III Semester

AEROSPACE MATERIALS AND PROCESSES			
Course Code	**21AS32**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	04	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3

Course objectives: This course will enable students to

- Acquire knowledge of different aerospace materials & their properties.
- Understand the Heat Treatment processes of aircraft metals and alloys
- Characteristics and Applications of Aluminium alloys, Ceramics, Composites and High Temperature Materials.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

Mechanical Behavior of Engineering Materials: Introduction to aerospace materials and their classification, Linear and non-linear elastic properties - Stress and Strain Curves - Yielding and strain Hardening, Toughness - Modules of resilience -- Bauchinger's effect - Effect of notches - Testing and flaw detection of materials and components, knowledge of various material testing machines

Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT

Module-2

Non-ferrous materials in aircraftconstruction: Aluminum anditsalloys: Types andidentification. Properties -Castings - Heat treatment processes - Surface treatments.

Magnesium and its alloys: Cast and Wrought alloys - Aircraft application, features specification, fabrication problems, Special treatments.

Titanium and its alloys: Applications, machining, forming, welding and heat treatment, Copper Alloys.

Wood and fabric in aircraft construction and specifications - Glues Use of glass, plastics & rubber in aircraft, Introduction to glass & carbon composite.

Teaching-Learning Process	. 1. Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem

Module-3	
Ferrous materials in aircraft construction: Steels: Plain and low carbon steels, various low alloy steels, aircraft steel specifications, corrosion and heat resistant steels, structural applications. Maraging Steels: Properties and Applications. Super Alloys: Use - Nickel base - Cobalt base - Iron base - Forging and Casting of Super alloys - Welding, Heat treatment.	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem
Module-4	
Ceramics and Composites: Introduction, modern ceramic materials, cermets, glass ceramic, production of semi-fabricated forms, Carbon/Carbon composites, Fabrication processes and its aerospace applications involved in metal matrix composites, polymer composites.	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem
Module-5	
Temperature driven Materials Characterization: Classification, production and characteristics, Methods and testing, Determination of mechanical and thermal properties of materials at elevated temperatures, Application of these materials in Thermal protection systems of Aerospace vehicles, High temperature material characterization.	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT

Course outcome (Course Skill Set)

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

1. Apply the knowledge about the mechanical behaviour of different aircraft & aerospace materials.
2. Explain the applications of Aluminium alloys, Ceramics and Composites Materials.
3. Evaluate the importance of high temperature materials and their characterization.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

Suggested Learning Resources:

Text Books

1. Titterton G F, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition, 1998, ISBN-13: 978-8175980136
2. H Buhl, Advanced Aerospace Materials, Springer, Berlin 1992, ISBN-13: 978-3540558880.

Reference Books

1. Balram Gupta, Aerospace material Vol. 1,2,3,4ARDB, S Chand & Co ,2009, ISBN-13: 978-8121922005.
2. Parker E R, Materials for Missiles and Space, McGraw-Hill Inc., US, 1963, ISBN-13**:** 978 0070485013
3. Hill E T, The Materials of Aircraft Construction, Pitman London.
4. C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore, 1993

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112107086.

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.

MANUFACTURING PROCESS LAB			
Course Code	**21AS32**	CIE Marks	
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	
Credits		Exam Hours	

Course objectives: This course will enable students to

1. Practice general-purpose machine tools and manufacturing process.
2. Operate the special purpose machine tools
3. Prepare physical models using different manufacturing processes.

Sl. NO	**Experiments**
1	Machining by plain turning, taper turning & step turning
2	Machining by knurling operation
3	Machining by drilling and boring operation
4	Machining by internal and external thread cutting
5	Machining by eccentric turning
6	Machining by square and hexagon in shaping machine
7	Cutting of gear teeth using milling machine
8	Grinding operations using grinding machine
9	CNC Machine tool operations and processes
10	Geometric dimensioning and Tolerancing
11	Operational introduction to industrial robotics.
12	Additive Manufacturing

Course outcomes (Course Skill Set):

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

1. Understand the Machining Processes..
2. Gain knowledge about the CNC Programming.
3. Apply the GD&T for various applications.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- https://miamioh.edu/cec/academics/departments/mme/about/facilities/instructional-labs/mfg-procs-lab/

III Semester

FLUID MECHANICS			
Course Code	**21AE33 / 21AS33**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	04	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3

Course objectives: This course will enable students to

- Understand the basic fluid properties.
- Understand the governing laws of fluid flow.
- Acquire the knowledge of types of fluid flows.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

Basic Considerations:

Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids.

Fluid Statics:

Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples.

Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT

Module-2

Fluids in motion:

Methods of describing fluid motion, types of fluid flow, continuity equation in 3 dimensions, velocity potential function and stream function. Types of motion, Source sink, doublet, plotting of stream lines and potential lines Numerical problems.

Fluid Kinematics:

Kinematics of fluid motion and the constitutive equations, Integral (global) form of conservation equations (mass, momentum, energy) and applications, Differential form of conservation equations (continuity, Navier-Stokes equations, energy equation).

Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT Assignment of Home/field work on real-life problem

Module-3	
Fluid Dynamics: Equations of motion: Euler's and Bernoulli's equation of motion for ideal and real fluids. Momentum equation, Fluid flow measurements. Numerical problems. **Dimensional analysis and similarity:** Dimensional homogeneity, methods of dimensional analysis, model analysis, types of similarity and similitude. Dimensionless numbers. Model laws. Numerical problems.	
Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT Assignment of Home/field work on real-life problem
Module-4	
Flow past Immersed bodies: Introduction to boundary layer, boundary layer thickness, Karman's integral momentum theory, drag on a flat plate for laminar and turbulent flow, Drag on immersed bodies. Expression for drag and lift. Kutta –Joukowsky theorem; Fundamentals of aerofoil theory, Numerical problems.	
Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT Assignment of Home/field work on real-life problem
Module-5	
Compressible flow and Boundary Layers theory: Steady, one-dimensional gas dynamics, Propagation of pressure waves in a compressible medium, velocity of sound, Mach number, Mach cone, Stagnation properties, Bernoulli's equation for isentropic flow, normal shock waves. Numerical Problem; Laminar and turbulent boundary layers.	
Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT Assignment of Home/field work on real-life problem
Course outcome: At the end of the course the student will be able to: 1. Evaluate the effect of fluid properties. 2. Apply the governing laws of fluid flow. 3. Classify different types of fluid flows.	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

7. First test at the end of 5th week of the semester
8. Second test at the end of the 10th week of the semester
9. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

10. First assignment at the end of 4th week of the semester
11. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

12. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

3. The question paper will have ten questions. Each question is set for 20 marks.
4. 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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Bansal, R.K, "Fluid Mechanics and Hydraulics Machines", Laxmi Publications (P) Ltd., New Delhi 2015, ISBN-13: 978-8131808153.
2. Radhakrishnan. E, "Fluid Mechanics", Prentice-Hall of India Pvt. Ltd, 2010, ISBN 13: 9788120331839.

Reference Books

1. Yunus A. Cengel & John M Cimbala, Fluid Mechanics and Applications, McGraw Hill Education; 3rd edition, 2013, ISBN-13: 978-0073380322.
2. Ramamritham. S "Hydraulic Fluid Mechanics and Fluid Machines", Dhanpat Rai& Sons, Delhi, 1988, ISBN 13: 9788187433804.

3. Kumar. K.L., "Engineering Fluid Mechanics" (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 1995, ISBN 13: 9788121901000.
4. Streeter. V. L., and Wylie, E.B., "Fluid Mechanics", McGraw Hill, 1983, ISBN 13: 9780070665781

Web links and Video Lectures (e-Resources):

- . https://home.iitk.ac.in/~nikhilk/Book.pdf
- https://nptel.ac.in/courses/112104118
  https://nptel.ac.in/courses/105101082

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.

FLUID MECHANICS LAB			
Course Code	**21AS33 / 21AE33**	CIE Marks	
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	
Credits		Exam Hours	

Course objectives: This course will enable students to

1. Familiarize with the flash point, fire point and viscosity of lubricating oils.
2. Study IC engine parts, opening and closing of valves to draw the valve-timing diagram.
3. Gain the knowledge of various flow meters and the concept of fluid mechanics.
4. Understand the Bernoulli's Theorem.

Sl. NO	Experiments
1	Calibration of Venturi meter.
2	Determination of discharge of a given Pipe Flow using Venturi meter/Orifice meter.
3	Determination of Coefficient of discharge for a small orifice by a constant head method.
4	Determination of Coefficient of discharge for a small orifice by a variable head method.
5	Determination of Viscosity of a Fluid.
6	Calibration of contracted Rectangular Notch.
7	Verification of Bernoulli's equation.
8	Pipe friction apparatus with loss of head on pipe fittings.
9	Determination of Coefficient of loss of head in a sudden contraction and friction factor.
10	Estimation of Major loss/Minor losses for a given flow system.
11	Determination of state of flow in a closed conduit using Reynolds Experiment.
12	Impact of Jet over a flat surface.

Course outcomes (Course Skill Set):

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

1. Operate the instrument and measure the BP, FP, IP and AF ratio.
2. Find the efficiency of the engine and Estimate the calorific value of the given fuel.

3. Verify the Bernoulli's equation.
4. Evaluate the viscosity of fluid.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- https://www.iitk.ac.in/me/fluid-mechanics-laboratory

III Semester

INTRODUCTION TO AEROSPACE ENGINEERING			
Course Code	**21AS34**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

- Understand basic principles of aviation and the history of space vehicles.
- Acquire the basic knowledge of aircraft structures, aerodynamics, propulsion, materials and aircraft systems & instrumentation.
- Understand the basics of space propulsion, spacecrafts and their orbits.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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 Aircrafts: History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, V/STOL machines, Modern developments in Aviation like UAV

Introduction to Space Flight: History of Space Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere, Introduction to basic orbital mechanics, types of Orbits (LEO, MEO, Geosynchronous and Geostationary, Polar orbits), Kepler's Laws of planetary motion.

Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT

Module-2

Basic principles of flight: Significance of speed of sound, Propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows, Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag components, lift curve, drag curve, types of drag, factors affecting lift and drag; Centre of pressure and its significance, Aerodynamic centre, Aspect ratio, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag.

Teaching-Learning Process	. **1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Module-3

Aircraft Propulsion: Introduction, Classification, Piston Engine & its application, Brayton cycle, Principle of operation of Turboprop, turbojet and turbofan engines, Introduction to ramjets and scramjets; performance characteristics.

Rocket Propulsion: Principles of operation of rocket, Classification of Rockets, Types of rockets and typical applications, Introduction to Space Exploration.

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Module-4

Aircraft Structures and Materials: Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Aluminium alloy, titanium, stainless steel and composite materials for aerospace applications.

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Module-5

Aircraft Instruments: Instrument Displays, Introduction to Navigation Instruments, Basic Air data systems & Probes, Mach meter, Air speed indicator, Vertical speed indicator, Altimeter, Gyro based instruments.

Aircraft Systems: Introduction to Hydraulic and pneumatic systems, Air Conditioning and Cockpit pressurization system, Generation and distribution of Electricity on board the airplane, Aircraft Fuel System, Fire Protection, Ice and Rain Protection System.

Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT

Course outcome (Course Skill Set)

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

1. Apply the basic knowledge & principles of aviation & spaceflight.
2. Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft & rocket propulsion and aircraft materials during the development of an aircraft
3. Appreciate the complexities involved during development of flight vehicles.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

13. First test at the end of 5th week of the semester
14. Second test at the end of the 10th week of the semester
15. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

16. First assignment at the end of 4th week of the semester
17. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

18. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

Suggested Learning Resources:

Text Books

1. John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673.
2. Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006, ISBN: 9788170020752

Reference Books

1. Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206
2. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition,2016, ISBN: 9781118753910
3. A.C. Kermode, "Flight without formulae", Pearson Education India,5th edition,1989, ISBN: 9788131713891
4. Nelson R.C., "Flight stability and automatic control", McGraw-Hill,2nd edition,1998, ISBN: 9780071158381

Web links and Video Lectures (e-Resources):

- . https://onlinecourses.nptel.ac.in/noc20_ae12/preview

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

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

III SEMESTER

COMPUTER-AIDED AIRCRAFT DRAWING			
Course Code	**21ASL35 / 21AEL35**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	50
Credits	01	Exam Hours	3

Course objectives: This course will enable students to

1. Understand and interpret drawings of machine and aircraft components
2. Prepare assembly drawings either manually or by using standard CAD packages.
3. Familiarize with standard components and their assembly of an aircraft.

Sl. NO	Experiments
1	**Sections of Solids:** Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.
2	**Orthographic Views:** Conversion of pictorial views into orthographic projections. of **simple machine parts** with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.
3	**Thread Forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.
4	**Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.
5	**Keys & Joints:** Parallel key, Taper key, Feather key, Gibhead key and Woodruff key
6	**Riveted Joints:** Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.
7	**Couplings:** Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)
8	Design of propeller and hub assembly.
9	Design of wing.
10	Design of fuselage.
11	Design of Landing Gear Assembly.
12	Design of UAV

Course outcomes (Course Skill Set):

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

1. Distinguish drawings of machine and aircraft components
2. Identify assembly drawings either manually or by using standard CAD packages.
3. Practise with standard components and their assembly of an aircraft.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- https://transport.itu.edu.tr/docs/librariesprovider99/dersnotlari/dersnotlarires112e/not/cadd-1.pdf?sfvrsn=4

Ability Enhancement Course

III Semester

Development of Soft Skills for Engineers			
Course Code	21AS381	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: This course will enable students to

1. Understand the significance of soft skills for engineers
2. Acquire verbal and non-verbal communication skills
3. Get the essence of personal and professional leadership skills

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

Foundations of everyday leadership, Emotional intelligence, Leadership and collaborative abilities, Listening skills, Research and analytical skills

Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT

Module-2

Verbal and non-verbal communication, Stress Management and Tolerance, Email Writing, Public speaking and presentation

Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Assignment of Home/field work on real-life problem

Module-3

Negotiation skills, and diffusing project conflict, managing project risks and changes, scope , time and cost management, Strategic Planning	
Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Assignment of Home/field work on real-life problem • Adoption of Project-based/Activity Based learning
Module-4	
Creativity and vision, Problem-solving, writing code and cross-functional skill, digital product management	
Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Practising the foundational knowledge
Module-5	
Adaptability and staying positive, Applications of everyday leadership, Teamwork and people skills	
Teaching-Learning Process	• Adoption of Project-based/Activity Based learning

Course outcome (Course Skill Set)

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

1. Apply soft skills for engineering profession.
2. Practise both verbal and non-verbal communication skills effectively.
3. Use personal and professional leadership skills

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

19. First test at the end of 5th week of the semester
20. Second test at the end of the 10th week of the semester
21. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

22. First assignment at the end of 4th week of the semester
23. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

24. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Fast-Tracking Your Career: Soft Skills for Engineering and IT Professionals 1st Edition by Wushow Chou (Author)
2. Soft Skills 3rd Edition: Personality Development for Life Success Paperback – 30 October 2021 by Prashant Sharma (Author)

Web links and Video Lectures (e-Resources):

- https://www.ktit.pf.ukf.sk/images/clanky/Dokumenty/Desire/Softskillsforengineers.pdf.

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.

Ethics, Technology and Engineering			
Course Code	21AS382	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: This course will enable students to

- Learn ethical values in engineering
- Understand how ethics are followed in technology and engineering
- Share the ethical practices

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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	
Moral sensibility: the ability to recognize social and ethical issues in engineering	
Teaching-Learning Process	Teaching in classroom through Chalk, Talk and ICT

Module-2	
Moral analysis skills: the ability to analyse moral problems in terms of facts, values, stakeholders and their interests;	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem

Module-3
Moral creativity: the ability to think out different options for action in the light of (conflicting) moral values and the relevant facts;

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem
Module-4	
Moral judgement skills: the ability to give a moral judgement on the basis of different ethical theories or frameworks including professional ethics and common sense morality;	
Teaching-Learning Process	**1.** Adoption of Project-based learning **2.** Practising the foundational knowledge
Module-5	
Moral decision-making skills: the ability to reflect on different ethical theories and frameworks and to make a decision based on that reflection.	
Teaching-Learning Process	**1.** Adoption of Project-based learning **2.** Practising the foundational knowledge
Course outcome (Course Skill Set): At the end of the course the student will be able to : 1. Develop Ethical values in engineering and Technology 2. Adopt ethical practices 3. Assimilate the ethics in Engineering and Technology	

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

25. First test at the end of 5th week of the semester
26. Second test at the end of the 10th week of the semester
27. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

28. First assignment at the end of 4th week of the semester
29. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

30. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

Suggested Learning Resources:

Books

1. Ethics, Technology and Engineering , An Introduction- Wiley-Blackwell (an imprint of John Wiley & Sons Ltd)
2. Ethics in Engineering | 4th Edition Paperback – 1 July 2017by Mike W. Martin (Author)

Web links and Video Lectures (e-Resources):

- https://cdn.prexams.com/6229/BOOK.pdf
- https://www.coursera.org/learn/ethics-technology-engineering

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.

Digitalization in Aerospace Engineering			
Course Code	21AS383	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: The course will enable the students to

- To become familiar with digitalization in Aeronautics
- To understand the importance of digitalization
- To accelerate the learning of digitalization in Aeronautics

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

Digitalisation and the Future of the Aerospace Industry, Digitization in Production, Human Factors 4.0: Requirements and challenges for humans, teams and organizations

Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT

Module-2

Managing Maintenance, Repair and Overhaul for Civil Aircraft, The psycho-social implications of digitalization, Collaborative Aircraft Design	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem
Module-3	
The Significance of Testing concerning Maintenance of Aircraft, Maintenance in the Age of Digitalisation	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Adoption of Project-based/Activity Based learning
Module-4	
Digital Avionics Networks, Mil-STD, Modeling and Simulation of Aerospace Systems, Digital Models	
Teaching-Learning Process	• Adoption of Project-based/Activity Based learning
Module-5	
Efficient Order Reduction of Parametric Models, Parametric Model Order Reduction for Structural Analysis	
Teaching-Learning Process	• Adoption of Project-based/Activity Based learning

Course outcome (Course Skill Set)

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

1. Apply digitalization in Aeronautics
2. Implement digitalization in collaborative design, maintenance, repair and overhaul
3. Enhance the productivity thru digitalization in Aeronautics

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

31. First test at the end of 5th week of the semester
32. Second test at the end of the 10th week of the semester
33. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

34. First assignment at the end of 4th week of the semester
35. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

36. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

Suggested Learning Resources:

Books

1. Aerospace and Digitalization: A Transformation Through Key Industry 4.0 Technologies (Springer Briefs in Applied Sciences and Technology) 1st ed. 2021 Edition by Diego Carou (Author)
2. Digitalisation in Aeronautics and Space by coursera
3. Mastering The Digital World : A Guide To Understanding, Using And Exploiting Digital Media by Peter Cope

Web links and Video Lectures (e-Resources):

1. https://www.lll.tum.de/certificate/digitalisation-in-aeronautics-and-space/
2. https://www.repository.cam.ac.uk/bitstream/handle/1810/278896/CDBB_REP_002_Lamb_Final.pdf

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.

Coding Literacy			
Course Code	21AS384	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: The course will enable the students to

- Become literate on foundation of codes
- Be familiar to the concepts of code development and operation
- Understand any code's structural components

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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 , How Computer Programming Is Changing Writing, Why is coding literacy important? devices and software , digital environments, rules of code

Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT

Module-2	
Core coding concepts including statement, variable, flow control, and functions through digital media, such as graphics, animation, and sound, and interaction.	
Teaching-Learning Process	**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
Module-3	
Coding versus programming, develop a code, read a code, run a code, find high-level logic, use/know tools, know the language/conventions, Read best practices/design patterns	
Teaching-Learning Process	**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
Module-4	
Code Review, **Simple Codes using Javascript, MATLAB, R and Python**	
Teaching-Learning Process	• Adoption of Project-based/Activity Based learning
Module-5	
Critical thinking and evaluation, functional skills, Advanced communication, collaboration, cultural and social understanding, **Capstone project using codes**	
Teaching-Learning Process	• Adoption of Project-based/Activity Based learning

Course outcome (Course Skill Set)

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

1. Develop literacy so as to understand any code
2. Start using the concepts of code and develop it
3. Share the literacy with others

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

37. First test at the end of 5th week of the semester
38. Second test at the end of the 10th week of the semester
39. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

40. First assignment at the end of 4th week of the semester
41. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

42. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

Suggested Learning Resources:

Books

1. Coding Literacy: How Computer Programming Is Changing Writing (Software Studies) by Annette Vee (Author)
2. The Pragmatic Programmer: From Journeyman to Master (2nd Edition) by Andrew Hunt and David Thomas
3. Computer Programming JavaScript, Python, HTML, SQL, CSS: The step by step guide for beginners to intermediate by Willam Alvin Newton (Author), Steven Webber (Author)

Web links and Video Lectures (e-Resources):

- https://static.realpython.com/python-basics-sample-chapters.pdf
- http://www.uop.edu.pk/ocontents/A%20Guide%20to%20MATALB.pdf
- https://matfuvit.github.io/UVIT/predavanja/literatura/TutorialsPoint%20JavaScript.pdf
- https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf

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.

IV Semester

AERODYNAMICS			
Course Code	**21AS42 / 21AE42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	04	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3

Course objectives: This course will enable students to

- Understand the basics of fluid mechanics as a prerequisite to Aerodynamics
- Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings
- Understand the concept of compressible flow and acquire the knowledge of shocks & wave formation

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

Two Dimensional Flows & Incompressible Flow Over Airfoil

Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D-Alembert's paradox, Numericals.

Incompressible flow over airfoils: Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. Numericals.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Practising the foundational knowledge

Module-2

Incompressible Flow Over Finite Wings

Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory: Downwash and induced drag. Elliptical and modified elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory- lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane.

Teaching-Learning Process	1. . Teaching in classroom through Chalk, Talk and ICT 2. Practising the foundational knowledge

Module-3	
Applications of Finite Wing Theory & High Lift Systems Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high – lift characteristics. Critical Mach numbers, Lift and drag divergence, shock induced separation, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects. Introduction to Source panel & vortex lattice method.	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem
Module-4	
Basics of Compressible Flow Basics of thermodynamics-definition and basic relation, Energy Equation- For flow and non-flow process, adiabatic energy equation, stagnation pressure, temperature, density, reference velocities, Bernoulli's equation, Effect of Mach number on Compressibility, Isentropic flow with variable area-Area ratio as a function of Mach number, Impulse function, Mass flow rate, Flow through nozzles and diffusers	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem
Module-5	
Normal, Oblique Shocks and Expansion Waves Governing Equations of Normal Shock Wave. Prandtl relation and Rankine - Hugoniot equation. Oblique shocks and corresponding relations. Shock polar & Hodograph plane. Supersonic flow over a wedge. Supersonic compression and supersonic expansion. Detached shocks. Mach reflection. Intersection of waves of same and opposite families.	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem
Course outcome (Course Skill Set) At the end of the course the student will be able to: 1. Evaluate typical airfoil characteristics and two-dimensional flows over airfoil 2. Compute and analyse the incompressible flow over finite wings 3. Apply finite wing theory and design high lift systems from the aerodynamics view point	

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks** (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)** The question paper will have ten questions. Each question is set for 20 marks. 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. The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Anderson J.D, "Fundamental of Aerodynamics", 5th edition, McGraw-Hill International Edition, New York **(**2011), ISBN-13: 978-0073398105.
2. Yahya, S.M., "Fundamentals of Compressible flow", Wiley Eastern, 2003

Reference Books

1. Clancy L. J. "Aerodynamics", Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804
2. Louis M. Milne-Thomson, "Theoretical Aerodynamics", Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804.
3. Radhakrishnan, E., "Gas Dynamics", Prentice Hall of India.1995 edition.
4. 4. E. L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", 5th edition, Elsevier, New York. (2010), ISBN-13: 978-0080966328

Web links and Video Lectures (e-Resources):

- . https://nptel.ac.in/courses/101105059

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.

AERODYNAMICS LAB			
Course Code	**21AS42**	CIE Marks	
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	
Credits		Exam Hours	

Course objectives: This course will enable students to

1. Be acquainted with basic principles of aerodynamics using wind tunnel.
2. Acquire the knowledge on flow visualization techniques.
3. Understand the procedures used for calculating the lift and drag.

Sl. NO	**Experiments**
1	Calibration of a subsonic wind tunnel: test section static pressure and total head distributions.
2	Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.
3	Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds.
4	Smoke flow visualization studies on a two dimensional multi element airfoil with flaps and slats at different angles of incidence at low speeds.
5	Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows.
6	Surface pressure distributions on a two-dimensional smooth and rough circular cylinder at low speeds and calculation of pressure drag.
7	Surface pressure distributions on a two-dimensional symmetric airfoil.
8	Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.
9	Calculation of total drag of a two-dimensional circular cylinder and cambered airfoil at low speeds using pitot-static probe wake survey.
10	Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.
11	Calculation of aerodynamic coefficients and forces acting on a model aircraft at various AOA and speeds using wind tunnel balance (With and Without Yaw).
12	Pressure measurements on airfoil for a case of reverse flow.

Course outcomes:

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

1. Apply the flow visualization techniques.
2. Estimate the pressure distribution over the bodies.
3. Calculate the lift and drag.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- https://aerospace.illinois.edu/research/research-facilities/aerodynamics-research-lab

IV Semester

AERO ENGINEERING THERMODYNAMOCS			
Course Code	**21AS43 / 21AE43**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	04	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3

Course objectives: This course will enable students to

- Understand various concepts and definitions of thermodynamics.
- Comprehend the I-law and II-law of thermodynamics.
- Acquire the knowledge of various types of gas cycles.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

Fundamental Concepts & Definitions:

Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and Modules, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements.

Work and Heat:

Mechanics-definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Practising the foundational knowledge

Module-2

First Law of Thermodynamics:

Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, analysis of unsteady processes such as film and evacuation of vessels with and without heat transfer.

Teaching-Learning Process	**1.** . Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Module-3

Second Law of Thermodynamics:
Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Reversible and Irreversible processes; factors that make a process irreversible, reversible heat engine, Carnot cycle, Carnot principles.

Entropy: Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy.

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Module-4

Pure Substances & Ideal Gases: Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams.

Thermodynamic relations
Maxwell's equations, Tds relations, ratio of heat capacities, evaluation of thermodynamic properties from an equation of state.

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Module-5

Gas Power Cycles: Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency.
Vapour power cycle: Simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle.

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Course outcome (Course Skill Set)

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

1. Apply the concepts and definitions of thermodynamics.
2. Differentiate thermodynamic work and heat and apply I law and II law of thermodynamics to different process.
3. Apply the principles of various gas cycles.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

7. First test at the end of 5th week of the semester
8. Second test at the end of the 10th week of the semester
9. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

10. First assignment at the end of 4th week of the semester
11. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

12. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

Suggested Learning Resources:

Text Books

1. A Venkatesh, "Basic Engineering Thermodynamics", Universities Press, India, 2007, ISBN 13: 9788173715877
2. P K Nag, "Basic and Applied Thermodynamics", 2nd Ed., Tata McGraw Hill Pub. 2002, ISBN 13: 9780070151314

Reference Books

1. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics: An Engineering Approach", Tata McGraw Hill publications, 2002, ISBN 13: 9780071072540

2. J.B. Jones and G.A. Hawkins, John Wiley and Sons, "Engineering Thermodynamics", Wiley 1986, ISBN 13: 9780471812029
3. G.J. Van Wylen and R.E. Sonntag, "Fundamentals of Classical Thermodynamics", Wiley Eastern, Wiley, 1985, ISBN 13: 9780471800149
4. Y.V.C. Rao, "An Introduction to Thermodynamics", Wiley Eastern, 1993, ISBN 13: 9788173714610.
5. B.K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics", PHI, New Delhi, 2010, ISBN 13: 978-8120341128.

Web links and Video Lectures (e-Resources):

- . https://nptel.ac.in/courses/101104067

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.

ENERGY CONVERSION AND HEAT & MASS TRANSFER LAB			
Course Code	**21AS43**	CIE Marks	
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	
Credits		Exam Hours	

Course objectives: This course will enable students to

1. Familiarize with the flash point, fire point and viscosity of lubricating oils.
2. Study IC engine parts, opening and closing of valves to draw the valve-timing diagram.
3. Gain the knowledge of various flow meters and the concept of fluid mechanics.
4. Understand the Bernoulli's Theorem.

Sl. NO	Experiments
1	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Martins Apparatus.
2	Determination of Calorific value of solid, liquid and gaseous fuels.
3	Determination of Viscosity of lubricating oil using Torsion viscometers.
4	Valve Timing diagram of 4-stroke IC Engine.
5	Calculation of work done and heat transfer from PV and TS diagram using Planimeter.
6	Performance Test on **Four stroke Petrol Engine/Multi Cylinder** and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat balance sheet.
7	Heat transfer through natural and forced convection.
8	Heat transfer from PIN-FIN apparatus.
9	Determination of thermal conductivity of insulating material.
10	Determination of overall heat transfer coefficient of a composite wall.
11	Determination of Stefan Boltzmann constant.
12	Determination of Critical heat flux and emissivity of a surface.

Course outcomes:

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

1. Calculate the flashpoint, calorific and viscosity values.
2. Analyse the performance of Four stroke and Multi cylinder engines
3. Determine the heat transfer 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1208&context=mesp

IV Semester

MECHANICS OF MATERIALS			
Course Code	**21AS44 / 21AE44**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	03	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

- Comprehend the basic concepts of strength of materials.
- Acquire the knowledge of stress, strain under different loadings.
- Understand the different failure theory.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

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

Module-1

Basics of linear elasticity: The concept of stress& strain, state of stress & Strain at a point, Equilibrium equations, The state of plane stress and plane strain. Compatibility equations, Constitutive Laws (Hooke's Law), Stress-strain curves for brittle and ductile materials, Allowable stress, Material selection for structural performance.

Simple & Compound Stresses: Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections. Elongation due to self-weight. Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses, Introduction to Plane stress, stresses on inclined sections, principal stresses & strains, Analytical & graphical method (Mohr's Circle) to find principal stresses & strains.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem

Module-2

Bending Moment and Shear Force in Beams: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams.

Euler-Bernoulli beam theory: The Euler-Bernoulli assumptions, Implications of the Euler-Bernoulli assumptions, the Euler-Bernoulli Beam theory derivation, Bending stress equation, Moment carrying capacity of a section. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections (Only Numerical).

Teaching-Learning Process	**1.** . Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Module-3

Deflection of Beams: Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method.

Torsion of Circular Shafts and Elastic Stability of Columns: Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts.

Teaching-Learning Process	**3.** Teaching in classroom through Chalk, Talk and ICT **4.** Assignment of Home/field work on real-life problem

Module-4

Virtual work principles: Introduction, Equilibrium and work fundamentals, Principle of virtual work, Principle of virtual work applied to mechanical systems, Principle of virtual work applied to truss structures, Principle of virtual work applied to beams. Principle of complementary virtual work, internal virtual work in beams and solids.

Energy methods: Conservative forces, Principle of minimum total potential energy, Strain energy in springs, Strain energy in beams, Strain energy in solids, Applications to trusses, Development of a finite element formulation for trusses, Principle of minimum complementary, Energy theorems, Reciprocity theorems, Saint-Venant's principle.

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Module-5

Mechanical Properties of materials:
Fracture: Type I, Type II and Type III.

Creep: Description of the phenomenon with examples. Three stages of creep, creep properties, stress relaxation.

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram.

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

1. Apply the basic concepts of strength of materials.
2. Compute stress, strain under different loadings.
3. Distinguish the different failure theories.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

13. First test at the end of 5th week of the semester
14. Second test at the end of the 10th week of the semester
15. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

16. First assignment at the end of 4th week of the semester
17. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

18. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

3. The question paper will have ten questions. Each question is set for 20 marks.
4. There will be 2 questions from each module. Each of the two questions under a module (with a

Suggested Learning Resources:

Text Books

1. S.S. Bhavaikatii, "*Strength of Materials*", Vikas Publications House, New Delhi, 2012, ISBN-13: 978-8125927914.
2. S. Ramamrutham, R Narayanan, "*Strength of Materials"*, Dhanapath Rai Publishing Company, New Delhi, 2012, ISBN 13: 9789384378264

Reference Books

1. T.H.G Megson "*Introduction to Aircraft Structural Analysis*", Butterworth-Heinemann Publications, 2007, ISBN 13: 9781856179324
2. Beer.F.P. and Johnston.R, "*Mechanics of Materials*", McGraw Hill Publishers, 2006, ISBN-13: 978-0073380285.
3. Timoshenko and Young "*Elements of Strength of Materials*', East-West Press, 1976, ISBN 10: 8176710199.
4. O.A.Bauchau and J.I.Craig "*Structural Analysis"* Springer Dordrecht Heidelberg London New York, ISBN 978-90-481-2515-9, e-ISBN 978-90-481-2516-6

Web links and Video Lectures (e-Resources):

- . https://nptel.ac.in/courses/105106172

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.

PROPULSION LAB			
Course Code	**21ASL46**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	03	SEE Marks	50
Credits	01	Exam Hours	3

Course objectives: This course will enable students to

1. Understand how to do the heat transfer.
2. Comprehend the cascade testing of axial compressor and axial turbine blade row.
3. Study the performance of propeller and jet engines.

Sl. NO	Experiments
1	Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles).
2	Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles).
3	Study of free convective and forced convective heat transfer over a flat plate.
4	Cascade testing of a model of axial compressor blade row.
5	Cascade testing of a model of axial Turbine blade row.
6	Study of performance of a propeller.
7	Determination of heat of combustion of aviation fuel.
8	Study of free and wall jet.
9	Measurement of burning velocity of a premixed flame.
10	Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio.
11	Measurement of nozzle flow.
12	Performance studies on a scaled jet engine.

Course outcomes (Course Skill Set):

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

1. Analyze the cascade testing of axial compressor and axial turbine blade row.
2. Evaluate the performance of a jet engine.
3. Perform the measurement of a flame and nozzle flow.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours Rubrics suggested in Annexure-II of Regulation book
Suggested Learning Resources: • https://www.jpl.nasa.gov/

Ability Enhancement Course - IV

IV Semester

Introduction to programming with MATLAB and Python			
Course Code	21AS481	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	02/week	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives:

1. To learn how to programme with MATLAB and Python
2. To be familiar with programming environments of MATLAB and Python
3. To carry lab sessions using MATLAB and Python

Teaching-Learning Process (General Instructions)

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

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

Module-1	
The basics of MATLAB and Python, MATLAB Environment, Python Environment	
Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT

Module-2	
Programming in MATLAB and Python for Aeronautical Engineering Problems, Running MATLAB, Syntax and Semantics of both MATLAB and Python, Data Visualisation in both the programming languages-MATLAB and Python, Programmer' ToolBox	
Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Assignment of Home/field work on real-life problem

Module-3

Lab practice of programming and submission of outputs of codes in MATLAB and Python, Matrices, Operators, Functions, debugging, File Input/Output	
Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Assignment of Home/field work on real-life problem • Adoption of Project-based/Activity Based learning
Module-4	
Course Introduction, Intro to Programming and The Python Language, Variables, Conditionals, Jupyter Notebook, and IDLE , Introduction to Lists, Loops, and Functions, More with Lists, Strings, Tuples, Sets, and PyCharm	
Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Practising the foundational knowledge
Module-5	
Coding Demonstration, Home Work in Python and MATLAB, Practice Quiz	
Teaching-Learning Process	• Adoption of Project-based/Activity Based learning

Course outcome (Course Skill Set)

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

1. Program with MATLAB and Python
2. Develop basic to complex code in the programming environments of MATLAB and Python
3. Modify and Maintain codes written using MATLAB and Python

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

19. First test at the end of 5th week of the semester
20. Second test at the end of the 10th week of the semester
21. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

22. First assignment at the end of 4th week of the semester
23. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

24. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination (SEE)

SEE paper shall be set for 50 question, each of 1 mark. The Pattern of the question paper is **MCQ** (Multiple Choice Questions). The time allotted for SEE is 01 hour. The Student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Programming in MATLAB ®: A problem-solving approach, 1e Paperback by Patel / Mittal (Author)
2. Python Programming: Using Problem Solving Approach by Reema Thareja (Author)

Web links and Video Lectures (e-Resources):

- https://cfm.ehu.es/ricardo/docs/python/Learning_Python.pdf
- https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.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.

Design Thinking for Innovation			
Course Code	21AS482	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	02/week	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives:

- What design thinking is and when to use it
- How to use design thinking to generate innovative ideas
- How to take the many ideas you generate and determine which ones are likely to produce specific, desired outcomes

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

What Is Design Thinking? Business Model Innovation, Challenges Best-Suited for Design Thinking, Visualization Tool

Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT

Module-2

Preparing Your Mind for Innovation, The Physics of Innovation, How Prepared Is Your Mind?, Storytelling Tools

Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Assignment of Home/field work on real-life problem

Module-3

Idea Generation, Process, Mind Mapping Tool, Experimentation

Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Assignment of Home/field work on real-life problem • Adoption of Project-based/Activity Based learning

Module-4

Human-centered Design, Developing and Testing Prototypes

Teaching-Learning Process	• Teaching in classroom through Chalk, Talk and ICT • Practising the foundational knowledge

Module-5

Interviewing & Empathy-building Techniques, Developing and Testing Prototypes, Making Sense of Observations & Insights

Teaching-Learning Process	• Adoption of Project-based/Activity Based learning

Course outcome (Course Skill Set)

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

- Use design thinking for innovation
- Generate innovative ideas based upon design thinking
- Determine which ones are likely to produce specific, desired outcomes

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

25. First test at the end of 5th week of the semester
26. Second test at the end of the 10th week of the semester
27. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

28. First assignment at the end of 4th week of the semester
29. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

30. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination (SEE)

SEE paper shall be set for 50 question, each of 1 mark. The Pattern of the question paper is **MCQ** (Multiple Choice Questions). The time allotted for SEE is 01 hour. The Student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Design Thinking: Integrating Innovation, Customer Experience, and Brand Value Paperback by Thomas Lockwood (Editor)
2. Design Thinking for Innovation: Research and Practice by Walter Brenner (Editor), Falk Uebernickel (Editor)

Web links and Video Lectures (e-Resources):

- https://i.experiencepoint.com/ebooks
- https://www.researchgate.net/publication/329310644_Handbook_of_Design_Thinking

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.

IV Semester

HIGH TEMPERATURE AND SMART MATERIALS			
Course Code	**21AS483**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives:

- Understand the different types of high temperature materials
- Select the materials for suitable applications.
- Get basic knowledge about the smart materials.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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 composite materials, Polymer matrix composites, Specialty composites, Carbon-Carbon composites, Nanocomposites

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem

Module-2

Carbon based materials, Ceramic materials, Metallic materials, High temperature polymers

Teaching-Learning Process	1. . Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem

Module-3

Materials for space environment: Radiation shielding materials, Atomic oxygen resistant materials, Space suit materials and materials for life support systems	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT
Module-4	
Smart materials and structures: System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem
Module-5	
Smart systems for space applications: Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT **2.** Assignment of Home/field work on real-life problem

Course outcome (Course Skill Set)

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

1. Identify the different types of high temperature materials
2. Apply the materials for suitable applications
3. Appreciate the use of smart materials.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

31. First test at the end of 5th week of the semester
32. Second test at the end of the 10th week of the semester
33. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

34. First assignment at the end of 4th week of the semester
35. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

36. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination (SEE)

SEE paper shall be set for 50 question, each of 1 mark. The Pattern of the question paper is **MCQ** (Multiple Choice Questions). The time allotted for SEE is 01 hour. The Student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. R.M. Jones, Mechanics of Composites, 2nd ed., Taylor & Francis, 1999.
2. T. G. Gutowski, (Ed.) Advanced Composites Manufacturing, John Wiley & Sons, New York 1997
3. G. Savage, Carbon-Carbon Composites, 1st ed., Chapman and Hall, 1993.
4. M. Scheffler, P. Colombo, Cellular Ceramics, Structure, Manufacturing, properties and Applications, 1st ed., Wiley-VCH, 2006.
5. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.
6. M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier 2005
7. Brian Culshaw, Smart Structures and Materials, Artech House, 2000

Web links and Video Lectures (e-Resources):

- . https://nptel.ac.in/courses/113105081

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 SPACE TECHNOLOGY			
Course Code	**21AS484**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	03	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: This course will enable students to

1. Understand the fundamentals of aerospace propulsion.
2. Understand the orbit mechanics and orbit maneuvers.
3. Acquire the knowledge of satellite attitude dynamics and space mission operations.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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 of Aerospace Propulsion, Space Environment, fundamentals of solid propellant rockets, Fundamentals of liquid propellant rockets, Rocket equation, Tsiolkovsky rocket equation, Concepts of Specific Impulse.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT

Module-2

Atmospheric Re-entry: Introduction-Steep Ballistic Re-entry, Ballistic Orbital Re-entry, Skip Re-entry, "Double-Dip" Re-entry, Skip reentry, glide reentry

Teaching-Learning Process	. 1. Teaching in classroom through Chalk, Talk and ICT

Module-3

Fundamentals of Orbit Mechanics, Orbit Manoeuvre,: Two-body motion, Basic Orbital Elements, Hohmann Transfer, Bielliptical Transfer

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT
Module-4	
Satellite Attitude Dynamics: Attitude Control for Spinning Spacecraft, Attitude Control for Non-spinning Spacecraft, The Yo-Yo Mechanism, Gravity – Gradient Satellite,	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT
Module-5	
Space Mission Operations: Supporting Ground Systems Architecture and Team interfaces, Mission phases and Core operations, Command, Planning, Tracking, Telemetry.	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT

Course outcome (Course Skill Set)

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

1. Distinguish the types of aerospace propulsion.
2. Determine the attitude of the satellites.
3. Support the space mission operations.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

37. First test at the end of 5th week of the semester
38. Second test at the end of the 10th week of the semester
39. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

40. First assignment at the end of 4th week of the semester
41. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

42. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination (SEE)

SEE paper shall be set for 50 question, each of 1 mark. The Pattern of the question paper is **MCQ** (Multiple Choice Questions). The time allotted for SEE is 01 hour. The Student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books

1. W.E. Wiesel," Spaceflight Dynamics",McGraw Hill,2nd edition,2014,ISBN-13: 978-9332901650
2. J.W. Cornelisse, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982.

Reference Books

1. Vincet L. Pisacane, "Fundamentals of Space Systems", Oxford University Press, 2005.
2. J.Sellers ,"Understanding Space: An Introduction to Astronautics" , McGraw Hill, 2nd edition,2000,ISBN-13: 978-0072424683
3. Francis J Hale, "Introduction to Space Flight", Pearson, 1993, ISBN-13: 978-0134819129.
4. Charies D.Brown ,"Spacecraft Mission Design", AIAA education Series, 1998.
5. Meyer Rudolph X, "Elements of Space Technology for aerospace Engineers", Meyer Rudolph X, Academic Press, 1999.

Web links and Video Lectures (e-Resources):

- . https://nptel.ac.in/courses/101101079

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.

V Semester

MECHANISM AND MACHINE THEORY			
Course Code	**21AS51**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the theory of mechanisms including velocity, acceleration and static force analysis.
2. Acquire knowledge of spur gears, gear train, balancing of rotating and reciprocating masses.
3. Understand the concept of governors and gyroscope.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher 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 Mechanisms:
Types of constrained motion, Link and its types, joints and its types, kinematic pair and its types, degrees of freedom, Grubler's criterion, Types of kinematic chains and inversions:

Inversions of Four bar chain: Beam engine, coupling rod of a locomotive, Watt's indicator mechanism. Inversions of Single Slider Crank Chain: Pendulum pump or Bull engine, Oscillating cylinder engine, Rotary internal combustion engine, Crank and slotted lever quick return motion mechanism, Whitworth quick return motion mechanism. Inversions of Double Slider Crank Chain: Elliptical trammels, Scotch yoke mechanism, Oldham's coupling. Straight line motion mechanisms: Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism and Ratchet and Pawl mechanism, Ackerman steering gear mechanism.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Velocity, Acceleration and static force analysis of Mechanisms (Graphical Methods):
Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons.

Static force analysis: Introduction: Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

Spur Gears and Gear Trains

Spur Gears: Gear terminology, law of gearing, Path of contact, Arc of contact, contact ratio of spur gear, Interference in involute gears, Methods of avoiding interference.

Gear Trains: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

Balancing of Rotating and Reciprocating Masses

Balancing of Rotating Masses: Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes (only Graphical Methods).

Balancing of Reciprocating Masses: Primary and Secondary Unbalanced Forces of Reciprocating Masses, Partial Balancing of Unbalanced Primary Force in a Reciprocating Engine, Balancing of Primary and secondary Forces of Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods)

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

Governors and Gyroscope

Governors: Types of governors; force analysis of Porter and Hartnell governors, Controlling force, stability, sensitiveness, isochronism, effort and power of Porter and Hartnell governors.

Gyroscopes: Vectorial representation of angular motion, gyroscopic couple, effect of gyroscopic couple on plane disc and aeroplane

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. Apply the theory of velocity, acceleration and static force analysis to design of mechanisms.
2. Design spur gears, gear train, balancing of rotating and reciprocating masses.
3. Apply governors and gyroscope.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. **Rattan S.S**, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009, ISBN: 007014477X, 9780070144774.

2. **J.J. Uicker, G.R. Pennock, J.E. Shigley.** "Theory of Machines & Mechanisms", OXFORD 3rd Ed. 2009, ISBN-13: 978-0195371239

Reference Books

1. **R. S. Khurmi, J.K. Gupta,** "Theory of Machines", Eurasia Publishing House, 2008, ISBN 13: 9788121925242.

2. **Robert L Norton,** "Design of Machinery" by McGraw Hill, 2001, **ISBN-13:** 978-0077421717.

3. **Ambekar,** "Mechanism and Machine theory", PHI Learning Pvt. Ltd., 2007, ISBN 13: 9788120331341.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/112105268

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.

V Semester

AEROSPACE PROPULSION			
Course Code	**21AS52**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the working principles of gas turbine and ramjet propulsion systems, the design principles of inlets, combustion chambers, nozzles used in them.
2. Learn the operation of compressors and turbines in gas turbine propulsion systems.
3. Understand the operation of rocket propulsion

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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: Classification of power plants - Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption - Thrust and power- Factors affecting thrust and power- Illustration of working of Gas turbine engine - Characteristics of turboprop, turbofan and turbojet , Ram jet, Scram jet – Methods of Thrust augmentation.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Propeller Blade Theory: Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

Nozzles and Combustion Chamber: Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio – Starting problem in supersonic inlets –Modes of inlet operation, jet nozzle – Efficiencies – Over expanded, under and optimum expansion in nozzles – Thrust reversal. Classification of Combustion chambers - Combustion chamber performance – Flame tube cooling – Flame stabilization.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

Compressor and Turbine: Introduction to centrifugal compressors- Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps- axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

Introduction to rocket propulsion: Introduction to rocket propulsion – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance – electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. Analyze the engineering concepts of air breathing propulsion systems.
2. Distinguish the different types of compressors.
3. Choose the propellant based on the application.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Hill P.G. and Peterson, C.R. Mechanics and Thermodynamics of Propulsion, Pearson India,2nd edition,2009, ISBN-13: 978-8131729519.
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo H.I.H, Gas Turbine Theory, DORLING KINDERSLEY,5th edition,2002, ISBN-13: 978-8177589023.

Reference Books

1. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985, ISBN-13: 978-0915928972.
2. G.P. Sutton, "Rocket Propulsion Elements", Wiley India Pvt Ltd, 7th Edition,2010, ISBN-13: 978-8126525775.
3. W.P.Gill, H.J.Smith & J.E. Ziurys, "Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 4th revised edition,2007,ISBN-13: 978-8120417106.

Web links and Video Lectures (e-Resources):

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.

ADVANCED PROPULSION LAB			
Course Code	**21AS52**	CIE Marks	
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	
Credits		Exam Hours	

Course objectives This course will enable students to

1. Understand how to do the heat transfer.
2. Comprehend the cascade testing of axial compressor and axial turbine blade row.
3. Study the performance of propeller and jet engines.

Sl. NO	**Experiments**
1	Study of forced convective heat transfer over a flat plate.
2	Determination of heat of combustion of aviation fuel.
3	Measurement of burning velocity of a premixed flame.
4	Combustion performance studies in a jet engine combustion chamber.
5	Study of Free Jet
6	Study of Wall jet
7	Preparation of Propellant

8	Computation of burning rate of the propellant.
9	Estimate the Calorific value of propellant
10	Measurement of Ignition delay of a single propellant with different shapes.
11	Establishing flame stability of pre-mixed flame through flame stability setup.
12	Performance study of Hybrid Motor using a thrust stand and Analysis of grain stress and strain of a solid propellant.

Course outcomes:

After studying this course, students will be able to:

1. Analyze the performance of jet engine.
2. Evaluate the performance of a propellant.
3. Differentiate among different equipments required for study of propulsion.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

V Semester

AEROSPACE STRUCTURES			
Course Code	**21AS53**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
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).	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
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, micro structures, inflatable structures, flying effector, Nano tubing.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Course outcome: After studying this course, students 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
3. Second test at the end of the 10th week of the semester
4. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

5. First assignment at the end of 4th week of the semester
6. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

7. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

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/101105084

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.

V Semester

AIRCRAFT PERFORMANCE AND STABILITY			
Course Code	**21AS54**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	04	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the aircraft performance in steady unaccelerated and accelerated flight.
2. Understand the airplane performance parameters and Acquire the knowledge on aircraft maneuver performance.
3. Understand the basics of aircraft stability and control
4. Understand the static longitudinal and static directional stability.

Teaching-Learning Process (General Instructions)

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

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

Module-1

The Equations of Motion Steady Unaccelerated Flight

Introduction, four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

Steady Performance – Level Flight, Climb & Glide

Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach, climb performance graph (hodograph diagram); maximum climb angle and rate of climb Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2	
Fundamental Airplane Performance Parameters The fundamental Parameters: Thrust – to – weight ratio, Wing loading, Drag polar, and lift-to – drag ratio. Minimum velocity. Aerodynamic relations associated with lift-to-drag ratio. **Range and Endurance:** Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance. Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.
Module-3	
Aircraft Performance in Accelerated Flight **Take-off Performance**: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length **Landing Performance and Accelerated Climb:** Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb. **Maneuver Performance** Turning performance: Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Static Longitudinal Stability and Control-Stick Fixed Historical perspective, Aerodynamic Nomenclature, Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane Introduction, Trim condition. Static margin. stick fixed neutral points. Longitudinal control, Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5	
Static Longitudinal Stability& Static Directional Stability and Control-Stick free Introduction, Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G. Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition. Weather cocking effect.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Course outcome: After studying this course, students will be able to: 1. Apply the basic airplane performance parameters. 2. Differentiate the aircraft performance in steady unaccelerated and accelerated flight. 3. Apply the basic concepts of aircraft stability and control. 4. Differentiate the static longitudinal and static directional stability.	

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

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4. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

5. First assignment at the end of 4th week of the semester
6. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

7. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. **John D. Anderson, Jr.** "Aircraft Performance and Design", McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 1999.

2. **John D. Anderson, Jr.**, "Introduction to flight" McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 2000.

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

Reference Books

5. **Perkins, C.D., and Hage, R.E.**, "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.

6. **Barnes W. McCormick,** ` Aerodynamics, Aeronautics, and Flight Mechanics`, John Wiley& Sons, Inc. 1995.

7. **Bandu N. Pamadi,** `Performance, Stability, Dynamics and Control of Airplanes`, AIAA 2nd Edition Series, 2004.

8. **John D. Anderson Jr**., "Introduction to flight" McGraw-Hill, International Editions, Aerospace Science Technology Editions, 2000.

9. **W.J. Duncan,** The Principles of the Control and Stability of Aircraft, Cambridge University Press, 2016.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/101104062
https://nptel.ac.in/courses/101104007

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.

V Semester

AEROSPACE STRUCTURES LAB			
Course Code	**PCC21ASL55**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	03	SEE Marks	50
Credits	01	Exam Hours	3

Course objectives: This course will enable students to

1. Learn about the simply supported beam, cantilever beam.
2. Understand the Maxwell's theorem and Poisson ration.
3. Acquire the knowledge about buckling load, shear failure and shear centre.

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

Course outcomes:

After studying this course, students will be able to:

1. Compute the deflection of simply supported beam and cantilever beam.
2. Verify the Maxwell's theorem.
3. Determine the buckling load, shear failure and shear centre.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours Rubrics suggested in Annexure-II of Regulation book
Suggested Learning Resources:

V SEMESTER

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS			
Course Code	**21AS56**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	02	Exam Hours	3

Course objectives: This course will enable students to

- To give an overview of the research methodology and explain the technique of defining a research problem.
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections.
- To explain several parametric tests of hypotheses and Chi-square test.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Reviewing the literature: Place of the literature review in research, bringing clarity and focus to research problem, improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

Design of Sample Surveys: Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. Data Collection: Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. Apply research methodology and IPR.
2. Distinguish the types of intellectual property.
3. Analyse options for protecting your creative innovations with copyright law.
4. Analyse and interpret a patent document for a competing product.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, New Age International, 4th Edition, 2018.

2. Ranjit Kumar, Research Methodology a step-by step guide for beginners, SAGE Publications Ltd, 3rd Edition, 2011.

Reference Books

1. Trochim, Research Methods: the concise knowledge base, Atomic Dog Publishing, 2005.

2. Fink A, Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications, 2009.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/110105139

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.

ABILITY ENHANCEMENT COURSE – V

V SEMESTER

PROBABILITY AND STATISTICS FOR AEROSPACE ENGINEERING			
Course Code	**21AS581**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	02	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: This course will enable students to

1. Understand the theory of mechanisms including velocity, acceleration and static force analysis.
2. Acquire knowledge of spur gears, gear train, balancing of rotating and reciprocating masses.
3. Understand the concept of governors and gyroscope.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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,

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3	
Curve Fitting, Regression, and Correlation, Goodness-of-Fit Tests,	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Hypothesis/Significance Testing, Reliability and Life Testing, Error Propagation Law	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Application of Probability and Statistics in Aerospace Engineering – Various Examples.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:
After studying this course, students will be able to:

1.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

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

Reference Books

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

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.

V SEMESTER

INTRODUCTION TO DATA ANALYTICS			
Course Code	**21AS582**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: This course will enable students to

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher 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 Probabilty, Independence, Expectation, Variance, Statistical Learning, Experiment Design, Confidence Interval and Hypothesis Testing,

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
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)	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Introduction to Big Data storage systems, Introduction to Big Data processing platforms, Deep Dive into Spark: RDD, Narrow, Wide Transformations	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Course outcome: After studying this course, students will be able to:	

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:
Text Books

Reference Books

Web links and Video Lectures (e-Resources):

https://iisc.talentsprint.com/cds/?utm_source=googlesearch&utm_medium=tcpa&utm_campaign=ts-googlesearch-iisc-cds-tcpa-datascience-keywords&utm_content=data-science-programme&utm_term=Learn%20data%20analysis&gclid=CjwKCAjwj42UBhAAEiwACIhADog_dmq8zIm6SCLNJThbj6jWBONtx8Ma11Fk9ASYFXKeqnz4Vr5dWRoCzA0QAvD_BwE

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.

V SEMESTER

VIRTUAL AIRCRAFT SIMULATION			
Course Code	**21AS583**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	02	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: This course will enable students to

1. Remember the terminologies of virtual aircraft simulation.
2. Understand the virtual aircraft simulation environment and settings.
3. Implement the skills of virtual flying.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT.

Module-2	
Air Traffic Control, Radio Communication from Pilot.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-3	
Flight Mode Annunciator mode English, Flight Instruments and their working principles	
Teaching-Learning Process	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.

<table>
<tr><th colspan="2">Module-4</th></tr>
<tr><td colspan="2">Flight Instrument Essentials, Aviation Meteorology</td></tr>
<tr><td>Teaching-Learning Process</td><td>1. Teaching in classroom through Chalk, Talk and ICT
2. Practising the foundational knowledge.</td></tr>
<tr><th colspan="2">Module-5</th></tr>
<tr><td colspan="2">Practice of Flight Simulator X installation and Settings.</td></tr>
<tr><td>Teaching-Learning Process</td><td>1. Adoption of Project-based/Activity Based learning.</td></tr>
<tr><td colspan="2">Course outcome:
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.</td></tr>
</table>

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
3. Second test at the end of the 10th week of the semester
4. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

5. First assignment at the end of 4th week of the semester
6. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

7. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text 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.youtube.com/watch?v=EOeDTr1x3XI

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.

V SEMESTER

AIR AND MISSILE DEFENCE SYSTEMS			
Course Code	**21AS584**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	02	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1.5

Course objectives: This course will enable students to

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Strategic Missiles Introduction, Atmospheric Reentry, Ballistic Missile Intercept, Threat analysis for Boost phase interception – Typical assessment errors. Introduction to Cruise Missiles , The Terrain-Contour Matching (TERCOM) Concept.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:
After studying this course, students 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

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

Web links and Video Lectures (e-Resources):

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.

VI Semester

AVIATION MANAGEMENT			
Course Code	**21AS61**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand the airline and airport operation, scheduling and management.
2. Acquire the general aviation management practices.
3. Grasp the broad disciplines of management at different levels of aviation industry.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Human Resources Management, Organizational Behaviour, Accounting for Management, Airline Economics, Customer Relationship Management.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

Airline Marketing Management, Total Quality Management, Strategic Management, Supply Chain management, Aircraft Maintenance Management.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4	
Business Application Software, Communication Skills and Business Correspondence, Research Methods in Business, International Business Management, Aviation Systems: Management of the Integrated Aviation Value Chain.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Aviation Law, Aviation Safety Management and Accident Investigations, Emerging Trends in Management - Case Study Analysis, Entrepreneurship Development, Airline Advertising and Sales Promotion.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. Apply the foundational knowledge of airline and airport operation, scheduling and management.
2. Implement the general aviation management practices.
3. 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text 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).

Reference Books

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

2. Aviation Leadership: The Accountable Manager by By **Mark J. Pierotti.**

3. Airline Management Finance -The Essentials By Victor Hughes.

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.

VI Semester

AIRCRAFT SYSTEMS AND AVIONICS			
Course Code	**21AS62**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the aircraft control systems.
2. Understand the aircraft systems.
3. Acquire the knowledge of avionics systems.

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3	
Aircraft Instruments: Flight Instruments, Gyroscope, Accelerometers, Air speed Indicators, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Power Distribution System: Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilization-typical application to avionics. Need for Avionics in civil and military aircraft.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Flight Deck and Cockpits: Control and display technologies CRT, LED, LCD, ELand plasma panel, Touch screen, Direct voice input (DVI), MFDS, HUD, MFK, HOTAS. **Avionics Systems Integration:** Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Electronic Warfare, and fire control system, Data buses, MIL–STD 1553 B.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Course outcome: After studying this course, students will be able to: 1. Distinguish the conventional and modern control systems. 2. Categorize different types of aircraft systems and instruments. 3. Identify the use of avionics 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Ian Moirand Allan Seabridge, 'Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration', Wiley India Pvt Ltd, 3rd edition, 2012, ISBN-13: 978-8126535217.

2. Pallet, E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific and Technical, 1996.

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

Reference Books

4. Lalit Gupta and OP. Sharma, 'Aircraft Systems (Fundamentals of Flight Vol. IV)', HimalayanBooks;2006.

5. Treager. S, "Gas Turbine Technology", McGraw-Hill, 3rd edition,2013, ISBN-13: 978-1259064876.

6. R.W. Sloley and W.H. Coulthard, 'The aircraft Engineers Handbook, No 4, Instruments', 6th Edition, 2005, ISBN-13: 978-8175980518.

7. SR. Majumdar, 'Pneumatic Systems', Tata McGraw Hill Publishing Co,1st Edition, 2001, ISBN-13: 978-0074602317.

8. William A Neese, 'Aircraft Hydraulic Systems', Himalayan Books, 2007.

9. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989, ISBN-13: 978-0582018815.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/101104071

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.

AVIONICS LAB			
Course Code	**21AS62**	CIE Marks	
Teaching Hours/Week (L:T:P: S)	2	SEE Marks	
Credits		Exam Hours	

Course objectives: This course will enable students to

1. Learn about the simply supported beam, cantilever beam.
2. Understand the Maxwell's theorem and Poisson ration.
3. Acquire the knowledge about buckling load, shear failure and shear centre.

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

Course outcomes:

After studying this course, students will be able to:

1. Perform measurements on different instruments used for flight operations
2. Perform analog /digital conversions and use microprocessors.
3. Handle functioning of MIL-STD-1553B Data Bus

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

https://www.iist.ac.in/departments/avionics-lab

VI Semester

ROCKETS AND MISSILES			
Course Code	**21AS63**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

Launch Vehicle Dynamics: Tsiolskovsky'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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students 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 missies.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
3. Second test at the end of the 10th week of the semester
4. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

5. First assignment at the end of 4th week of the semester
6. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

7. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

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. SS. Chin, 'Missile Configuration Design', McGraw Hill, 1961.

2. Cornelisse, J.W, Schoyer H.F.R. and Wakker, K.F., Rocket Propulsion and Space-Flight 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. Parker, E.R., Materials for Missiles and Spacecraft, McGraw Hill, 1982.

Web links and Video Lectures (e-Resources):

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.

PROFESSIONAL ELECTIVE COURSE - I

VI Semester

INTRODUCTION TO ASTOPHYSICS AND SPACE ENVIRONMENT			
Course Code	**21AS641**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the basics of astrophysics and space environment.
2. Study the relativistic quantum mechanics.
3. Acquire the knowledge of sun and solar system.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Sun & Solar System**:** The sun, helioseismology, convection, solar magnetism: flux tubes, sun spots, 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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. Evaluate the Black body radiation, specific intensity, flux density., etc .
2. Apply the 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
3. Second test at the end of the 10th week of the semester
4. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

5. First assignment at the end of 4th week of the semester
6. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

7. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

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):

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.

VI SEMESTER

RADAR AND MICROWAVE ENGINEERING			
Course Code	**21AS642**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the basics of Radars.
2. Understand the wave propagation and waveguides.
3. Acquire the knowledge of MTI, SST and types of Radars.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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 Radar: Basics, Radar Frequencies, Radar Range Equation, Types of Radar, Doppler Effect, FMCW Radar, Secondary Radar and its applications, Comparison of primary and secondary radar.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Radar Transmitter: Introduction, Block diagram, Modulator, Line type modulator, Hard tube modulator, duplexer, balanced duplexer and circulator.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

Wave Guides: Basics, Propagation, field configuration, modes, group and phase velocity, cut off wavelength, waveguide dimensions, types of waveguides, WG Tees, hybrid junction, bends, twists and tapers.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

Radar Receiver: Functions, block diagram, noise figure, detection and extraction of information, automatic detectors, false alarm, missed detection, clutter and reduction techniques, CFAR, AGC, STC, side lobe suppression, radar data processing, pulse compression technique, radar displays, synthetic displays.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

Moving Target Indicator: Principles, Block diagram of MTI, delay line canceller, blind speed, Digital MTI.
SST Radars: Search and surveillance Radar, Principles of tracking radar .
Types of Radars in IAF: MPR, Rohini, LLLWR, LLTR, TRS-2215, THD 1955.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:
After studying this course, students will be able to:

1. Apply of concepts of Radars.
2. Classify the modulators, duplexer and circulators.
3. Identify the applications of different types of radars.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. M. I. Skolnik, Introduction to Radar Systems, Tata McGraw-Hill, 2017.
2. Peyton Z Peebles, Radar Principles, Wiley, 1998.

Reference Books

1. Liao, Microwave Devices and Circuits, 3rd edition, Pearson, 2003.
2. Mark Richards, Fundamentals of Radar Signal Processing, 2nd Edition, McGraw Hill, 2014.
3. Toomay J.C, Principles of Radar, Prentice Hall India, 2010.
4. George W. Stimson, Hugh Griffiths, Introduction to Airborne Radar, 3rd Edition, SciTech, 2014.

Web links and Video Lectures (e-Resources):

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.

VI SEMESTER

THEORY OF VIBRATIONS			
Course Code	**21AS643**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:
After studying this course, students will be able to:

1. Apply the principle of super position to Simple Harmonic Motions.
2. Determine the vibrations using vibration instruments.
3. 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

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):

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.

VI SEMESTER

GAS TURBINE TECHNOLOGY AND SPACE PROPULSION			
Course Code	**21AS644**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

1. Comprehend the types of engines and its applications.
2. Understand the materials required for engine manufacturing.
3. Acquire the knowledge of engine performance, testing and rocket propulsion.

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

Compressor: Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation.
Combustor: Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation.
Turbines: Turbine MAP. Turbine Testing and Performance Evaluation.
Inlet duct & nozzles: Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

Types of engine testing's: Normally Aspirated Testing, Open Air Test Bed, Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in flight. Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology.
Rocket Propulsion: Types of rocket engines, propellants, combustion instabilities, rocket propulsion theory, performance of rocket engine, multistage rockets, orbital and escape velocities, Electric and In-Space Propulsion i. Power limitations ii. Electrothermal; Electrostatic; Electrodynamic propulsion systems

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:
After studying this course, students will be able to:

1. Select the suitable materials for engine manufacturing.
2. Evaluate the performance of the engine.
3. Test the engine using several types of engine testing methods and acquire knowledge on rocket propulsion.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Irwin E. Treager, **'**Gas Turbine Engine Technology ', Mc Graw Hill Education,3rd edition, 2013, ISBN-13: 978-1259064876.

2. P.P Walsh and P. Peletcher, 'Gas Turbine Performance' Blackwell Science, 1998, ISBN0632047843.

Reference Books

1. Advanced Aero-Engine Testing, AGARD-59, Publication.

2. 2.MIL–5007E, 'Military Specifications: Engine, Aircraft, Turbo Jet & Turbofan; General Specification for Advance Aero Engine testing',1973.

3. J P Holman, 'Experimental methods for Engineers ', Tata Mc Graw Hill,7th edition,2007, ISBN-13: 978-0070647763.

4. A S Rangawala, Turbomachinery Dynamics-Design and operations, McGraw–Hill, 2005, ISBN-13: 978-0071453691.

Web links and Video Lectures (e-Resources):

https://web.iitd.ac.in/~pmvs/course_mcl341.php

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.

OPEN ELECTIVE COURSE – 1

VI SEMESTER

INTRODUCTION TO AEROSPACE HISTORY			
Course Code	**OEC21AS651**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

1. Learn the history and chronology of aviation and its development.
2. Understand the basic flight mechanics.
3. Compare the historical developments in aviation.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3	
Elementary Thermodynamics, Introduction to viscous flow, Historical Notes- Reynolds and His Number, Airfoils, Wings and Other Aerodynamic shapes.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Elements of Airplane Performance, Rate of Climb, Range and Endurance- Propeller-driven Airplane and Jet Airplane.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Principles of Stability and Control, History Note: The development of Flight Controls, Jet Propulsion.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

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://www.youtube.com/watch?v=JVJrWgU2Xfs

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.

VI SEMESTER

INTRODUCTION TO HELICOPTERS			
Course Code	**21AS652**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the basic elements, kinematics of helicopter.
2. Remember the equations of motions for helicopter.
3. Gain knowledge on aerodynamics of propeller.

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4	
Aerodynamic Velocity, Inertial Velocity, Wash Velocity, and Gusts, Aerodynamics of Airfoils, Wings, and Fins.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Aerodynamics of Propellers, Propeller Analysis, Introduction to Aeroelastic Rotor Models, Rotor Downwash Modelling, Aerodynamic Interference, Engines Drive Trains, Controls, Landing Gear, Trimming.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

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

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.

VI SEMESTER

INDIAN AVIATION			
Course Code	**21AS653**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the Indian Aviation Sector.
2. Enumerate the Aviation policies and procedure.
3. Identify the areas of Aviation for improvement.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4	
Liberalization, Liberalization, Foreign Direct Investment- Low Cost Carriers, Greenfield airports, post 1991 growth in the aviation sector.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
The failing state of the aviation sector, Taxation, Infrastructure, The Dollar to Rupee situation, Discussion on case studies.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:
After studying this course, students 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

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

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.

VI SEMESTER

AIRLINE AND AIRPORT MANAGEMENT			
Course Code	**21AS654**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the basic airline and airport management principles.
2. Develop the broad skills of management in aviation industry.
3. Understand the statistics of management in aviation sector.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

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

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.

VI Semester

FLIGHT MODELLING, ANALYSIS AND SIMULATION LAB			
Course Code	**21ASL66**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	03	SEE Marks	50
Credits	01	Exam Hours	3

Course objectives: This course will enable students to

1. Understand the procedure to draw the geometric models of symmetric, cambered aerofoil, nozzle, wing and other structures.
2. Acquire the knowledge of types of meshing.
3. Understand the basics of flow and stress analysis.

Sl. NO	Experiments
1	Modeling of 2-D Incompressible and Inviscid Flow over Symmetrical/Cambered Airfoil, and Plotting of Pressure distribution and Velocity vectors for Subsonic/Supersonic Mach numbers.
2	Modeling of 2-D Compressible and Viscid Flow over Symmetrical/Cambered Airfoil, and Plotting of Pressure distribution and Velocity vectors for Subsonic Mach numbers.
3	Isentropic Flow Analysis in a 2-D Subsonic Diffuser and a Subsonic Nozzle.
4	Isentropic Flow Analysis in a 2-D Supersonic Diffuser and a Supersonic Nozzle.
5	Geometric Modeling and Mesh Generation of a 2-D Pipe and Modeling of Steady/Unsteady Heat Convection and Conduction (Rayleigh Flow).
6	Structural Modeling of Sandwich Beam of Rectangular Cross-section and Analyses for Stress for Unsymmetrical bending case.
7	Structural Modeling and Stress Analysis of a Fuselage Frame.
8	A Plate fixed at one end has a hole in centre and has varying thickness, determine stresses developed due to applied static loads in vertical direction.
9	Simulate a spring- mass- damper system with and without a forcing function though SIMULINK
10	Simulate a bomb drop from an aircraft on a moving tank in pure pursuit motion
11	Develop a straight and level flight simulation program using MATLAB
12	Simulate aircraft Take-off and Landing with trajectory tracing

Course outcomes:

After studying the course, the students will be able to

1. Draw the geometric models of symmetric, cambered aerofoil, nozzle, wing and other structures.
2. Apply different types of meshing.
3. Perform the flow and stress analysis

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each 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. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by 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 internal /external 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% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

https://www.youtube.com/watch?v=LzQPJRt00Ng

VII SEMESTER

CONJUGATE HEAT TRANSFER (CHT)			
Course Code	**21AS71**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand what is conjugate heat transfer and its significance.
2. Remember the basics principles of conjugate heat transfer phenomenon.
3. Acquire the knowledge of solving the conjugate heat transfer problem.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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, Conjugate problem, Body domain, fluid domain, initial, boundary and conjugate conditions, Heat Transfer by Solids and Fluids, Conjugate Heat Transfer Applications.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Fourier's law, Conduction processes, Thermal resistance, Fins, Heat equation and lumped capacitance, Effective Heat Transfer.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

Incompressible fluid flow, Subsonic analysis, multiphase fluid flow analysis, static and dynamic heat transfer, Fluid and Solid Interactions, Natural Convection, Forced Convection.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4	
Radiative Heat Transfer, Elementary convection, including laminar and turbulent boundary layers, Thermal radiation, including Stefan-Boltzmann law, Basic concepts of heat exchanger.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Construction of a general solution of Heat Conduction Equation, Factors of conjugation, Solution of characteristic Problem – Harmonic Law of Oscillation, Universal Algorithm of computation of the factor of conjugation, Nucleate boiling, Dropwise condensation, Turbulent Heat Transfer.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. Apply the basics principles of conjugate heat transfer phenomenon.
2. Analyse conjugate heat transfer problems.
3. Implement the knowledge of solving the conjugate heat transfer problem.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Numerical Heat Transfer and Fluid Flow by Suhas V Patankar, CRC Press.

2. Computational Fluid Mechanics and Heat Transfer by Dale Anderson, Richard H. Pletcher, John C. Tannehill, Ramakanth Munipalli, Vijaya Shankar.

Reference Books

1. Fundamentals of Engineering Numerical Analysis by Parviz Moin.

2. Computational Heat Transfer by Yogesh Jaluria and Kenneth E Torrance.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/112103297

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.

VII Semester

Global Navigation Satellite Systems			
Course Code	**PCC21AS72**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	02	Exam Hours	3

Course Objectives:
This course will enable students to

1. Understand the basic of GPS.
2. Comprehend the GPS Signals, orbits and errors.
3. Acquire the knowledge on IRNSS.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

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

Module-1

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:
After studying this course, students will be able to:

1. Describe about the GPS and its signals.
2. Classify the types of satellite constellation.
3. Identify the orbits, position and errors.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. G S RAO, **Global Navigation Satellite Systems,** McGraw-Hill, New Delhi, 2010.

2. Rajat Acharya, **Understanding Satellite Navigation,** Academic Press, 2014.

Reference Books

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

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

Web links and Video Lectures (e-Resources):

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.

PROFESSIONAL ELECTIVE COURSE -II

VII SEMESTER

WIND TUNNEL TECHNIQUES			
Course Code	**21AS731**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

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

2. Pope. A and Goin. L, "High Speed Wind Tunnel Testing", John Wiley, 1985.

Reference Books

1. E. Radhakrishnan, Instrumentation, Measurements, and Experiments in Fluids, CRC Press, 2007.

2. Bradsaw "Experimental Fluid Mechanics", Pergamon Press, 2nd Revised edition,1970, ISBN-13: 978-0080069814.

3. Short term course on Flow visualization techniques, NAL, 2009.

4. Lecture course on Advanced Flow diagnostic techniques, NAL.

5. NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998.

Web links and Video Lectures (e-Resources):

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

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

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.

VII Semester

CRYOGENICS			
Course Code	**21AS732**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand the basic of cryogenic engineering.
2. Understand the cryogenic properties and insulation.
3. Acquire the knowledge on storage of cryogenic liquids and equipment's.

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3	
Cryogenic Insulation: Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Storage and Instrumentation of Cryogenic liquids: Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenicenvironment; Cryostats.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Cryogenic Equipment: Cryogenic heat exchangers - recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryopumping; Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

4. T.M. Flynn, Marcel Dekker., Cryogenic Engineering, CRC Press,2nd edition, 2004, ISBN-13: 978-8126504985.

5. Bose and P. Sengupta, "Cryogenics: Applications and Progress", Tata McGraw Hill.

Reference Books

1. J.G. Weisend II, Taylor and Francis , "Handbook of Cryogenic Engineering", CRC Press,1st edition,1998,ISBN-13: 978-1560323327.

2. R. Barron, "Cryogenic Systems", Oxford University Press.

3. K.D. Timmerhaus and T.M. Flynn, "Cryogenic Process Engineering", Plenum Press,1st edition,2013, ISBN-13: 978-1468487589.

4. G.G. Haselden, "Cryogenic Fundamentals", Academic Press.

5. C.A. Bailey, "Advanced Cryogenics", Springer,1971, ISBN-13: 978-0306304583.

6. R.W. Vance and W.M. Duke, "Applied Cryogenic Engineering", John Wiley & sons,1962, ISBN-13: 978-0471902706.

Web links and Video Lectures (e-Resources):

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.

VII Semester

FLIGHT TESTING			
Course Code	**21AS733**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:
This course will enable students to

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

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

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

Module-1

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

Flight test instrumentation: Planning flight test instrumentation, Measurement of flight parameters. Onboard and ground based data acquisition system. Radio telemetry.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3	
Stability and control - longitudinal and manoeuvring Static & dynamic longitudinal stability: - methods of flight testing and data reduction techniques. Stick free stability methods. Manoeuvring stability methods & data reduction.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Stability and control - lateral and directional Lateral and directional static & dynamic stability: - Coupling between rolling and yawing moments. Steady heading slide slip. Definition of Roll stability. Adverse yaw effects. Aileron reversal. Regulations, test techniques and method of data reduction.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Flying qualities: MIL and FAR regulations. Cooper-Harper scale. Pilot Rating. Flight test procedures. **Hazardous flight testing:** Stall and spin- regulations, test and recovery techniques. Test techniques for flutter, vibration and buffeting.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Course outcome: After studying this course, students will be able to: 1. Measure the flight parameters. 2. Estimate the performance of flight. 3. Apply the FAR regulations.	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

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

Reference Books

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

Web links and Video Lectures (e-Resources):

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

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

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.

VII SEMESTER

CONTROL ENGINEERING			
Course Code	21AS734	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

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

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction to Control Systems and Mathematical Models

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

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Block Diagrams and Signal Flow Graphs

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

Transient and Steady State Response Analysis

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

<table>
<tr><th colspan="2">Module-3</th></tr>
<tr><td colspan="2">System stability analysis using Routh’s – Hurwitz Criterion.

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

Frequency Response Analysis Using Bode Plots:
Bode attenuation diagrams for first and second order systems, Simplified Bode diagrams, Stability analysis using Bode plots and determination of phase margin and gain margin and gain.</td></tr>
<tr><td>Teaching-Learning Process</td><td>1. Teaching in classroom through Chalk, Talk and ICT.
2. Assignment of Home/field work on real-life problem.</td></tr>
<tr><th colspan="2">Module-4</th></tr>
<tr><td colspan="2">Frequency Response Specification and Analysis using Polar plots:
Specification: Frequency response definition, frequency response specifications and its relationship with time response specifications.

Analysis: Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles.</td></tr>
<tr><td>Teaching-Learning Process</td><td>1. Teaching in classroom through Chalk, Talk and ICT.
2. Assignment of Home/field work on real-life problem.</td></tr>
<tr><th colspan="2">Module-5</th></tr>
<tr><td colspan="2">Feedback control systems:
Types of controllers – Proportional, Integral, Derivative controllers, Proportional – Integral, Proportional – Integral – Derivative controllers; Compensation methods – Series and feedback compensation, Lead, Lag and Lead-Lag Compensators.

State Variable Characteristics of Linear Systems:
Introduction to concepts of states and state variable representation of linear systems, Advantages and Disadvantages over conventional transfer function representation, state equations of linear continuous data system. Matrix representation of state equations, Solution of state equation, State transition matrix and its properties, controllability and observability, Kalman and Gilberts test.</td></tr>
<tr><td>Teaching-Learning Process</td><td>1. Teaching in classroom through Chalk, Talk and ICT.
2. Assignment of Home/field work on real-life problem.</td></tr>
</table>

Course outcome:

After studying this course, students will be able to:

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4^{th} week of the semester
5. Second assignment at the end of 9^{th} week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13^{th} week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

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

Reference Books

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

Web links and Video Lectures (e-Resources):

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

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.

VII SEMESTER

AI AND ML FOR AEROSPACE APPLICATIONS			
Course Code	**21AS735**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3	
Data Acquisition, Data Quality and Transformation, Handling Text Data, Principles of Big Data, Data Visualization, Sampling and Estimation, Inferential Statistics	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Linear Regression, Multiple Linear Regression, Non-Linear Regression, Forecasting models, Foundations for ML, Clustering, Naïve Bayes Classifier, K-Nearest Neighbors, Support Vector Machines, Support Vector Machines.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Foundations for AI, **AI:** Application areas, AI Basics (Divide and Conquer, Greedy, Branch and Bound, Gradient Descent), NN basics (Perceptron and MLP, FFN, Backpropagation), Convolution Neural Networks, Recurrent Neural Networks, Deep Learning.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Course outcome: After studying this course, students will be able to: 1. Apply the basics of Artificial Intelligence and Machine Learning 2. Use the knowledge of the foundations of AL and AL 3. Implement the information on its different algorithms and their applications in Aerospace Engineering.	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

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

Reference Books

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

Web links and Video Lectures (e-Resources):

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

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

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.

PROFESSIONAL ELECTIVE COURSE - III

VII Semester

SPACE MECHANICS			
Course Code	**21AS741**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand the basic concepts of space mechanics and the general N-body.
2. Study satellite injection and satellite orbit perturbations.
3. Acquire the knowledge of interplanetary and ballistic missile trajectories.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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 life time.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
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.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, the students 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

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. VandeKamP 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://nptel.ac.in/courses/101105083

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.

VII Semester

SPACE VEHICLE DESIGN			
Course Code	**21AS742**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand space mission analysis and design process
2. Acquire the knowledge of spacecraft configuration and structural design
3. Comprehend the importance of space craft attitude control and instrumentation.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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 Launch Vehicle: Launch Vehicles Available Launch Vehicle Capabilities Deciding which Launch Vehicle to Use Characteristics of Spacecraft Necessary to Choose a Launch Vehicle Structures. Primary Structural Design Other Functional Divisions Mechanisms Used by the Other Subsystem. Materials for Constructing Spacecraft Manufacturing Techniques Applicable to the Structure.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Propulsion: Rocket Propulsion Fundamentals, Ascent Flight Mechanics, Launch Vehicle selection, Entry flight Mechanics, Entry heating, entry vehicle design, Aero assisted orbit transfer.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

Introduction to Launch Vehicle structures: Loads on the vehicle structures, Stages, Motor case, Base shroud, Inter stages, Heat shield, Equipment Bay and their functions Modelling and Analysis Structures. Loads and Stresses Thin-Walled Pressure Vessels Buckling of Beams Thin-Wall Assumption. Finite Element Analysis.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

Vehicle Dynamics: Mode shape and frequencies of launch vehicles, Vibrations. Flexible Body Dynamics of Liquid propellant in Moving containers Sloshing, POGO Orbital Vibration Mitigation Vibrations Aero elastic phenomenon of launch vehicles.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

Technologies and Examples: Available Technologies, Available Launch Vehicles, New Technologies. Magnetically Inflated Cable System Flying Effector Nano tubing Example, Load and Deflection Nodal Analysis Example, Material Selection Analysis Example, Strained Example, Reaction Wheel Example, Space Shuttle Landing Example, Vibrations Example.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, the students will be able to:

1. Carry out space mission analysis and design process
2. Explain a spacecraft configuration.
3. Apply the concepts of space craft attitude control and instrumentation.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. M.D. Griffin, J.R. French, "Space Vehicle Design", AIAA Series, 1991.
2. P. Fortescue, J. stark, and G. Swinerd, " Spacecraft Systems Engineering" Wiley-Blackwell,4th revised edition,2011, ISBN-13: 978-0470750124.

Reference Books

1. W.J. Larson and J. R. Wertz., "Space Mission Analysis and design", Springer,2nd edition,1992,ISBN-13: 978-9401051927.
2. M.J.L. Turner, "Rocket and Spacecraft Propulsion" (Principles, Practice and New Developments), Springer,3rd edition,2009,ISBN-13: 978-3642088698.

Web links and Video Lectures (e-Resources):

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.

VII Semester

SATELLITE COMMUNICATION			
Course Code	**21AS743**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand the elements of satellite communication.
2. Understand the Different modulation and Multiplexing Schemes.
3. Acquire the knowledge of Satellite Telemetry, Tracking and Telecommand.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. Apply of 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

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):

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.

VII Semester

GUIDANCE, NAVIGATION & CONTROL			
Course Code	**21AS744**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Comprehend the basic concepts of navigation, guidance and control.
2. Acquire the knowledge of radar systems and other guidance systems.
3. Understand the missile guidance and control system.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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: Concepts of navigation, guidance and control. Introduction to basic principles. Air data information.

Radar Systems: Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector. Limitation of MTI performance. MTI from a moving platform (AMTI).

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Tracking with Radar: Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT).

Other Guidance Systems: Gyros and stabilized platforms. Inertial guidance and Laser based guidance. Components of Inertial Navigation System. Imaging Infrared guidance. Satellite navigation. GPS.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3	
Transfer Functions: Input-output Transfer function. Basic altitude reference. Concepts of Open loop and Close Loop. **Missile Control System:** Guided missile concept. Roll stabilization. Control of aerodynamic missile. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Missile Guidance: Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-5	
Integrated Flight/Fire Control System: Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. Rate of change of Euler angle, Auto Pilot.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:
After studying this course, students will be able to:

1. Apply the basic concepts of navigation, guidance and control.
2. Compare the different types of missile guidance system performance.
3. Integrate the flight and fire control 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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. P.T. Kabamba and A.R. Girard, Fundamentals of Aerospace Navigation and Guidance, Cambridge Aerospace Series, 2014.

2. John H Blakelock, ` Automatic control of Aircraft & Missiles`, Wile –Inter Science Publication, 2nd edition, May 1990.

Reference Books

1. R.B. Under down & Tony Palmer, `Navigation`, Black Well Publishing; 2001.

2. Merrilh I. Skolnik, ` Introduction to Radar Systems`, 3rd edition, Tata Mc Graw Hill, 2001.

3. George M. Siouris, Missile Guidance and Control Systems, Springer, 2004.

Web links and Video Lectures (e-Resources):

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.

VII Semester

SATELLITE DESIGN AND SYSTEMS			
Course Code	**21AS745**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand about the space environment and spacecraft.
2. Know the attitude sensors and actuators.
3. Understand the TT&C system.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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: 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

Power sources: Power sources, Energy storage, Solar panels, Deployable solar panels, Spacecraft Power management, Power distribution, Deep Space Probes.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

Coordinate System: Coordinate system, AOCS requirements, Environment effects, Attitude stabilization, Attitude sensors, Actuators, Design of control algorithms.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-4

Temperature and Requirements: 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.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. Identify the satellite constellations.
2. Analyse the power requirement for a spacecraft
3. Select a suitable material for designing a spacecraft.

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**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.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Fortescue, Peter, 'Spacecraft Systems Engineering' John Wiley England,4th edition,2011, ISBN-13: 978-0470750124.

2. Patel, Mukund R, 'Spacecraft Power Systems', CRC Press Boca Raton,2nd edition, 2005.

Reference Books

1. Wilbur L. Pritchard and Joseph A. Sciulli, Satellite Communication Systems Engineering, Pearson Education India,2nd edition,2003, ISBN-13: 978-8131702420.

2. Marcel J. Sidi, "Spacecraft Dynamics and control, A Practical Engineering Approach", Cambridge University Press, Reprint edition,2000, ISBN-13: 978-0521787802.

Web links and Video Lectures (e-Resources):

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.

Open Elective II

EARTH AND SPACE SCIENCE			
Course Code	**21AS751**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand the basics of Earth Science
2. Acquire the knowledge of Space Science
3. Connect the concepts of Earth and Space Science for aeronautical/Aerospace Engineering

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

A brief History of discovery, Exploration of Solar System, The Sun and the Beyond, Remote Sensing of The Earth's Climate System, Remote Sensing Methodology, Measurement by remote sensing, Atmospheric factors, Instrumental factors, Using Reflected Sunlight, Using Thermal Emission, Using Radar	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Planetary Science, Terrestrial Planets, Outer Planets, Comets, Asteroids, Magnetosphere, Missions, Space Plasma Physics	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.
Module-5	
Space Weather, Solar Activity, The Solar Wind, Aurora, Solar flares, The Ionosphere, Coronal Mass Ejections and Geomagnetic Storms, The Physics of the Sun, X-Ray Astronomy	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

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

Reference Books

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

Web links and Video Lectures (e-Resources):

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

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

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.

AVIATION AND INTERNET INFRASTRUCTURE			
Course Code	**21AS752**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

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

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3

IoT and Service Oriented Infrastructure for Flight 4.0, Big Data and Data Analytics in Aviation, Ontologies in Aeronautics, TCP/IP, In-Flight Wi-Fi	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Advances in Software Engineering and Aeronautics, Autonomy and Safety of Unmanned Aircraft Systems	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.
Module-5	
Aerospace Engineering Curricular Expansion in Information Systems, Networking, Webservices, Cloud Computing	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

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

Reference Books

1. Aircraft Technology by Melih Cemal Kushan

Web links and Video Lectures (e-Resources):

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

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

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.

AIR TRAFFIC AND WEATHER			
Course Code	**21AS753**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Understand the Air Traffic Control
2. Acquire Knowledge on the weather condition for flight traffic
3. Remember the symbols of ATC for different weather conditions

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-2

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

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.

Module-3	
Problems- Traffic, Weather, Congestion, Air traffic flow management, Airport capacity, Traffic Management Overview Basic Traffic Management Techniques and Terms Ground Delay Programs (GDP) Time-based Flow Management (TBFM) Traffic Management Advisor (TMA) Airspace Flow Programs (AFP) Ground Stops (GS) Adaptive Compression (AC) Integrated Collaborative Rerouting (ICR) Delay Tier Information Operational Information System (OIS)	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
Weather Tools De-icing/Anti-icing Severe Weather Avoidance Plan (SWAP) Routes Preferred Routes Coded Departure Routes (CDR) National Playbook Flow Evaluation Area (FEA)/Flow Constrained Area (FCA), **Global air-traffic management**	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.
Module-5	
Callsigns, Technology, Air Naviation Service providers and Air traffic service providers, Privatization ATC regulations Weather Conditions Worldwide, METAR, Cloud reporting Abbreviation	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. Mastering the Systems: Air Traffic Control and Weather by Richard L. Collins

2. Aviation Weather for Pilots and Flight Operation Personnel Gordon Press Publishers

Reference Books

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

Web links and Video Lectures (e-Resources):

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

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

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.

INDUSTRIAL AERODYNAMICS			
Course Code	21AS754	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Familiarize non-aeronautical uses of aerodynamics in road vehicles, buildings and problems of flow induced vibrations.
2. Understand methods for constructing various tall structures.
3. Understand the effect of wind on different structures

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher 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	
ATMOSPHERE: Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows. Case Study – Measurement of basic wind parameters in open atmospheric condition	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.
Module-2	
WIND ENERGY COLLECTORS Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.
Module-3	
VEHICLE AERODYNAMICS Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
BUILDING AERODYNAMICS Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics. Case Study – Experimental analysis of high rise buildings	

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.

Module-5

FLOW INDUCED VIBRATIONS

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.

Course outcome:

After studying this course, students will be able to:

1. To familiarize the learner with atmosphere and its effect on the structures.
2. To explore the aerodynamics of different structures
3. To estimate the performance of the vehicle at different speeds

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and road vehicles", Plenum press, New York, 1978.
2. N.G. Calvent, "Wind Power Principles", Charles Griffin & Co., London, 1979.

Reference Books

1. P. Sachs, "Winds forces in engineering", Pergamon Press, 1978.
2. R.D. Blevins, "Flow induced vibrations", Van Nostrand, 1990

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc22_ae09/preview
https://www.youtube.com/watch?v=z3QJT0CfJLw

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.

BASICS OF FLIGHT SIMULATION			
Course Code	21AS755	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	04	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course will enable students to

1. Understand the basic principle of working of flight components
2. Remember the names of components and their functions
3. Think to simulate a flight

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

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

Module-1	
Historical Perspectives, The case for simulation, Engineering Flight Simulation, The changing role of simulation,	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.
Module-2	
The organisation of flight simulator, Equation of Motion, Aerodynamic model, Engine Model, Engine model, data acquisition model, Gear Model , weather model, Visual System, Sound System, Motion System, Controls, Instrument Display, Navigation Systems, Maintenance	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Practising the foundational knowledge.
Module-3	
Principles of Flight Modeling , Newtonian Mechanics, Differential Equations, Numerical Integration, Real-time computing, Flight Data	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.
Module-4	
The atmosphere, forces, moments, Axes System, Quaternions, Equations of Motions, propulsion-Piston Engine, Jet Engine, the landing gear	
Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT. 2. Assignment of Home/field work on real-life problem.

Module-5	
Simulation of flight control systems, the Laplace transform, PID control systems, Trimming, Aircraft Displays, Attitude Indicator, Altimeter, Airspeed Indicator, compass card, Automatic Direction Finding(ADF), VHF omnidirectional Range(VOR), Distance Measuring Equipment(DME),Instrrument Landing Systems(ILS), GPS, Inertial Naviation System	
Teaching-Learning Process	**1.** Teaching in classroom through Chalk, Talk and ICT. **2.** Assignment of Home/field work on real-life problem.
Course outcome: After studying this course, students will be able to: 1. Apply the basic principle of working of flight components 2. Practise the names of components and their functions 3. Simulate a flight	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /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 subject (**duration 03 hours)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

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

Reference Books

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

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=QL4q_Tbv0jM

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.