Global Navigation Satellite Systems		Semester	7
Course Code	**BAS701**	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 basics of GPS.
- Comprehend the GPS Signals, orbits and errors.
- Acquire the knowledge on IRNSS.

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

Overview of GPS:

Basic concept, system architecture, space segment, user segment, GPS aided Geo-augmented navigation (GAGAN) architecture

MODULE-2

GPS Signals

Signal structure, anti-spoofing (AS), selective availability, Difference between GPS and GALILEO satellite construction

MODULE-3

GPS orbits and satellite position determination:

GPS orbital parameters, description of receiver independent exchange format (RINEX) – Observation data and navigation message data parameters, GPS position determination.

MODULE-4

GPS Errors:

GPS error sources – clock error, ionospheric error, tropospheric error, multipath, ionospheric error estimation using dual frequency GPS receiver.

MODULE-5

Overview of IRNSS:

Basics, NavIC System Architecture, Space Segment, Ground Segment, User Segment, IRNSS Services Carrier Frequencies, Data Structure, System Time, Frame Structure, Navigation Data, Ionosphere Correction Coefficients, TEC Calculation.

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

Sl.NO	Experiments
1	Simulation of Hoffmann transfer
2	Simulation of velocity calculations for orbit manoeuvring
3	Simulation of time period calculations for orbital motion
4	Simulation of orbit propagation
5	Simulation of Attitude and orbital perturbations
6	Link budget analysis
7	Simulate satellite transfer orbits
8	Calculation of Total Electron Content using Matlab
9	Simulate the path of Medium Earth Orbit GPS satellites
10	Study on RINEX files.
11	Study experiment on Differential GPS
12	Study experiment on Ionospheric Error correction models.

Course outcomes (Course Skill Set):

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

- Describe the GPS and its signals.
- Classify the types of satellite constellation.
- Identify the orbits, position and errors.

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. G S RAO, **Global Navigation Satellite Systems,** McGraw-Hill,New Delhi, 2010.
2. Rajat Acharya, **Understanding Satellite Navigation,** Academic Press, 2014.

Reference Books:

1. B. Hoffman – Wellenhof, H. Liehtenegger and J. Collins, 'GPS – Theory andPractice', Springer, 2001.

2. James Ba – Yen Tsui, 'Fundamentals of GPS receivers – A software approach', JohnWiley & Sons, 2001.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/105/107/105107194/

http://acl.digimat.in/nptel/courses/video/105107194/105107194.html

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	**BAS702/BAE702**	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: **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. **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	**BAS703/BAE703**	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.

Hypersonics		Semester	7
Course Code	**BAS714A**	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 hypersonic flows.
- Understand the approximate methods for inviscid hypersonic flows.
- Acquire the knowledge of viscous interactions in hypersonic flows.

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

Basics of Hypersonic Flows: Thin shock layers, entropy layers, low density and high-density flows, hypersonic flight paths hypersonic flight similarity parameters, shock wave and expansion wave relations of inviscid hypersonic flows.

Module-2

Surface Inclination Methods for Hypersonic Inviscid Flows: Local surface inclination methods, modified Newtonian Law, Newtonian theory – tangent wedge or tangent cone and shock expansion methods, Calculation of surface flow properties.

Module-3

Approximate Methods for Inviscid Hypersonic Flows: Approximate methods hypersonic small disturbance equation and theory, thin shock layer theory, blast wave theory, entropy effects, rotational method of characteristics, hypersonic shock wave shapes and correlations

Module-4

Viscous Hypersonic Flow Theory: Navier–Stokes equations, boundary layer equations for hypersonic flow, hypersonic boundary layer, hypersonic boundary layer theory and non-similar hypersonic boundary layers, hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating, heat flux estimation

Module-5

Viscous Interactions in Hypersonic Flows: Strong and weak viscous interactions, hypersonic shockwaves and boundary layer interactions, Estimation of hypersonic boundary layer transition, Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

Course outcome (Course Skill Set)

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

1. Apply the basics of hypersonic flows.
2. Apply the approximate methods for inviscid hypersonic flows.
3. Classify the viscous interactions in hypersonic flows.

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. John D. Anderson, Jr, Hypersonic and High Temperature Gas Dynamics, AIAA Series,2nd revised edition,2006, ISBN-13: 978-1563477805.
2. John. D. Anderson, Jr., Modern Compressible Flow with Historical perspective Hypersonic Series, McGraw Hill Education,3rd edition, 2012, ISBN-13: 978-1259027420

Reference Books

1. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series,1994, ISBN-13: 978-1563470356
2. John T. Bertin, Hypersonic Aerothermodynamics, AIAA Inc., Washington D,1994.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/101/103/101103003/

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.

Cryogenics		Semester	7
Course Code	**BAS714B**	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

1. Understand the basic of cryogenic engineering.
2. Understand the cryogenic properties and insulation.
   Acquire the knowledge on storage of cryogenic liquids and equipments.

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 Cryogenic Engineering: Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium, Liquefaction systems of hydrogen and helium gases, Liquefaction systems of hydrogen and helium gases, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison.

Module-2

Properties: Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative - Linde - Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative - Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator,

Module-3

Cryogenic Insulation: Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations

Module-4

Storage and Instrumentation of Cryogenic liquids: Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

Module-5

Cryogenic Equipment: Cryogenic heat exchangers - recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryopumping; Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport.

Course outcome (Course Skill Set)

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

1. Recognize the basic of cryogenic engineering.
2. Identify the storage and instrumentation required for cryogenic liquids.
3. Classify the types of cryogenic equipments

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. T.M. Flynn, Marcel Dekker., Cryogenic Engineering, CRC Press,2nd edition, 2004,ISBN-13: 978-8126504985
2. A. Bose and P. Sengupta, "Cryogenics: Applications and Progress", Tata McGraw Hill.

Reference Books

1. J.G. Weisend II, Taylor and Francis , "Handbook of Cryogenic Engineering", CRC Press,1st edition,1998,ISBN-13: 978-1560323327
2. R. Barron,"Cryogenic Systems", Oxford University Press.
3. K.D. Timmerhaus and T.M. Flynn, "Cryogenic Process Engineering", Plenum Press,1st edition,2013,ISBN-13: 978-1468487589
4. G.G. Haselden,"Cryogenic Fundamentals", Academic Press.
5. C.A. Bailey,"Advanced Cryogenics", Springer,1971,ISBN-13: 978-0306304583

Web links and Video Lectures (e-Resources):
https://archive.nptel.ac.in/courses/112/101/112101004/
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	**BAS714C**	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	**BAS714D/BAE714D**	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 SCIENCES		Semester	7
Course Code	**BAS755A/BAE755A**	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	**BAS755B/BAE755B**	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.

INDUSTRIAL AERODYNAMICS		Semester	5
Course Code	**BAS755C**	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	03
Examination type (SEE)	Theory		

Course objectives: This course will enable students to

- Understand the basics of experimental aerodynamics.
- Understand the procedures for model measurements.
- Understand the aerodynamics of different shaped bodies & wind tunnel correction techniques

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

Wind Energy Collectors: Horizontal axis and vertical axis machines. Power coefficient. Betz coefficient by momentum theory.

Vehicle Aerodynamics: Power requirements and drag coefficients of automobiles. Effects of cut back angle. Aerodynamics of Trains and Hovercraft.

Module-2

Building Aerodynamics: Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, building ventilation and architectural aerodynamics.

Flow Induced Vibrations: Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall

Module-3

Model Measurements: Balances: - design, installation and, calibration. Internal balances. Mounting of models, rigidity. Measurement of interference. Lift and drag measurements through various techniques. Testing procedures. Testing:- 3-D wings, controls, complete model, power effects, aero elasticity, dynamic stability. Testing with ground plane, testing wind mill generator. Testing for local loads. Testing of rotor. Testing engines, Jettison tests. Data reduction. Data correction.

Module-4

Aerodynamics of Slender and Blunt Bodies: Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.

Module-5

Wind Tunnel Boundary Corrections and Scale Effects: Effects of lateral boundaries. Method of images. Wall corrections. Effects of Buoyancy, Solid Blocking, Wake Blocking. General downwash correction. Lift interference correction. Corrections for reflection plane models. Scale effects on aerodynamic characteristics and stability derivatives

Course outcome (Course Skill Set)

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

1. Distinguish the building and vehicle aerodynamics.
2. Evaluate the boundary corrections and scale effects.
3. Evaluate the aerodynamics of different shaped bodies & wind tunnel correction 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. Jewel B. Barlow, William H RAE, Jr. and Alan Pope, ' Low speed Wind Tunnel Testing', John Wiley & Sons,3rd edition,2010,ISBN-13: 978-8126525683
2. M. Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and road Text Vehicles", Plenum press, New York, 1978.

Reference Books:

1. P. Sachs, "Winds forces in engineering", Pergamon Press, 2nd edition, 2013.
2. R.D. Blevins, "Flow induced vibrations", Van Nostrand, 1990.
3. N.G. Calvent, "Wind Power Principles", Calvert Technical Press, 2nd edition, 2004, ISBN-13: 978-0951362068.
4. Anderson Jr., D., – "Modern compressible flows", McGraw-Hill Book Co., New York 1999

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/101/105/101105088/
- http://acl.digimat.in/nptel/courses/video/101105088/L01.html

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	**BAS755D/BAE755D**	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.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations