AVIATION MANAGEMENT		Semester	5
Course Code	**BAS501/BAE501**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives: This course will enable students to

- Acquire the leadership and perception of design feedback system.
- Realize the customer needs & Quality
- Understand the airline and airport operation, scheduling and management
- Acquire the general aviation management practices
- Grasp the broad disciplines of management at different levels of aviation industry

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

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,

Module-2

Continuous Process Improvement:

Process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Tools and Techniques: Benching marking, information technology, quality management systems, environmental management system, quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance.

Module-3

Customer Satisfaction and Employee Involvement:

Customer Satisfaction : customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, Case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.

Module-4

Airline and Airport Management, Airline Operation and Scheduling, Data Analysis for Business Decisions, Economic Analysis for Business Decisions, Aircraft Rules and Regulation, Airline Business in the 21st Century. Human Resources Management, Organizational Behaviour, Accounting for Management, Airline Economics,

Module-5

Business Application Software, Communication Skills and Business Correspondence, Research Methods in Business, International Business Management, Aviation Systems: Management of the Integrated Aviation Value Chain Aviation Law , Aviation Safety Management and Accident Investigations, Emerging Trends in Management - Case Study Analysis, Entrepreneurship Development, Airline Advertising and Sales Promotion

Course outcome (Course Skill Set)

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

1. Analyse customer need and perceptions of design feedback systems
2. Infer the customer perception of quality
3. Apply the foundational knowledge of airline and airport operation, scheduling and management
4. Implement the general aviation management practices
5. Prepare for the management at different levels of aviation industry

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:

Books

1. Introduction to Aviation Management, Andreas Wald, Christoph Fay, Ronald Gleich, LIT Verlag Münster,
2. Aviation Management (Ground Service & In-flight Service) Paperback – 1 January 2021 by Arijit Das (Author)
3. Total Quality Management: Dale H. Bester field, Publisher Pearson Education India, ISBN: 8129702606, Edition 03/e Paperback (Special Indian Edition)

Reference Books

1. Aviation Management : Global And National Perspectives Hardcover – 1 January 2008 by Ratandeep Singh (Author)

2. Aviation Leadership: The Accountable Manager by Mark J. Pierotti Airline Management Finance -The

Essentials By Victor Hughes

3. A New American TQM, four revolutions in management, Shoji Shiba, Alan Graham, David Walden, Productivity press, Oregon, 1990

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=6Uk8F3_9ywY

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.

Theory of Vibrations		Semester	5
Course Code	**BAS502**	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:

- Understand the basic concepts of vibrations.
- Understand the working principle of vibration measuring instruments.
  Acquire the knowledge of numerical methods for multi-degree freedom systems

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: Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems.

MODULE-2

Undamped Free Vibrations: Single degree of freedom systems. Undamped free vibration, natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.

Damped Free Vibrations: Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement.

MODULE-3

Forced Vibration: Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation, transmissibility ratio. due to harmonic excitation and support motion.

Vibration Measuring Instruments & Whirling of Shafts: Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral and torsional Vibrations.

MODULE-4

Systems with Two Degrees of Freedom: Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Geared systems. Forced Oscillations-Harmonic excitation. Applications:

a) Vehicle suspension.
b) Dynamic vibration absorber.
c) Dynamics of reciprocating Engines.

Continuous Systems: Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams.

MODULE-5

Numerical Methods for Multi-Degree Freedom Systems:

Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix iteration-Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method.

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

Sl.NO	Experiments
1	Simulate simple harmonic motion
2	Simulate vibration dampening effects on beams
3	Simulate comparison between damped and undamped oscillations
4	Frequency response for a spring-mass system; simulation of the oscillations.
5	Simulate a spring- mass- damper system with and without a forcing function using Matlab
6	Perform Modal Analysis of a Wing and Find the first 6 modes of vibration of the airfoil using ANSYS Workbench.
7	Perform Modal Analysis of a Satellite and Find the first 6 modes of vibration of the simplified CubeSat - P-POD configuration using ANSYS Workbench.
8	Perform modal analysis of a composite monocoque
9	Perform modal analysis on canard-controlled missiles
10	Perform modal analysis on missile grid fin cells at supersonic speeds
11	Study experiment on Single degree of freedom systems, steady state solution with viscous damping
12	Study experiment on Holzer's method and Stodola method

Course outcomes (Course Skill Set):

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

- Apply the principle of super position to Simple Harmonic Motions.
- Determine the vibrations using vibration instruments.
- Apply the numerical methods for multi-degree freedom systems

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. 1. W.T. Thomson and Marie Dillon Dahleh, Theory of Vibration with Applications, Pearson Education 5th edition, 2008, ISBN-13: 978-8131704820.
2. V.P. Singh, Mechanical Vibrations, Dhanpat Rai& Company Pvt. Ltd.,2016, ISBN-13: 978-8177004014.

Reference Books:

1. S.S. Rao, Mechanical Vibrations, Pearson Education Inc, 4th Edition,2003, ISBN-13: 978-8177588743
2. S. Graham Kelly, Mechanical Vibrations- Schaum's Outline Series, Tata McGraw Hill, Special Indian edition, 2007.
3. J.S. Rao & K. Gupta, Theory & Practice of Mechanical vibrations, New Age International Publications, New Delhi, 2001.
4. Leonanrd Meirovitch, Elements of Vibrations Analysis, Tata McGraw Hill, Special Indian edition, 2007.

Web links and Video Lectures (e-Resources): https://archive.nptel.ac.in/courses/112/103/112103111/
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.

Aerospace Structures		Semester	5
Course Code	**BAS503**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:2:0	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

- Comprehend the basic concepts of stress and strain.
- Acquire the knowledge of types of loads on aerospace vehicles.
- Understand the theory of elasticity.

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

Design for Static Strength

Introduction: Normal, shear, biaxial and tri-axial stresses, Stress tensor, Principal Stresses, Stress Analysis, Design considerations, Codes and Standards. Static Strength: Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, and Distortion energy theory, failure of brittle and ductile materials, Stress concentration, and Determination of Stress concentration factor.

Module-2

Design for Impact and Fatigue Strength

Impact Strength: Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Fatigue Strength: Introduction, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

Module-3

Loads on Aircraft and Aircraft Materials

Loads on Aircraft: Structural nomenclature, Types of loads, load factor, Aerodynamics loads, Symmetric manoeuvre loads, Velocity diagram, Function of structural components.

Aircraft Materials: Metallic and non-metallic materials, Use of Aluminium alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application.

Module-4

Failure concepts: Stability problems of thin-walled structures– Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham's and Gerard's methods–Sheet stiffener panels-Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams (Wagner's).

Module-5

Launch Vehicle and Spacecraft Structures: Launch vehicle structures – Loads and stresses, thin-walled pressure vessels, Buckling of beams, thin wall assumption. spacecraft - mini, microstructures, inflatable structures, flying effector, nano tubing.

Course outcome (Course Skill Set)

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

1. Apply the basic concepts of stress and strain analysis.
2. Compute the impact stress.
3. Identify appropriate materials for suitable application based on properties.

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. **V.B. Bhandari,** 'Design of Machine Elements', Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

2. **Megson, T.M.G** 'Aircraft Structures for Engineering Students', Edward Arnold, 1995.

3. **Timoshenko and Goodier,"** 'Theory of Elasticity', McGraw Hill Co.

Reference Books

1. **Robert L. Norton,** Machine Design, Pearson Education Asia, 2001.

2. **Donaldson, B.K.,** "Analysis of Aircraft Structures – An Introduction", McGraw-Hill, 1993.

3. **Timoshenko, S.,** "Strength of Materials", Vol. I and II, Princeton D Von Nostrand Co, 1990.

4. **Joseph E Shigley and Charles R. Mischke**, Mechanical Engineering Design, McGraw Hill International edition, 6th Edition 2009.

5. **Peery, D.J., and Azar, J.J.,** "Aircraft Structures", 2nd edition, McGraw, Hill, N.Y., 1993.

6. **Bruhn. E.H.** "Analysis and Design of Flight Vehicles Structures", Tri – state off set company, USA, 1985.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/101105332

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.

Aerospace Structures Lab		Semester	5
Course Code	**BASL504**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical		

Course objectives: This course will enable students to

- Learn about the simply supported beam, cantilever beam.
- Understand Maxwell's theorem and Poisson ration.
- Acquire the knowledge about buckling load, shear failure and shear center.

Sl.NO	Experiments
1	Deflection of a Simply Supported Beam.
2	Deflection of a cantilever Beam.
3	Beam with combined loading by using superposition theorem.
4	Verification of Maxwell's Reciprocal Theorem.
5	Determination of Young's Modulus using strain gages.
6	Poisson Ratio Determination.
7	Buckling load of slender Eccentric Columns and Construction of Southwell Plot.
8	Shear Failure of Bolted and Riveted Joints.
	Demonstration Experiments (For CIE)
9	Bending Modulus of sandwich Beam.
10	Fault detection and de-lamination studies in composite plate.
11	Determination of fundamental frequency and spectrum analysis of a cantilever beam and harmonics.
12	Vibration induced structural damage studies.

Course outcomes (Course Skill Set):

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

- Compute the deflection of simply supported beam and cantilever beam.
- Verify Maxwell's theorem.
- Determine the buckling load, shear failure and shear center.

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 (CIE):

CIE marks for the practical course are**50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

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FINITE ELEMENT METHODS		Semester	5
Course Code	**BAS515A/BAE515A**	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 importance of discretisation of domain using different finite elements
- Acquire the knowledge of different loading and boundary conditions
- Understand the governing methods of finite element analysis

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: Basic Concepts, Background Review: Stresses and Equilibrium, Plane stress, Plane strain, Potential energy and Equilibrium. Rayleigh - Ritz Method, Galerkin's Method, Simple applications in structural Analysis. Construction or discrete models - sub domains and nodes - simple elements for the FEM - Simplex, complex and multiples elements Polynomial selection -illustrative examples Elements and shape functions and natural coordinates, Use of local and natural coordinates, compatibility and convergence requirements of shape functions.

Module-2

Fundamentals of Finite Element Method: Construction of shape functions for bar element and beam element, Bar elements, uniform bar elements, uniform section, mechanical and thermal loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary conditions.

Module-3

Analysis of Two and Three dimensional Elements: Shape functions of Triangular, Rectangular and Quadrilateral elements, different types of higher order elements, constant and linear strain triangular elements, stiffness matrix Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family.

Module-4

Theory of Isoparametric Elements and Axisymmetric: Isoparametric, sub parametric and super-parametric elements, characteristics of Isoparametric quadrilateral elements, structure of computer program for FEM analysis, description of different modules, pre and post processing, Axisymmetric formulation finite element modeling of triangular and quadrilateral element.

Module-5

Field Problems: Heat transfer problems, Steady state fin problems, 1D heat conduction governing equation, Derivation of element matrices for two dimensional problems, Dynamic consideration- Formulation- Hamilton's principle, Element mass matrices.

Course outcome (Course Skill Set)

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

1. Apply discretisation technique for domain decomposition.
2. Evaluate the effects of different loading and boundary conditions
3. Analyze the governing equations of finite element 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.

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:

Books

1. Chandrupatla T. R., "Finite Elements in engineering", PHI, 3rd edition, 2002, ISBN-13: 978-8120321069.
2. Bhavikatti, Finite element Analysis, New Age International,3rd edition,2015, ISBN-13: 978-8122436716

Reference Books:

1. 1.Rajasekharan. S - "Finite element analysis in engineering design", Wheeler Publishers
2. 2.Bathe. KJ, "Finite Element Procedures", PHI Pvt. Ltd., New Delhi,1996, ISBN-13: 978-8126529988
3. 3.Zienkiewicz. O.C. - "The Finite Element Method", Elsevier,7th edition,2013, ISBN-13: 978-9351071587
4. 4.Rao S. S., "Finite Elements Method in Engineering", Elsevier,5th edition, 2008, ISBN-13: 978-9380931555
5. 5.C.S. Krishnamurthy - "Finite Element analysis - Theory and Programming", Tata McGraw Hill Co. Ltd, New Delhi,2nd edition,2011,ISBN-13: 978-0074622100.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/content/syllabus_pdf/105105041.pdf

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	5
Course Code	**BAS515B**	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 wind tunnel testing.
- Understand the types and functions of wind tunnels.
- Acquire the knowledge on conventional measurement techniques and special wind tunnel 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

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

Module-2

Types And Functions of Wind Tunnels: Classification and types, special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions, Layouts, sizing and design parameters.

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. Rathakrishnan, 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.

Satellite Communication		Semester	5
Course Code	**BAS515C**	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 elements of satellite communication.
- Understand the Different modulation and Multiplexing Schemes.
- Acquire the knowledge of Satellite Telemetry, Tracking and Telecommand.

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

Elements Of Satellite Communication: Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Satellite – description of different Communication subsystems, Bandwidth allocation.

Module-2

Transmission, Multiplexing, Multiple Access and Coding: Different modulation and Multiplexing Schemes, Multiple Access Techniques FDMA, TDMA, CDMA and DAMA, Coding Schemes, Satellite Packet Communications.

Module-3

Satellite Link Design: Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse.

Module-4

Satellite Telemetry, Tracking and Telecommand: Introduction to telemetry systems, Aerospace transducer, signal conditioning, multiplexing methods, Analog and digital telemetry, Command line and remote-control system, Application of telemetry in spacecraft systems, Base Band Telemetry system, Computer command & Data handling, Satellite command system, Issues.

Module-5

Applications: VSAT-VSAT Technologies, Networks MSS-AMSS, MMSS.

Course outcome (Course Skill Set)

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

1. Applying concepts of orbital mechanics.
2. Classify the modulation and Multiplexing Schemes.
3. Identify the applications of satellites.

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. Wilbur L. Pritchard and Joseph A. Sciulli, Satellite Communication Systems Engineering, Pearson Education India,2nd edition,2003, ISBN-13: 978-8131702420.
2. Timothy Pratt and Charles W. Bostain, Satellite Communications, John Wiley and Sons,2nd edition,2006, ISBN-13: 978-8126508334.

Reference Books:

1. Tri T Ha, Digital Satellite Communication, McGraw Hill Education, 2nd edition, 2008, ISBN-13: 978-0070077522.
2. Kadish, Jules E, Satellite Communications Fundamentals, Artech House, Boston ,2000, ISBN-13: 978-1580531368
3. Lida, Takashi ed., Satellite communications: System and its design technology, IOS Press, US, 2000, ISBN-13: 978-1586030858
4. Maral, Gerard, Satellite communications systems: Systems, techniques and technology, John Wiley, New York 2002.
5. Elbert, Bruce R, Satellite communication applications handbook, Artech house Boston 2004.Publishers, New Delhi 1991.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/noc/courses/noc16/SEM2/noc16-ec10/

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.

Introduction to Astrophysics and Space Environment		Semester	5
Course Code	**BAS515D**	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 astrophysics and space environment.
- Study relativistic quantum mechanics.
- Acquire the knowledge of sun and solar system.

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: Overview of major contents of universe, Black body radiation, specific intensity, flux density, luminosity, Basics of radiative transfer (Emission/absorption coefficients, source functions), Magnitudes, distance modulus, Color index, Extinction, Color temperature, effective temperature, Brightness temperature, bolometric magnitude/luminosity, Excitation temperature, kinetic temperature, Utility of stellar spectrum.

Module-2

Basic knowledge of stellar atmospheres: Binaries, variable stars, clusters, open and globular clusters, Laws of planetary motion, Motions and Distances of Stars, Statistical and moving cluster parallax, Velocity Dispersion, Compact objects (BH-systems, Accretion rate/efficiency, Eddington luminosity), Shape, size and contents of our galaxy, Normal and active galaxies, High energy physics (introduction to X-ray and Gamma-ray radiation processes), Newtonian cosmology, microwave background, early universe.

Module-3

Relativistic Quantum Mechanics: Scattering, classical radiation field, creation, annihilation and number operators. Quantized radiation field, unified approach to emission, absorption, and scattering of photons by atoms, radiation damping and resonance fluorescence, dispersion relations and causality, relativistic wave equation (Klein- Gordon and Dirac equations), basics of quantum electrodynamics.

Module-4

Sun & Solar System: The sun, helioseismology, convection, solar magnetism: flux tubes, sunspots, dynamo, solar cycle, chromosphere, corona, solar wind, physical processes in the solar system; dynamics of the solar system; physics of planetary atmospheres; individual planets; comets, asteroids, and other constituents of the solar system; extra-solar planets; formation of the solar system, stars, and planets.

Module-5

Space Environment: Introduction, Vacuum Environments and its effect, Neutral environment and its effects, Plasma environment, Radiation Environment and its effects, Debris Environment and its effects.

Course outcome (Course Skill Set)

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

1. Evaluate the Black body radiation, specific intensity, flux density, etc.
2. Apply relativistic quantum mechanics.
3. Identify and sun and the solar system.

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. Shu, F., The Physical Universe, University of California, 1981, ISBN-13: 978-0935702057.
2. Padmanabhan, T., Theoretical Astrophysics, Cambridge University Press, south Asian edition, 2010, ISBN-13: 978-1107400597.

Reference Books:

1. Sakurai, JJ., Advanced Quantum Mechanics, Pearson Education India,1st edition,2002, ISBN-13: 978-8177589160.
2. Stix, M., The Sun: An Introduction, Springer, Reprinted edition, 2012, ISBN-13: 978-3642624773.
3. Alan C. Tribble, The Space Environment, Princeton University Press, Revised edition, 2003, ISBN-13: 978-0691102993

Web links and Video Lectures (e-Resources):
• https://nptel.ac.in/courses/115105046
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.

Avionics Systems		Semester	6
Course Code	**BAS601**	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:

- Understand the need for avionics in civil, military and space systems.
- Appreciate the use of microprocessors, data buses and avionics system architectures.
- Acquire the knowledge of display technologies, communication and navigation systems.

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

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-2

Inertial Navigation System: Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing.

Electronic Flight Control System: Fly-by-wire system: - basic concept and features. Pitch and Roll rate: - command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis.

MODULE-3

Electronic Flight Instrument Systems: Display -units, presentation, failure, and annunciation. Display of air data.

Introduction to Avionics Sub Systems and Electronic Circuits: Typical avionics subsystems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.

MODULE-4

Principles of Digital Systems: Digital Computers, Microprocessors, Memories

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

MODULE-5

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

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

Sl.NO	Experiments
1	Addition of 8-bit and 16-bit numbers using microprocessor.
2	Subtraction of 8-bit and 16-bit numbers using microprocessor.
3	Interface programming with 4-digit 7 segment display and switches and LEDs
4	Binary Comparator Circuits.
5	Encoder Circuits.
6	Decoder Circuits.
7	Multiplexer Circuits
8	Demultiplexer Circuits
9	Timer Circuits and Shift Registers.
10	16 Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular wave by Digital to Analog Converter.
11	Study of MIL-STD-1553 B Data Bus
12	Study of Pulse Amplitude Modulation (PAM) and Demodulation

Course outcomes (Course Skill Set):

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

- Select the suitable data bus based on the application.
- Identify the suitable navigation systems.
- Distinguish the avionics system architecture

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. R.P.G. Collinson., "Introduction to Avionics Systems", Springer,3rd edition, 2011, ISBN-13: 978-9400707078

2. Ian Moir, Allan Seabridge, Aircraft Systems: Mechanics, Electrical and Avionics Subsystems Integration, Wiley, 3rd Edition, 2012.

Reference Books:

1. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989, ISBN-13: 978-0582018815.
2. Spitzer, C.R., "Digital Avionic Systems", McGraw-Hill Inc., US, 2nd edition, 1992, ISBN-13: 978-0070603332.
3. Mike Tooley and David Wyatt, Aircraft Communications and Navigation Systems, Butterworth Heinemann, 2007.
4. D.R. Cundy and R.S. Brown, Introduction to Avionics, Pearson, 2010.

Web links and Video Lectures (e-Resources):

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.

Rockets and Missiles		Semester	6
Course Code	**BAS602**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	50hrs	Total Marks	100
Credits	04	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives: This course will enable students to

- Understand the types of space launch vehicles and missiles.
- Study solid and liquid rocket motors.
- Acquire knowledge of launch vehicle dynamics, attitude control, rocket testing and materials.

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: Space launch Vehicles and military missiles, function, types, role, mission, mission profile, thrust profile, propulsion system, payload, staging, control and guidance requirements, performance measures, design, construction, operation, similarities and differences. Some famous space launch vehicles and strategic missiles.

Module-2

Solid Propellant Rocket Motor Systems: Solid Propellant rocket motors, principal features, applications. Solid propellants, types, composition, properties, performance. Propellant grain, desirable properties, grain configuration, preparation, loading, structural design of grain. Liners, insulators and inhibitors, function, requirements, materials. Rocket motor casing – materials. Nozzles, types, design, construction, thermal protection. Igniters, types, construction. Description of modern solid boosters I) Space Shuttle SRB, II) the Arienne SRB

Liquid Propellant Rocket Motor Systems: Liquid propellants, types, composition, properties, performance. Propellant tanks, feed systems, pressurization, turbo-pumps, valves and feed lines, injectors, starting and ignition. Engine cooling, support structure. Control of engine starting and thrust build up, system calibration, integration and optimisation – safety and environmental concerns. Description of the space shuttle main engine. Propellant slosh, propellant hammer, geysering effect in cryogenic rocket engines.

Module-3

Aerodynamics of Rockets and Missiles: Classification of missiles. Airframe components of rockets and missiles, Forces acting on a missile while passing through atmosphere, method of describing aerodynamic forces and moments, lateral aerodynamic moment, lateral damping moment, longitudinal moment of a rocket, lift and drag forces, drag estimation, body upwash and downwash in missiles. Rocket dispersion, re-entry body design considerations.

Module-4

Launch Vehicle Dynamics: Tsiolkovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging. Earth

launch trajectories – vertical segment, the gravity turn, constant pitch trajectory, orbital injection. Actual launch vehicle trajectories, types. Examples, the Mu 3-S-II, Ariane, Pegasus launchers. Reusable launch vehicles, future launchers, launch assist technologies.

Attitude Control of Rockets and Missiles: Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques.

Module-5

Rocket Testing: Ground Testing and Flight Testing, Types of Tests facilities and safeguards, monitoring and control of toxic materials, instrumentation and data management. Ground Testing, Flight Testing, Trajectory monitoring, post -accident procedures. Description of a typical space launch vehicle launch procedure.

Materials: Criteria for selection of materials for rockets and missiles, requirements for choice of materials for propellant tanks, liners, insulators, inhibitors, at cryogenic temperatures, requirements of materials at extremely high temperatures, requirements of materials for thermal protection and for pressure vessels.

Course outcome (Course Skill Set)

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

1. Identify the types of space launch vehicles and missiles.
2. Distinguish the solid and liquid propellant motors.
3. Classify different types of materials used for rockets and missiles

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. George P Sutton and Oscar Biblarz, 'Rocket Propulsion Element', John Wiley and Sons Inc,7th edition, 2010, ISBN-13: 978-8126525775.
2. Jack N Neilson, 'Missile Aerodynamics ', AIAA,1st edition, 1988, ISBN-13: 978-0962062902.

Reference Books

1. S S Chin, 'Missile Configuration Design'. McGraw Hill; First Edition.
2. Cornelisse, J.W., Schoyer H.F.R. and Wakker,. K.F., Rocket Propulsion and Spaceflight dynamics, Pitman, 1979, ISBN-13: 978-0273011415
3. Turner, M.J.L., Rocket and Spacecraft propulsion, Springer,3rd edition,2010, ISBN-13: 978-3642088698.
4. Ball, K.J., Osborne, G.F., Space Vehicle Dynamics, Oxford University Press, 1967, ISBN-13: 978-0198561071
5. 5. Parker, E.R., Materials for Missiles and Spacecraft, McGraw Hill, 1982

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc22_ae03/preview
https://archive.nptel.ac.in/courses/101/108/101108054/

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.

Space Mechanics		Semester	6
Course Code	**BAS613A**	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 concepts of space mechanics and the general N-body.
- Study satellite injection and satellite orbit perturbations.
- Acquire the knowledge of interplanetary and ballistic missile trajectories.

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

Space Environment: Peculiarities of space environment and its description, effect of space environment on materials of spacecraft structure and astronauts, manned space missions, effect on satellite lifetime.

Module-2

Basic Concepts and Two body Problem: The solar system, reference frames and coordinate systems, terminology related to the celestial sphere and its associated concepts, Kepler's laws of planetary motion and proof of the laws, Newton's universal law of gravitation, motion of body under central force field, two body problem, relations between position and time, orbital elements, orbit types.

Module-3

Satellite Injection and Satellite Perturbations: General aspects of satellite injection, satellite orbit transfer, various cases, orbit deviations due to injection errors, special and general perturbations, Cowell's method and Encke's method, method of variations of orbital elements, general perturbations approach.

Module-4

Interplanetary Trajectories: Two-dimensional interplanetary trajectories, fast interplanetary trajectories, three dimensional interplanetary trajectories, launch of interplanetary spacecraft, trajectory estimation about the target planet, concept of sphere of influence, Lambert's theorem

Module-5

Ballistic Missile Trajectories: Introduction to ballistic missile trajectories, boost phase, the ballistic phase, trajectory geometry, optimal flights, time of flight, re-entry phase, the position of impact point, influence coefficients

Course outcome (Course Skill Set)

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

1. Apply the basic concepts of space mechanics and the general N-body.
2. Explain satellite injection and satellite orbit perturbations.
3. Distinguish between interplanetary and ballistic missile trajectories.

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:

Books

Text Books

1. Cornelisse, J.W., Rocket Propulsion and Space Dynamics, W.H. Freeman&co,1984.
2. Thomson, Introduction to Space Dynamics, Dover Publications, Revised edition,2012

Reference Books

1. Vande Kamp, P., "Elements of Astromechanics", Pitman,1979
2. Willian E. Wiesel, Space Flight Dynamics, Create Space Independent Publishing Platform, 3rd Edition ,2010, ISBN-13: 978-1452879598
3. George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements, Wiley India Pvt Ltd,7th edition, 2010, ISBN-13: 978-8126525775.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/101/105/101105083/

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 Mechanics		Semester	6
Course Code	**BAS613B**	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 Flight Forces, Flight Performance.
- Understand the Straight and level flight, Maneuver Performance.
- Acquire the knowledge of aircraft static and dynamic stability.

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

Flight Environment, Flight Forces and Steady Flight Performance: The atmosphere as flight environment. The International Standard Atmosphere Model. The Force and Moment Systems of an Aircraft. Preliminary basic aerodynamic and propulsion properties.

Static Longitudinal Stability and Control (Stick Fixed): Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes - Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point

Module-2

Static Longitudinal Stability and Control (Stick Free): Stick free stability-Hinge moment coefficient - Stick free neutral points-Symmetric manoeuvres - Stick force gradients - Stick _ force per 'g' - Aerodynamic balancing. Determination of neutral points and maneuver points from flight test.

Module-3

Lateral and Directional Stability: Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects

- Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - Rudder lock

Module-4

Dynamic Stability: Dynamic longitudinal stability: Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing-the stick - Brief description of lateral and directional. Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin

Module-5

Helicopter Flight Dynamics: Rotor function in vertical flight, Rotor Mechanism for forward flight, Trim, Stability and control

Course outcome (Course Skill Set)

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

1. Apply the basic concepts of aircraft stability and control.
2. Differentiate the static longitudinal and static directional stability.
3. Estimate the dynamic derivatives.

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. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2007.

Reference Books:

1. Bandu N. Pamadi, `Performance, Stability, Dynamics and Control of Airplanes`, AIAA 2nd Edition Series, 2004.
2. John D. Anderson, Jr., "Introduction to flight" McGraw-Hill, International Editions, Aerospace Science Technology Editions, 2000.
3. W.J. Duncan, The Principles of the Control and Stability of Aircraft, Cambridge University Press, 2016.
4. J.Seddon, "Basic Helicopter Aerodynamics", AIAA Series, 1990.
5. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982

Web links and Video Lectures (e-Resources):
• https://nptel.ac.in/domains/discipline/101?course=110_0
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.

Spacecraft Systems		Semester	6
Course Code	**BAS613C**	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 spacecraft mission and AOCS.
- Comprehend the power generation and storage systems.
- Acquire the knowledge on propulsion, structural and thermal systems.

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

Satellite Mission And Configuration: Mission Overview – Requirements for different missions – Space Environment, Spacecraft configuration- Spacecraft Bus – Payload – Requirements and constraints – Initial configuration decisions and Trade-offs – Spacecraft configuration process – Broad design of Spacecraft Bus – Subsystem layout – Types of Satellites – Constellations – Applications.

Module-2

Attitude And Orbit Control System (AOCS): Coordinate system – AOCS requirements – Environment effects – Attitude stabilization – Attitude sensors – Actuators – Design of control algorithms.

Module-3

Power Generation: Study of Solar spectrum, Solar cells, Solar Panel design, Solar Panel Realization, Solar Panel testing, Effects of Solar cells and panels (IR, UV, Particles)

Energy Storage Technology

Types of batteries – Primary & Secondary batteries - Nickel Cadmium - Nickel-Hydrogen – Nickel metal hydride - Lithium-ion –Lithium Polymer - Silver Zinc– Electrical circuit model – Performance characteristics of batteries - Application of batteries in launch vehicles and satellites – Fuel Cell –Polymer Electrolyte membrane Fuel Cell – Regenerative Fuel Cell.

Module-4

Power Converters

DC – DC converters – Basic Convertors - Buck, Boost, Buck- boost converter –Derived converters: Fly back converter – Transformer coupled forward converter – Push-Pull converter - CUKs convertor–Resonant converter – Voltage and current regulators

Power Control, Conditioning and Distribution

Solar Array Regulators – Battery changing schemes – Protection Schemes - Distribution – Harness -Thermal Design - EMI/EMC/ESD/Grounding schemes for various types of circuits and systems

Module-5

Propulsion Systems, Structures And Thermal Control: Systems Trade-off – Mono-propellant systems – Thermal consideration – System integration design factors – Pre-flight test requirements – System reliability Configuration design of Spacecraft structure – Structural elements – Material selection – Environmental Loads -Vibrations – Structural fabrication – Orbital environments - Average temperature in Space – Transient temperature evaluation – Thermal control techniques – Temperature calculation for a spacecraft – Thermal design and analysis program structure – Thermal design verification – Active thermal control techniques.

Telemetry Systems: Base Band Telemetry system – Modulation – TT & C RF system – Telecommand system – Ground Control Systems.

Course outcome (Course Skill Set)

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

1. Identify the spacecraft mission and configuration.
2. Describe the power requirements and its design concepts.
3. Classify the Propulsion, thermal control and telemetry systems.

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. Fortescue Peter, 'Spacecraft Systems Engineering' Wiley-Blackwell England,4th edition,2003, ISBN-13:978-0470750124.
2. Patel Mukund R, 'Spacecraft Power Systems' CRC Press Boca Raton,1st

edition,2005,ISBN-13: 978-0849327865

Reference Books:

1. Wilbur L. Pritchard and Joseph A. Sciulli, Satellite Communication Systems Engineering, Prentice Hall, New Jersey, 1986.
2. Marcel j. sidi, "Spacecraft Dynamics and control, A Practical Engineering Approach", Cambridge University Press, Reprint edition,2000, ISBN-13: 978-0521787802
3. Kaplan m, "Modern Spacecraft Dynamics and control", Wiley Press,1976, ISBN-13: 978-0471457039
4. Maxwell Noton, "Spacecraft navigation and guidance", Springer (London, New York), Reprint edition of 1998, ISBN-13: 978-1447115854
5. James R. Wertz and Wiley J. Larson, Space Mission Analysis and Design, Microcosm, Third Edition– 1999.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc20_ce62/preview
- https://archive.nptel.ac.in/courses/117/105/117105131/

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.

Heat and Mass Transfer		Semester	6
Course Code	**BAS613D**	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 different modes of heat transfer.
- Understand the free convection and forced convection.
- Acquire the knowledge of heat transfer problems in combustion chambers.

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

Fundamentals: Different modes of heat transfer and mass and momentum transfer, elements of mass diffusion and boundary layer theory. Mass transfer definition and terms used in mass transfer analysis, Fick's First law of diffusion (no numerical).

Module-2

Conduction: Derivation of general three dimensional conduction equation in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems. Effect of variation of thermal conductivity on heat transfer in solids - Heat transfer problems in infinite and semi-infinite solids - Extended surfaces. One dimensional transient heat conduction: Systems with negligible internal resistance, Significance of Biot and Fourier Numbers, Chart solutions of transient conduction systems.

Module-3

Convection: Concepts of Continuity, Momentum and Energy Equations. Dimensional analysis-Buckingham's Pi Theorem - Application for developing non-dimensional correlation for convective heat transfer

Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate , Use of empirical relations for Vertical plates and pipes.

Forced Convection: External Flows, Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders. Internal Flows, Concepts about Hydrodynamic and Thermal Entry Lengths, use of empirical correlations for Horizontal Pipe Flow and annulus flow.

Module-4

Radiation & Heat Exchangers Design: Radiation: Introduction to physical mechanism - Radiation properties - Radiation shape factors - Heat exchange between non-black bodies - Radiation shields

Heat Exchangers: Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems.

Module-5

Heat and Mass Transfer Problems in Aerospace Engineering: Heat transfer problems in gas turbine combustion chambers - Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer.

Mass Transfer: Introduction, Ficks law, Species conservation equation, Introduction to convective and diffusive mass transfer.

Course outcome (Course Skill Set)

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

1. Describe the fundamentals of heat and mass transfer.
2. Familiarize the student in the area of conduction, convection and radiation.
3. Analyze the problems due to heat transfer in several areas.

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:

Books

Text Books

1. Ozisik, Heat transfer-A basic approach, Tata McGraw Hill 2002
2. Holman, J.P., " Heat Transfer ", McGraw Hill Book Co., Inc., New York, 8th edition., 1996, ISBN-13: 978-0071143202

Reference Books

1. Sachdeva, S.C., " Fundamentals of Engineering Heat and Mass Transfer ", Wiley Eastern Ltd., New Delhi, 1981.

2. Sutton, G.P., “Rocket Propulsion Elements ", John Wiley and Sons, 5th Edn.1986.
3. Mathur, M.and Sharma, R.P., " Gas Turbine and Jet and Rocket Propulsion “, Standard Publishers, New Delhi 1988.
4. P.K. Nag, Heat transfer, Tata McGraw Hill 2002
5. Yunus A- Cengel , Heat transfer, a practical approach, Tata McGraw Hill , 3rd edition, 2007.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/108/112108149/

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.

INTRODUCTION TO AEROSPACE HISTORY		Semester	6
Course Code	**BAS654A/BAE654A**	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

- Learn the history and chronology of aviation and its development
- Understand the basic flight mechanics
- Compare the historical developments in aviation

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

Aerospace History, The first decade, World War I, Between the Wars, the advent of jets and missiles, the space age, growth of the aircraft industry, cooperation and consolidation in a global economy, The First Aeronautical Engineers, Internationalization, Mergers and divestitures

Module-2

The Aeronautical Triangle, The problem of Propulsion, Fundamental Physical Quantities of Flowing Gas, The source of all aerodynamics forces, Anatomy of Airplane, The NACA and NASA, The Standard Atmosphere, Basic Aerodynamics, Continuity, Momentum and Energy Equations

Module-3

Elementary Thermodynamics, Introduction to viscous flow, Historical Notes- Reynolds and His Number, Airfoils, Wings and Other Aerodynamic shapes

Module-4

Elements of Airplane Performance, Rate of Climb, Range and Endurance- Propeller-driven Airplane and Jet Airplane

Module-5

Principles of Stability and Control, History Note: The development of Flight Controls, Jet Propulsion

Course outcome (Course Skill Set)

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

1. Appreciate the history and chronology of aviation and its development
2. Apply the basic flight mechanics
3. Prepare for the new developments in aviation

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. Flight: The Complete History of Aviation by R.G. Grant (Author), Smithsonian Institution (Contributor)
2. Introduction to Flight: Its Engineering and History by JD Anderson

Reference Books

1. Aviation History by Anne Marie Millbrooke
2. A Chronology of Aviation: A Day-by-day History of a Century by Jim Winchester

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/101/104/101104017/

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.

INTRODUCTION TO HELICOPTERS		Semester	6
Course Code	**BAS654B/BAE654B**	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 elements, kinematics of helicopter.
- Remember the equations of motions for helicopter.
- Gain knowledge on aerodynamics of propeller.

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, Elements of a helicopter, Performance, Components, Vectors and Vector Resolutions.

Module-2

Axis Systems, Kinematics and Flight Dynamics, Quaternions, Mass Properties, Equations of Motion.

Module-3

Applied forces and moments, Longitudinal Equations of Motion, Atmosphere, Bernoulli's Equation, Compressibility and Wing lift, Wing Drag.

Module-4

Aerodynamic Velocity, Inertial Velocity, Wash Velocity, and Gusts, Aerodynamics of Airfoils, Wings, and Fins.

Module-5

Aerodynamics of Propellers, Propeller Analysis, Introduction to Aeroelastic Rotor Models, Rotor Downwash Modelling, Aerodynamic Interference, Engines Drive Trains, Controls, Landing Gear, Trimming.

Course outcome (Course Skill Set)

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

1. Apply the basic elements, kinematics of helicopter.
2. Analyse the equations of motions for helicopter.
3. Implement aerodynamics of propeller.

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. Introduction to Helicopter Aerodynamics by Wieslaw Zenon Stepniewski.
2. Fundamentals of Helicopter Dynamics by C. Venkatesan.

Reference Books

1. Basic Helicopter Aerodynamics by J Seddon.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/101/104/101104017/

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.

INDIAN AVIATION		Semester	6
Course Code	**BAS654C**	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 Indian Aviation Sector.
- Enumerate the Aviation policies and procedure.
- Identify the areas of Aviation for improvement.

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

History of Indian Aviation Sector, Regulatory and Legislative Framework, Ministry of Civil Aviation, National Civil Aviation Policy, Airports Authority of India Act.

Module-2

Opportunity for Foreign Investment in the Indian Aviation Sector, Investment in Airline Operators, Investment in Airports, The Airport Act, International Conventions, Bilateral Agreements.

Module-3

Growth of Indian Aviation Sector, Recent trends and Strategies, Growth Drivers, Growth Drivers.

Module-4

Liberalization, Liberalization, Foreign Direct Investment- Low-Cost Carriers, Greenfield airports, post 1991 growth in the aviation sector.

Module-5

The failing state of the aviation sector, Taxation, Infrastructure, The Dollar to Rupee situation, Discussion on case studies.

Course outcome (Course Skill Set)

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

1. Relate the Indian Aviation Sector with its counterparts.
2. Implement the Aviation policies and procedure.
3. Improve the areas of Aviation in India.

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. Indian Aviation Industry - Opportunities And Challenges Paperback – 1 January 2006by Ravi Kumar V V (Author).
2. Indian Airline: A study of its Airlines by Desari Panduranga Rao.

Reference Books

1. Journey of Civil Aviation in India By Rajesh Jethwani.
2. Indian Airlines (Ministry of Tourism and Civil Aviation).

Web links and Video Lectures (e-Resources):

https://www.iata.org/en/pressroom/pr/2018-09-04-01/

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.

AIRLINE AND AIRPORT MANAGEMENT		Semester	6
Course Code	**BAS654D**	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 airline and airport management principles.
- Develop broad skills of management in aviation industry.
- Understand the statistics of management in aviation sector.

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

Contemporary issues facing the aviation and aerospace industries, airline management principles and processes, airline, economics, organization, forecasting, marketing, alliances, pricing, technology management.

Module-2

Scheduling, finance, fleet planning, labour relations and air freight, Business ethics pertaining to airlines, marketing, route analysis, aircraft selection, financial analysis, federal regulations, Aviation Law, Aircraft Rules & Security.

Module-3

Leadership and Communication Skills, Personality Development, Grooming, Airport Ground Handling, Ticketing (Computerized Reservation Systems), Interview Skills and Group Discussion, Airport Strategic Planning.

Module-4

Airline and Airport Organization, Management Accounting, Airline Customer Service, Business Computing, Environmental Engineering.

Module-5

E-Business Information Systems, Logistics and Air cargo Management, Statistics for Aviation, Disaster Management, Human Resource Management, Management Information System.

Course outcome (Course Skill Set)

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

1. Apply the basic principles of airline and airport management.
2. Utilize the broad skills of management in aviation industry.
3. Analyse the statistics of management in aviation sector.

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. Airline Operations and Management by Gerald N Cook, Bruce Billig.

2. Airport Management by C. Daniel Prather.

Reference Books

1. Business and Corporate Aviation Management, Second Edition, John J. Sheehan Published:

April 23rd 2013 and ISBN: 9780071801904.

2. Aviation Maintenance Management, Second Edition by Harry A. Kinnison, Tariq Siddiqui

Published: November 13th 2012 , ISBN: 9780071805025.

Web links and Video Lectures (e-Resources):

https://www.uwl.ac.uk/courses/aviation-airline-and-airport-management

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.

PROBABILITY AND STATISTICS FOR AEROSPACE ENGINEERING		Semester	6
Course Code	**BAS657A/BAE657A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15hrs	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- To study the basics of statistics, measure central tendency and dispersion.
- Develop statistical methods for correlation, regression analysis and curve fitting.
- Explore the principles of probability.

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

Definitions of Probability, Basic Laws of Probability, Probability Distributions, Distribution (Population) Parameters,

Module-2

Chebyshev's Theorem, Simulation (Monte Carlo Methods). Estimation Theory, Point Estimation.

Module-3

Curve Fitting, Regression, and Correlation, Goodness-of-Fit Tests,

Module-4

Hypothesis/Significance Testing, Reliability and Life Testing, Error Propagation Law.

Module-5

Application of Probability and Statistics in Aerospace Engineering – Various Examples.

Course outcome (Course Skill Set)

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

1. Elucidate the basic principles of statistics
2. Apply the correlation and regression analysis to engineering problem
3. Apply the principles of probability to engineering problems.

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 Examination (CIE)

- 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 Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Rheinfurth. MH, Probability and Statistics in Aerospace Engineering, University Press of the Pacific, 2006.

Web links and Video Lectures (e-Resources):

- https://ntrs.nasa.gov/api/citations/19980045313/downloads/19980045313.pdf

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.

VIRTUAL AIRCRAFT SIMULATION		Semester	6
Course Code	**BAS657B/BAE657B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:0:0	SEE Marks	50
Total Hours of Pedagogy	30hrs	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- Remember the terminologies of virtual aircraft simulation
- Understand the virtual aircraft simulation environment and settings
- Implement the skills of virtual flying

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 virtual Aviation , Aviation rules and Organisation
Module-2
Air Traffic Control, Radio Communication from Pilot
Module-3
Flight Mode Annunciator mode English, Flight Instruments and their working principles
Module-4
Flight Instrument Essentials, Aviation Meteorology
Module-5
Practice of Flight Simulator X installation and Settings

Course outcome (Course Skill Set)

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

1. Use the settings and controls of virtual aircraft simulation
2. Plan the new flying path for a specific situation
3. Fly an aircraft virtually

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 Examination (CIE)

- 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 Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Flight Simulation Virtual Environments in Aviation By Alfred T. Lee, ISBN 9781138246195 Published September 9, 2016 by Routledge
2. Principles of Flight Simulation, David Allerton, ISBN: 978-0-470-75436-8

Web links and Video Lectures (e-Resources):

- https://www.flightsimulator.com/
- https://www.youtube.com/watch?v=EOeDTr1x3XI

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.

Introduction to Data Analytics		Semester	6
Course Code	**BAS657C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:0:0	SEE Marks	50
Total Hours of Pedagogy	30hrs	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

This course will enable students to

- Understand the basics of data analytics.
- Acquire the knowledge of the foundations of AL and AL.
- Gather the information on Big data analysis.

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

Probabilistic Description of Events and Data: Probability Axioms, Random Variables, PDF, PMF, Conditional Probability, Independence, Expectation, Variance, Statistical Learning, Experiment Design, Confidence Interval and Hypothesis Testing.

Module-2

Bayesian Learning, Univariate and Multivariate Calculus, Norms of Vectors and Functions, Taylor's theorem and Automatic Differentiation, Fundamentals of Linear Algebra Spaces, Machine Learning Tools.

Module-3

The ML Process: Problem Formulation to Solution, Linear Regression, Bias/Variance, Regularization, Stochastic Gradient Descent, Linear Classification: Logistic Regression, Linear SVM, Classification Metrics (Confusion Matrix), Nonlinear SVM, Decision Tree.

Module-4

Ensemble Methods: Random Forest, Gradient Boosting, Unsupervised Learning: Clustering, Anomaly Detection, Mini-Projects in Machine Learning Algorithms in Multiple Domains (Rental Business, Healthcare, Banking, NLP, Customer Segmentation).

Module-5

Introduction to Big Data storage systems, Introduction to Big Data processing platforms, Deep Dive into Spark: RDD, Narrow, Wide Transformations.

Course outcome (Course Skill Set)

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

1. Apply the basics of data analytics for various applications
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 Examination (CIE)

- 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 Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

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
4. Artificial Intelligence: A Modern Approach, 4th US ed. by Stuart Russell and Peter Norvig

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc21_cs45/preview

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.

Air and Missile Defence Systems		Semester	6
Course Code	**BAS657D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:0:0	SEE Marks	50
Total Hours of Pedagogy	30hrs	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives: This course will enable students to

- Understand the advanced concepts of missile guidance systems
- Obtain mathematical knowledge that are needed in understanding the physical processes.
- Get the exposure on various topics such as missile systems, missile airframes, autopilots, and guidance laws.

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

Missile Systems Introduction

History of guided missile for defence applications- Classification of missiles–missile system elements, missile ground systems.

Module-2

Missile Airframes, Autopilots and Control

Missile aerodynamics, Phases of missile flight. Missile control configurations. Missile Mathematical Model. Autopilots — Definitions, Types of Autopilots, Pitch Autopilot Design, Pitch-Yaw-Roll Autopilot Design.

Module-3

Missile Guidance Laws

Tactical Guidance Intercept Techniques, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, comparison of guidance system performance.

Module-4

Strategic Missiles

Introduction, Atmospheric Re-entry, Ballistic Missile Intercept, Threat analysis for Boost phase interception – Typical assessment errors. Introduction to Cruise Missiles, The Terrain-Contour Matching (TERCOM) Concept.

Module-5

Weapon Delivery Systems

Weapon Delivery Requirements, Factors Influencing Weapon Delivery Accuracy, Unguided Weapons, The Bombing Problem, Guided Weapons, Integrated Flight Control in Weapon Delivery, Missile Launch Envelope.

Course outcome (Course Skill Set)

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

1. Students will understand the advanced concepts of missile guidance and control
2. Necessary mathematical knowledge that are needed in understanding the physical processes.
3. The students will have an exposure on various topics such as missile systems, missile airframes, autopilots, guidance laws.

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 Examination (CIE)

- 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 Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. Siouris, G.M. "Missile Guidance and control systems", Springer, 2003.
2. Blakelock, J. H.; Automatic Control of Aircraft and Missiles, 2nd Edition, John Wiley & Sons, 1990

Reference Books

1. Fleeman, Eugene L.; Tactical Missile Design, First Edition, AIAA Education series, 2001.
2. Garnell, P., "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980.
3. Joseph Ben Asher and Isaac Yaesh "Advances in Missile Guidance Theory" AIAA Education series, 1998

1. 4. Paul Zarchan “Tactical and Strategic Missile Guidance” AIAA Education series,2007.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/101/108/101108054/

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.

Space Flight Simulation Lab		Semester	6
Course Code	**BASL606**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical		

Course objectives:

- Understand the basics of Matlab.
- Acquire the knowledge of simulation.
- Understand the basics of trajectory.

Sl.NO	Experiments
1	Draw Pole-Zero map of dynamic system model with plot customization option
2	Plot root locus with variables in transfer function through MATLAB
3	Plot root locus for a dynamic system though MATLAB
4	Draw Bode plot from a transfer function in MATLAB and explain the gain and phase margins
5	Simulate a simple servo-mechanism motion with feedback- in the time domain, and in `s` domain
6	Simulate a bomb drop from an aircraft on a moving tank in pure pursuit motion
7	Simulate two body problem
8	Simulate atmospheric entry of capsule/space vehicle
	Demonstration Experiments (For CIE)
9	Simulate rocket launch trajectory
10	Study and implementation of frame conversions
11	Given a Quartic characteristic equation, determine two quadratics that shall result in poles of short-period oscillations and poles of Phugoid. Vary the coefficients of polynomial to study the movement of poles.
12	Given a Quartic characteristics equitation, determine Poles and Time constants for Roll mode, Spiral motion, and Dutch roll. Vary the coefficients of polynomial to study the movement of poles.

Course outcomes (Course Skill Set):

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

- Apply the transfer function.
- Apply the simulation principles.
- Perform the trajectory 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

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- https://nptel.ac.in/courses/112105045