersonic Mach numbers. |
| 3 | Modeling of 2-D Compressible and Viscid Flow over Symmetrical/Cambered Aerofoil, and Plotting of Pressure distribution and Velocity vectors for Subsonic Mach numbers. |
| 4 | Isentropic Flow Analysis in a 2-D Subsonic Diffuser and a Subsonic Nozzle. |
| 5 | Isentropic Flow Analysis in a 2-D Supersonic Diffuser and a Supersonic Nozzle. |
| 6 | Geometric Modeling and Mesh Generation of a 2-D Convergent-Divergent Nozzle and Analyses of flow for Adiabatic Conditions (Fanno Flow). |
| 7 | Geometric Modeling and Mesh Generation of a 2-D Pipe and Modeling of Steady/Unsteady Heat Convection and Conduction (Rayleigh Flow). |
| 8 | Structural Modeling of Sandwich Beam of Rectangular Cross-section and Analyses for Stress for Unsymmetrical bending case. |
| 9 | Structural Modeling and Stress Analysis of a Torsion Box of a Wing, Fuselage Frame & Tapered I-Section Spar. |
| 10 | Determine the Natural frequency and Mode shapes of a Cantilever beam under UDL. |
| 11 | A Plate fixed at one end has a hole in centre and has varying thickness, Determine stresses developed due to applied static loads in vertical direction. |

| | |
|---|---|
| 12 | A Tapered Plate fixed at one end has a hole in centre and has varying thickness, determine stresses developed due to applied static loads in vertical direction. |

**Course outcomes (Course Skill Set):**

At the end of the course, the student will be able to:

- Differentiate the FDM, FVM and FEM
- Perform the flow, structural and thermal analysis.
- Utilize the discretization methods according to the application.
- Apply different types of meshing.
- Perform the flow and stress analysis.

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**CIE for the theory component of the IPCC (maximum marks 50)**

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

**CIE for the practical component of the IPCC**

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

**SEE for IPCC**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

**The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component**.

**Suggested Learning Resources:**

**Text Books**


1. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Springer, Berlin,2nd edition, 2002,ISBN-13: 9783540543046
2. John D. Anderson, "Computational Fluid Dynamics", McGraw Hill, 2013, ISBN-13: 978-0070016859.


**Reference Books:**


1. John F. Wendt, "Computational Fluid Dynamics - An Introduction", Springer, 3rd edition,2013
2. Charles Hirsch, "Numerical Computation of Internal and External Flows", Elsevier, 1st edition, 2007, ISBN-13: 9789381269428.
3. Klaus A Hoffmann and Steve T. Chiang. "Computational Fluid Dynamics for Engineers", Vols. I & II Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 1993.


**Web links and Video Lectures (e-Resources):**

- https://doc.cfd.direct/notes/cfd-general-principles/
- http://www.ae.iitm.ac.in/~krishna/ecfd4tab.pdf
- https://nptel.ac.in/courses/112105045
- https://onlinecourses.nptel.ac.in/noc21_me126/preview

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

1. Experimentation – gathering knowledge through experience through lab.
2. Exploration – gathering knowledge and attaining skills through active investigation.
3. Expression – encouraging students to express their views through visual presentations.

| CONTROL ENGINEERING | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE703/BAS703** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 4:1:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hrs | Total Marks | 100 |
| Credits | 04 | Exam Hours | 03 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Understand the basic concepts of control systems and mathematical models.
- Acquire the knowledge on block diagrams and signal flow graphs.
- Understand the frequency response analysis and various types of plots.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

**Introduction to Control Systems and Mathematical Models**

**Introduction:** Concept of controls, Open loop and closed loop systems with examples, Concepts of feedback and basic structure of feedback control system, requirements of an ideal control system.

**Mathematical Models:** Transfer function models of mechanical systems, electrical circuits, DC and AC motors in control systems, Analogous systems: Force voltage and Force current analogy.

**Module-2**

**Block Diagrams and Signal Flow Graphs**

Transfer functions definition and its properties, block representation of control systems and terminologies, block diagram algebra and reduction of block diagrams, Signal flow graph method, Mason's gain formula and its applications.

**Transient and Steady State Response Analysis**

Introduction, type and order of systems, time response specifications, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response.

**Module-3**

**System stability** analysis using Routh's – Hurwitz Criterion.

**Root Locus Plots**

Definition of root loci, General rules for constructing root loci, Analysis using root locus plots, Determination of desired gain, limit gain, gain margin and conditional stability.

**Frequency Response Analysis Using Bode Plots:**

Bode attenuation diagrams for first and second order systems, Simplified Bode diagrams, Stability analysis using Bode plots and determination of phase margin and gain margin and gain.

**Module-4**

**Frequency Response Specification and Analysis using Polar plots:**

**Specification:** Frequency response definition, frequency response specifications and its relationship with time response specifications.

**Analysis:** Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles.

**Module-5**

**Feedback control systems:**

Types of controllers – Proportional, Integral, Derivative controllers, Proportional – Integral, Proportional – Integral – Derivative controllers; Compensation methods – Series and feedback compensation, Lead, Lag and Lead-Lag Compensators.

**State Variable Characteristics of Linear Systems**:

Introduction to concepts of states and state variable representation of linear systems, Advantages and Disadvantages over conventional transfer function representation, state equations of linear continuous data system. Matrix representation of state equations, Solution of state equation, State transition matrix and its properties, controllability and observability, Kalman and Gilberts test.

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Apply the concepts of control systems.
2. Reduce the block diagrams and signal flow graphs.
3. Determine the frequency response analysis by using various types of plots.

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**


1. U.A. Bakshi and V.U. Bakshi, Control Engineering, Technical Publications, ISBN: 978-93-5099-657-7.
2. A. Nagoor Kani, Control Systems Engineering, RBA Publications, 2014.

**Reference Books**


1. Katsuhiko Ogatta, Modern Control Engineering, Pearson Education,2004.
2. I.J. Nagrath and M. Gopal, Control Systems Engineering, New Age Publishers, 2017.
3. Richard. C. Dorf and Robert.H. Bishop, Modern Control Systems, Addison Wesley, 1999.
4. N.S. Nise, Control Systems Engineering, 6th Edition, Wiley, 2012.


**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/108106098
- https://nptel.ac.in/courses/108102043

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

| GAS TURBINE TECHNOLOGY | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE714A** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Comprehend the types of engines and its applications.
- Understand the materials required for engine manufacturing.
- Acquire the knowledge of engine performance and testing.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

**Types, Variation & Applications:** Types of engines showing arrangement of parts. Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Comparison of thrust and specific fuel consumption. Thrust, pressure and velocity diagrams.

**Engine Parts:** Compressor assembly, types of burners: advantages and disadvantages. Influence of design factors on burner performance. Effect of operating variables on burner performance. Performance requirements of combustion chambers. Construction of nozzles. Impulse turbine and reaction turbine. Exhaust system, sound suppression. Thrust reversal: types, design & systems. Methods of thrust augmentation, after burner system.

**Module-2**

**Materials and Manufacturing:** Criteria for selection of materials. Heat ranges of metals, high temperature strength. Surface finishing. Powder metallurgy. Use of composites and Ceramics. Super alloys for Turbines.

**Systems:** Fuel systems and components. Sensors and Controls. FADEC interface with engine. Typical fuel system. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas turbine starters.

**Module-3**

**Engine Performance:** Design & off - design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process & Wind milling of Engines. Thrust engine start envelope. Starting torque and speed requirements Calculations for design and off-design performance from given test data– (case study for a single shaft Jet Engine). Engine performance monitoring.

**Module-4**

**Compressor:** Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation.

**Combustor:** Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation.

**Turbines:** Turbine MAP. Turbine Testing and Performance Evaluation.

**Inlet duct & nozzles:** Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation.

**Module-5**

**Engine Testing:** Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine-operating limits. Methods of displacing equilibrium lines.

**Types of engine testing's**: Normally Aspirated Testing, Open Air Test Bed, Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in flight. Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology.

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Select the suitable materials for engine manufacturing.
2. Evaluate the performance of the engine.
3. Test the engine using several types of engine testing methods.

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**

1. Irwin E. Treager, 'Gas Turbine Engine Technology ', Mc Graw Hill Education, 3rd edition, 2013, ISBN-13: 978-1259064876.
2. P.P Walsh and P. Peletcher, 'Gas Turbine Performance' Blackwell Science, 1998, ISBN0632047843.

**Reference Books**

1. Advanced Aero-Engine Testing, AGARD-59, Publication.
2. MIL–5007E, 'Military Specifications: Engine, Aircraft, Turbo Jet & Turbofan; General Specification for Advance Aero Engine testing', 1973.
3. J P Holman, 'Experimental methods for Engineers ', Tata Mc Graw Hill, 7th edition, 2007, ISBN-13: 978-0070647763.
4. A S Rangawala, Turbomachinery Dynamics-Design and operations, McGraw–Hill, 2005, ISBN-13: 978-0071453691.

**Web links and Video Lectures (e-Resources):**

- https://archive.nptel.ac.in/content/storage2/courses/112104117/ui/Course_home-lec16.htm

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

| WIND TUNNEL TECHNIQUES | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE714B** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Understand the basic of wind tunnel testing.
- Understand the types and functions of wind tunnel.
- Acquire the knowledge on conventional measurement techniques and special wind tunnel.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

**Principles of Model Testing:** Buckingham Theorem, Non-dimensional numbers, Scale effect, Geometric Kinematic and Dynamic similarities.

**Module-2**

**Wind Tunnels:**

Classification - Special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions – Water tunnels: Advantages, limitations and configurations for aeronautical and non-aeronautical applications – Layouts -Sizing, design parameters and loss estimation. Model making; Use of CFD in wind tunnel and water tunnel design.

**Module-3**

**Calibration of Wind Tunnels:** Test section speed, Horizontal buoyancy, Flow angularities, Flow uniformity & turbulence measurements, Associated instrumentation, Calibration of subsonic & supersonic tunnels.

**Module-4**

**Conventional Measurement Techniques**: Force measurements and measuring systems, Multi component internal and external balances, Pressure measurement system, Steady and Unsteady Pressure, single and multiple measurements, Velocity measurements, Intrusive and Non-intrusive methods, Flow visualization techniques, surface flow, oil and tuft, flow field visualization, smoke and other optical and nonintrusive techniques.

**Module-5**

**Special Wind Tunnel Techniques**: Intake tests, store carriage and separation tests, Unsteady force and pressure measurements, wind tunnel model design.

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Apply the principles and procedures for model testing in the wind tunnel.
2. Classify the types and functions of wind tunnel.
3. Distinguish the conventional measurement techniques and special wind tunnel techniques

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**


1. Rae W.H. and Pope. A, "Low Speed Wind Tunnel Testing", John Wiley Publication, 3rd edition, 2010, ISBN-13: 978-8126525683.
2. Pope. A and Goin. L, "High Speed Wind Tunnel Testing", John Wiley, 1985.


**Reference Books**


1. E. Radhakrishnan, Instrumentation, Measurements, and Experiments in Fluids, CRC Press, 2007.
2. Bradsaw "Experimental Fluid Mechanics", Pergamon Press, 2nd revised edition, 1970, ISBN-13: 978-0080069814.
3. Short term course on Flow visualization techniques, NAL, 2009.
4. Lecture course on Advanced Flow diagnostic techniques, NAL.
5. NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998.


**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/101106040

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

| FLIGHT TESTING | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE714C** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Comprehend the basic concepts of flight test instrumentation.
- Acquire the knowledge of performance flight testing and stability control.
- Understand the flying qualities.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

**Introduction:** Sequence, Planning and governing regulations of flight testing. Aircraft weight and centre of gravity, flight testing tolerances. Method of reducing data uncertainty in flight test data -sources and magnitudes of error, avoiding and minimizing errors.

**Flight test instrumentation:** Planning flight test instrumentation, Measurement of flight parameters. On-board and ground based data acquisition system. Radio telemetry.

**Module-2**

**Performance flight testing - range, endurance and climb:** Airspeed – in flight calibration. Level flight performance for propeller driven aircraft and for Jet aircraft - Techniques and data reduction. Estimation of range, endurance and climb performance.

**Performance flight testing -take-off, landing, turning flight:** Manoeuvring performance estimation. Take-off and landing -methods, procedures and data reduction.

**Module-3**

**Stability and control - longitudinal and manoeuvring:**

Static & dynamic longitudinal stability: - methods of flight testing and data reduction techniques. Stick free stability methods. Manoeuvring stability methods & data reduction.

**Module-4**

**Stability and control - lateral and directional:**

Lateral and directional static & dynamic stability: **-** Coupling between rolling and yawing moments. Steady heading slide slip. Definition of Roll stability. Adverse yaw effects. Aileron reversal. Regulations, test techniques and method of data reduction.

**Module-5**

**Flying qualities:** MIL and FAR regulations. Cooper-Harper scale. Pilot Rating. Flight test procedures.

**Hazardous flight testing:** Stall and spin- regulations, test and recovery techniques. Test techniques for flutter, vibration and buffeting.

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Measure the flight parameters.
2. Estimate the performance of flight.
3. Apply the FAR regulations.

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**

1. Ralph D Kimberlin, Flight Testing of Fixed Wing Aircraft, AIAA educational Series, 2003.
2. Benson Hamlin, Flight Testing- Conventional and Jet-Propelled Airplanes, Mac Millan, 1946.

**Reference Books**

1. AGARD, Flight Test Manual Vol. I to IV.
2. A.J. Keane, A. Sobester, Small Unmanned fixed-wing Aircraft Design, Wiley, 2017.
3. A. Filippone, Flight Performance of Fixed and Rotary Wing Aircraft, AIAA Series, 2006.

**Web links and Video Lectures (e-Resources):**

- https://onlinecourses.nptel.ac.in/noc21_ae05/preview

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

| AI AND ML FOR AEROSPACE APPLICATIONS | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE714D/BAS714D** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Understand the basics of Artificial Intelligence and Machine Learning
- Acquire the knowledge of the foundations of AI and AL
- Gather the information on its different algorithms and their applications in Aerospace Engineering

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

**Introduction:** Data Science, AI & ML, Scientific Method, Modeling Concepts, CRISP-DM methods, Programming: Commands and Syntax , Packages and Libraries, Introduction to Data Types, Data Structures in R - Vectors, Matrices, Arrays, Lists, Factors, Data Frames, Importing and Exporting Data., Control structures and Functions

**Module-2**

Descriptive Statistics Data exploration, Qualitative and Quantitative Data, Measure of Central Tendency, Measure of Positions , Measure of Dispersion , Anscombe's quartet, Statistical Analysis Initial Data Analysis, Probability

**Module-3**

Data Acquisition , Data Quality and Transformation, Handling Text Data, Principles of Big Data, Data Visualization, Sampling and Estimation, Inferential Statistics

**Module-4**

Linear Regression, Multiple Linear Regression, Non-Linear Regression, Forecasting models, Foundations for ML, Clustering, Naïve Bayes Classifier, K-Nearest Neighbors, Support Vector Machines, Support Vector Machines

**Module-5**

Foundations for AI,

AI: Application areas, AI Basics (Divide and Conquer, Greedy, Branch and Bound, Gradient Descent), NN basics (Perceptron and MLP, FFN, Back propagation), Convolution Neural Networks, Recurrent Neural Networks, Deep Learning

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Apply the basics of Artificial Intelligence and Machine Learning
2. Use the knowledge of the foundations of AL and AL
3. Implement the information on its different algorithms and their applications in Aerospace Engineering

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**

1. The Hundred-Page Machine Learning Book by Andriy Burkov
2. Machine Learning by Tom M Mitchell
3. Artificial Intelligence: A Modern Approach, 4th US ed. by Stuart Russell and Peter Norvig

**Reference Books**

1. Machine Learning and Data Mining in Aerospace Engineering by Aboul Ella Hassanien
2. Applications of Machine Learning by Jitendra Kumar Verma
3. Artificial Intelligence and Machine Learning for Business for Non-Engineers by CRC Press

**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/106106198

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

| EARTH AND SPACE SCIENCE | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE755A/BAS755A** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Understand the basics of Earth Science
- Acquire the knowledge of Space Science
- Connect the concepts of Earth and Space Science for aeronautical/Aerospace Engineering

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

Earth System Science, Doing Science, Earth in Space, Near-Earth Objects, Plate tectonics, Continental Drift, Plate Boundaries, The Science of Earth Quakes, Seismic Waves, Earth quake hazards

**Module-2**

Volcanoes and Mountains, Rocks and Minerals, weathering and Soils, Physical Weathering, weathering rates, Oceans and Coastlines, Ocean Waters, Oceanic Circulations, Shoreline feature and protection, The atmosphere, Earth's climate System.

**Module-3**

A brief History of discovery, Exploration of Solar System, The Sun and the Beyond, Remote Sensing of The Earth's Climate System, Remote Sensing Methodology, Measurement by remote sensing, Atmospheric factors, Instrumental factors, Using Reflected Sunlight, Using Thermal Emission, Using Radar

**Module-4**

Planetary Science, Terrestrial Planets, Outer Planets, Comets, Asteroids, Magnetosphere, Missions, Space Plasma Physics

**Module-5**

Space Weather, Solar Activity, The Solar Wind, Aurora, Solar flares, The Ionosphere, Coronal Mass Ejections and Geomagnetic Storms, The Physics of the Sun, X-Ray Astronomy

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Appreciate the foundations of Earth Science
2. Apply the knowledge of Space Science
3. Analyse Earth and Space Sciences for aeronautical/Aerospace Engineering

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**

1. Exploring Earth Science - 16 edition ISBN13: 978-0078096143 by Stephen Reynolds
2. Space Science by Louise K Harra and K O Mason , Imperial College Press

**Reference Books**

1. Principles of Environmental Science: Inquiry and Applications. William Cunningham, Mary Cunningham ISBN13: 9780073532516
2. Earth Science / Edition 13 by Edward J. Tarbuck
3. Concepts in Space Science by RR Daniel

**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/115107121
- https://nptel.ac.in/courses/105104152

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

| AIR TRAFFIC AND WEATHER | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE755B/BAS755B** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40HRS | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Understand the Air Traffic Control
- Acquire Knowledge on the weather condition for flight traffic
- Remember the symbols of ATC for different weather conditions

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

The earth's atmosphere, Temperature, Atmospheric Pressure and Altimetry, Wind, moisture, cloud formation, precipitation, Stable and Unstable Air, clouds, Air masses and Fonts.

**Module-2**

Turbulence, Icing, Thunderstorm, High Altitude Weather, Arctic weather, Tropical Weather

**Module-3**

Problems- Traffic, Weather, Congestion, Air traffic flow management, Airport capacity, Traffic Management Overview

Basic Traffic Management Techniques and Terms Ground Delay Programs (GDP) Time-based Flow Management (TBFM) Traffic Management Advisor (TMA) Airspace Flow Programs (AFP) Ground Stops (GS) Adaptive Compression (AC) Integrated Collaborative Rerouting (ICR) Delay Tier Information Operational Information System (OIS)

**Module-4**

Weather Tools De-icing/Anti-icing Severe Weather Avoidance Plan (SWAP) Routes Preferred Routes Coded Departure Routes (CDR) National Playbook Flow Evaluation Area (FEA)/Flow Constrained Area (FCA), Global air-traffic management

**Module-5**

Call signs, Technology, Air Navigation Service providers and Air traffic service providers, Privatization ATC regulations Weather Conditions Worldwide, METAR, Cloud reporting Abbreviation.

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Implement the knowledge during the Air Traffic Control
2. Analyse the weather condition for flight traffic
3. Apply the symbols of ATC for different weather conditions

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**

1. Mastering the Systems: Air Traffic Control and Weather by Richard L. Collins
2. Aviation Weather for Pilots and Flight Operation Personnel Gordon Press Publishers

**Reference Books**

1. New Concepts and Methods in Air Traffic Management by Amedeo R Odoni, Springer
2. Air Traffic Control by Max Mulder , published by InTech

**Web links and Video Lectures (e-Resources):**

- https://www.ll.mit.edu/about/facilities/air-traffic-control-automation-aviation-weather-decision-support-laboratories

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

| BASICS OF FLIGHT SIMULATION | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE755C** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Understand the basic principle of working of flight components
- Remember the names of components and their functions
- Think to simulate a flight

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

Historical Perspectives, The case for simulation, Engineering Flight Simulation, The changing role of simulation,

**Module-2**

The organisation of flight simulator, Equation of Motion, Aerodynamic model, Engine Model, Engine model, data acquisition model, Gear Model , weather model, Visual System, Sound System, Motion System, Controls, Instrument Display, Navigation Systems, Maintenance

**Module-3**

Principles of Flight Modeling , Newtonian Mechanics, Differential Equations, Numerical Integration, Real-time computing, Flight Data

**Module-4**

The atmosphere, forces, moments, Axes System, Quaternions, Equations of Motions, propulsion-Piston Engine, Jet Engine, the landing gear

**Module-5**

Simulation of flight control systems, the Laplace transform, PID control systems, Trimming, Aircraft Displays, Attitude Indicator, Altimeter, Airspeed Indicator, compass card, Automatic Direction Finding(ADF), VHF omnidirectional Range(VOR), Distance Measuring Equipment(DME),Instrument Landing Systems(ILS), GPS, Inertial Navigation System

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Apply the basic principle of working of flight components
2. Practise the names of components and their functions
3. Simulate a flight.

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
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- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**

1. Principles of Flight Simulation by David Allerton, Wiley Publisher
2. Flight Dynamics, Simulation, and Control by Ranjan Vepa , CRC press

**Reference Books**

1. Flight Simulation by JM Rolfe and K J Staples, Cambridge University Press
2. In-flight Simulation-theory and Application by Edwin A. Kidd, Gifford Bull, Robert P. Harper

**Web links and Video Lectures (e-Resources):**

- http://helijah.free.fr/dev/Principles-of-Flight-Simulation.pdf
- https://onlinecourses.nptel.ac.in/noc21_ae05/preview

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

| AVIATION AND INTERNET INFRASTRUCTURE | | Semester | 7 |
|---|---|---|---|
| Course Code | **BAE755D/BAS755D** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40hrs | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course objectives:** This course will enable students to

- Understand the need for the flight 4.0
- Gain Knowledge on both aviation and its internet infrastructure
- Understand the operation and working principle of internet infrastructure

**Teaching-Learning Process (General Instructions)**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

**Module-1**

The Aerospace Sector, Aerospace Transformation through Industry 4.0 technologies, Flight 4.0: The changing Technology Landscape, The Internet : An Introduction

**Module-2**

Advances in Avionics Platforms: Multicore systems, Emerging trends in Avionics Networking, Internet Infrastructure working principle

**Module-3**

IoT and Service Oriented Infrastructure for Flight 4.0, Big Data and Data Analytics in Aviation, Ontologies in Aeronautics, TCP/IP, In-Flight Wi-Fi

**Module-4**

Advances in Software Engineering and Aeronautics, Autonomy and Safety of Unmanned Aircraft Systems

**Module-5**

Aerospace Engineering Curricular Expansion in Information Systems, Networking, Web services, Cloud Computing

**Course outcome (Course Skill Set)**

At the end of the course, the student will be able to :

1. Analyse the need for the flight 4.0
2. Implement Knowledge on both aviation and its internet infrastructure
3. Modify the operation and working principle of internet infrastructure

## Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Text Books**

1. Advances in Aeronautical Informatics- Technology towards Flight 4.0 by Umut Durak, Springer
2. Principles of flight 4.0 by ISBN 9788281070318, 8281070315

**Reference Books**

1. Aircraft Technology by Melih Cemal Kushan

**Web links and Video Lectures (e-Resources):**

- https://www.coursera.org/lecture/cybersecurity-policy-aviation-internet/l26-internet-infrastructure-vCsja

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Experimentation – gathering knowledge through experience through lab.
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