Semester- I

Applied Mathematics			
Course Code	MAE101	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03 Hrs

Course Learning objectives:

- Apply principles of vector operations to engineering problems
- Solve close form solutions
- Apply finite difference approximate to solve elliptic, hyperbolic and parabolic form of equations

Module-1 (8 Hours)

Review of Fourier series and Applications, Review of Laplace Transforms and Applications. Classification of second order linear partial differential equations, Canonical forms for hyperbolic, parabolic and elliptic equations, Homogeneous and Non-Homogeneous equations with constant coefficients. Applications

Module-2 (8 Hours)

Vector Functions, General rules for differentiation, Velocity and Acceleration, Gradient of a scalar field, Directional Derivative, Properties of Gradient, Divergence of vector point function, Curl of a vector point function, Properties of Divergence and Curl. Applications Integration of vector functions, Line integral, Circulation, Work done by a force, Surface integrals, Volume integrals, Divergence Theorem of Gauss, Green's Theorem in the plane, Stoke's Theorem, problems on all the three theorems and Applications

Module-3(8 Hours)

Review of Complex analysis, Complex analysis applied to potential theory, Electrostatic fields, conformal mapping, Heat problems, Fluid flow, General properties of Harmonic functions, Complex Integration, Cauchy's Theorem, Cauchy's Integral Formula, Cauchy's Integral Formula for Derivatives, Taylor's and Laurent's series. Applications. Singular point, Residue, Method of finding Resides, Residue Theorem, Contour Integration, Integration round the unit circle, Rectangular contour. Applications.

Module-4 (8 Hours)

Numerical Solutions algebraic and transcendental equations: False position method, Newton – Raphson method, Iteration method, Aitken's method, Solution of linear simultaneous equations. Gauss elimination method, Inverse of a matrix , Gauss-Seidal method, Crout's method. Solution of Ordinary Differential Equations: Taylor's Series method, Picard's method, Euler's method, Euler's Mo dified method, Runge-Kutta 4^{th} order method. Predictor and corrector method (Milen's and Adams-Bashfourth) Applications.

Module-5(8 Hours)

Finite differences, Interpolation, Newton's Forward & Backward Interpolation formulae, Lagrange's formula, Newton's Divided difference, Central difference formulae (all formulae with proof). Numerical Differentiation, Numerical Integration (all rules with proof).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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25Marks**or**oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Advanced Engineering Mathematics, Erwin Kreyszing, John Wiley &Sons (Asia) Pvt. Ltd, 9th edition & 2011.
2. Advanced Engineering Mathematics, H K Dass, S Chand and Company Ltd, 12th edition &2006

Reference books:

1. Engineering Mathematics, Bali and Iyengar, Laxmi Publications (P) Ltd, 6thedition &2005
2. Advanced Engineering, C. Ray Wylie and Louis C Barret, Mathematics Tata McGraw Hill Publishing Co. Ltd., 6th edition.
3. Advanced Engineering Mathematics, Michael D Greenberg, Pearsons India Ltd, 2nd edition&2002.
4. Higher Engineering Mathematics, B S Grewal, khanna publisher, 12th edition. Text Books:

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=KCS-VTm398I&list=PLhSp9OSVmeyLke5_cby8i8ZhK8FHpw3qs
- https://www.youtube.com/watch?v=0vdrqijpwoM
- https://www.youtube.com/watch?v=YThPIdcwr78
- https://nitkkr.ac.in/docs/15-%20Solutions%20of%20Algebric%20and%20Transcendental%20Equations.pdf
- https://www.youtube.com/watch?v=i38MSuBRZaE

Skill Development Activities Suggested

- Solve an ODE using MATLAB/SCILAB

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply principles of vector operations to engineering problems	L1,L2
CO2	Solve close form solutions	L3,L4
CO3	Apply finite difference approximate to solve elliptic, hyperbolic and parabolic form of equations	L1,L2

Program Outcome of this course

Sl. No.	Description	POs
01	An ability to independently carry out research /investigation and development work to solve practical problems.	P01
02	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
03	Acquire technical competence, comprehensive knowledge and understanding the methodologies and technologies associated with Aerospace Engineering. Apply knowledge to identify, formulate and analyse complex engineering problems	PO4
04	Having an ability to apply knowledge of science, mathematics, engineering & technology for development of Aerospace Propulsion technologies.	PO5
05	Acquire the skills for uses of contemporary techniques, resources and modern engineering and IT tools	PO6
06	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	PO7

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**	**-**	**1**	**1**	**2**	**1**	**1**	**-**
CO2	**1**	**-**	**1**	**2**	**2**	**1**	**1**	**-**
CO3	**2**	**-**	**2**	**3**	**3**	**2**	**3**	**-**

Semester - 1

Numerical Methods for Aerospace Engineering			
Course Code	MAE102	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:00	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

1. Understand Finite Element Method (FEM)
2. Acquire the knowledge on two and three dimensional finite element analysis
3. Gain knowledge on Analysis software in aero structure analysis of beams and trusses.
4. Acquire foundations of MAT Lab for simulation

MODULE-1 (10 Hours)

Introduction to Finite Element Method:
Basics of Finite Element Method (FEM): Fundamental concepts: Introduction to Elasticity discretization, and element types. **Boundary conditions:** Homogeneous and non-homogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Convergence criteria, Discretisation process, Numerical Integration: One Dimensional Two and Three Dimensional, Static Structural Analysis: Performing and interpreting basic static structural analysis using Ansys Workbench

MODULE-2 ((8 Hours)

Advanced Structural Analysis: Dynamic Analysis: Modal analysis, harmonic analysis, and transient dynamic analysis, stress analysis of trusses, beam and airframe structures, Finite Element Analysis of Thin Plate, Finite Element Analysis of Thick Plate

MODULE-3 (8 Hours)

Optimization and Nonlinear Analysis: Optimization Techniques: Parameter optimization and response surface analysis. Nonlinear Analysis: Large deformation, material nonlinearity
Advanced Fluid Flow And Heat Transfer Analysis: Steady state heat transfer, Basic differential equation for fluid flow in pipes and fluid flow problems.

MODULE-4 (8 Hours)

Numerical Methods in MATLAB: Numerical Solutions of Equations: Root-finding methods, numerical integration, and differentiation. Solving ODEs and PDEs: Implementing numerical solutions for ordinary and partial differential equations. Data Analysis and Visualization: Techniques for data processing, curve fitting, and visualization in MATLAB.

MODULE 5 (6 Hours)

Dynamic Systems Simulation using MATLAB and Simulink: Introduction to Simulink: Building and simulating dynamic models in Simulink. Control Systems Design: Designing and analyzing control systems using Simulink. Case Studies: Simulation of aerospace systems such as flight dynamics and propulsion systems.

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

Sl.NO	Experiments
	Experiments using Finite Element Method (FEM) in Ansys Workbench
1	Experiment 1: Static Structural Analysis of a Cantilever Beam: Objective: Analyze the stress distribution and deformation of a cantilever beam subjected to a point load at its free end.
2	Experiment 2: Modal Analysis of an Aircraft Wing Section Objective: Determine the natural frequencies and mode shapes of an aircraft wing section.
3	Experiment 3: Thermal Analysis of a Turbine Blade Objective: Analyze the temperature distribution in a turbine blade under steady-state thermal conditions.
4	Experiment 4: Buckling Analysis of a Thin-Walled Cylinder Objective: Evaluate the critical buckling load of a thin-walled cylindrical structure under axial compression.
5	Experiment 5: Transient Thermal Analysis of a Rocket Nozzle Objective:Analyze the transient thermal response of a rocket nozzle during the launch phase.
6	Experiment 6: Nonlinear Structural Analysis of a Composite Plate Objective: Investigate the large deformation behavior of a composite plate under uniform pressure.
7	Experiment 7: Harmonic Analysis of a Jet Engine Turbine Disk Objective: Determine the response of a jet engine turbine disk to harmonic loading conditions.
	Experiments using MATLAB and Simulink
8	Experiment 8: Numerical Integration and Differentiation Using MATLAB Objective: Implement numerical methods for integration and differentiation using MATLAB.
9	Experiment 9: Solving Ordinary Differential Equations (ODEs) Using MATLAB Objective: Solve ODEs related to aerospace engineering problems, such as projectile motion or damping in oscillatory systems.
10	Experiment 10: Dynamic System Simulation Using Simulink Objective: Model and simulate a dynamic aerospace system, such as an aircraft flight control system, using Simulink.

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **25 Marks**
2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for **10 marks**. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test at the end /after completion of all the experimentsshallbe conducted for **50 marks** and scaled down to **05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

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

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. 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.
4. The students have to answer 5 full questions, selecting one full question from each module.

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

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

Suggested Learning Resources:

Text books:

1. "Finite Element Procedures" by Klaus-Jürgen Bathe, Prentice Hall, ISBN: 978-0133014587.
2. "MATLAB for Engineers" by Holly Moore, Pearson, ISBN: 978-0134589645.

Reference books:

1. "The Finite Element Method: Its Basis and Fundamentals" by O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu, Butterworth-Heinemann.
2. "Introduction to MATLAB for Engineers" by William J. Palm III, McGraw-Hill Education.
3. "Engineering Analysis with ANSYS Workbench 18" by Saeed Moaveni, Pearson.
4. "The Finite Element Method In Engineering" by Singiresu S.Rao Sixth Edition., Elsevier, ISBN: 978-012811768-2

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=h7dhDe-fZeg
2. **https://www.youtube.com/watch?v=xoEhbJXCBEU&list=PLxeI6KO3PAQ_3xQzNdy5I9kIwdwKlNWNQ**
3. **https://youtu.be/-EYL9BPIZI4**

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

- Writing a small program to solve Truss and beam problem
- Take an open source FEA Software, Compile and generate an executive Problem
- 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.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply FEA the one, two and three dimensional problems.	L1,L2
CO2	Simulate the real life problems of aero structure analysis using FEM.	L3,L4
CO3	Distinguish the use of different commercial FEM softwares for static and dynamic problems.	L1,L3,L4
CO4	Understand and apply simulation software using MAT Lab	L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Acquire technical competence, comprehensive knowledge and understanding the methodologies and technologies associated with Aerospace Engineering. Apply knowledge to identify, formulate and analyse complex engineering problems	PO4
5	Having an ability to apply knowledge of science, mathematics, engineering & technology for development of Aerospace Propulsion technologies.	PO5
6	Acquire the skills for uses of contemporary techniques, resources and modern engineering and IT tools	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**2**	**1**	**2**	**2**	**2**	**2**	**-**	**-**
CO2	**2**	**2**	**3**	**2**	**3**	**2**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**3**	**3**	**-**	**-**
CO4	**2**	**1**	**2**	**2**	**1**	**2**	**-**	**-**

Semester- I

Aerospace Propulsion			
Course Code	MAE103	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:01	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03 Hrs

Course Learning objectives:

- Identify the various types of gas turbine engines.
- Distinguish between different types of rocket engines and aircraft engines.
- Carry out engine performance analysis and health monitoring.

Module-1 (8 Hours)

Introduction to Gas Turbine Engines: Atmospheric Properties. Turbojet, Turbofan, Turboprop, Turbo-shaft Engine Construction and Nomenclature, theory and performance, introduction to compressors, turbines, combustors and after burners for aircraft engines.

Module-2 (8 Hours)

Fuel and Fuel Systems for Gas Turbine Engines: Fuel specification, fuel properties, liquid fuel handling and treatment, heavy fuels, fuel gas handling and treatment, equipment for removal of particulate and liquids from fuel gas systems, fuel heating, cleaning of turbine components, fuel economics, operating experience, heat tracing of piping systems. Types of heat tracing systems, storage of liquids.

Module-3 (8 Hours)

Engine Air Frame Integration: Engine Performance theory, Propeller theory – pusher and tractor mode. Thrust vectoring nozzles.

Introduction to Rocket Propulsion and Space Mission: Classification and fundamentals. Fuels and propellants. Rocket combustion processes. Introduction to Space mission. Fuel cells for space mission.

Module-4 (8 Hours)

Solid Propellant Rocket Description: Performance Estimation, Flame spread and Ignition transient. Mechanical characterization of propellants. Grain design. Burn rate estimation.

Liquid Propellant Rocket Description: Performance estimation. Injectors. Cooling systems. Combustion instabilities.

Hybrid Propellant Rocket Description: Performance estimation, Mission requirements and Power plant selection. Cryogenic engines. Ramjet and Scramjet engines, introduction to Electric propulsion.

Module-5 (8 Hours)

Engine Performance and Health Monitoring: Performance and Matching of modules of gas turbines-turbomachine aerothermodynamics, aerothermal equations, efficiencies, dimensional analysis, compressor performance characteristic, turbine performance characteristics, Engine health monitoring 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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text books:

1. Aerospace Propulsion, Dennis G Shepherd, AmericanElsovier Publishing Co Inc NY.
2. Rocket Propulsion Elements, George P Sutton and Donald M Ross, John Wiley & Sons NY
3. Gas turbine by V Ganeshan, TMH Publication 2018

Reference books:

1. Aircraft power plants, Michael J Kroes and Thomas W Wild, Macmillan/McGraw Hill NY.
2. Aircraft Gas Turbine Engine Technology, E. Irwin Treager, 3rd Edition, 1995, 'ISBN-002018281
3. Mechanics & Thermodynamics of Propulsion, Hill, P.G. , Peterson, C.R. Addison, Wesley Longman INC, 1999.
4. Design of Liquid Propellant Rocket Engines, Huzel and Houng, NASA SP 125, 1971.
5. Rocket Propulsion, Barrere et al., Elsevier Co., 1960
6. Fundamental Aspects of Solid Propellant Rockets, Williams F A. et al., Agardograph, 116,Technivision, 1970.
7. Gas turbine engineering handbook, Meherwan P. Boyce, Gulf professional publisher, Elsevier, 2006

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/101/106/101106033/
- https://archive.nptel.ac.in/courses/101/106/101106033/
- https://archive.nptel.ac.in/courses/101/104/101104018/
- https://www.digimat.in/nptel/courses/video/101101002/L42.html

Skill Development Activities Suggested

- Making a model of various Aircraft engine integration using available software
- Tutorials
- Group discussions
- Assignment
- Technical Quiz and seminar
- Exploration – gathering knowledge and attaining skills through active investigation.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain construction and operation of various propulsion devices	L1,L2
CO2	Solve problems related to combustion Engine and performance analysis	L3,L4
CO3	Specify space mission propulsion requirements	L1, L2,L3

Program Outcome of this course

Sl. No.	Description	POs
01	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
02	An ability to write and present a substantial technical report/document.	PO2
03	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
04	Acquire technical competence, comprehensive knowledge and understanding the methodologies and technologies associated with Aerospace Engineering. Apply knowledge to identify, formulate and analyse complex engineering problems	PO4
05	Having an ability to apply knowledge of science, mathematics, engineering & technology for development of Aerospace Propulsion technologies.	PO5

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**	**1**	**3**	**3**	**3**	**-**	**-**	**-**
CO2	**2**	**1**	**3**	**2**	**2**	**-**	**-**	**-**
CO3	**3**	**1**	**2**	**1**	**1**	**-**	**-**	**-**

Semester- 1

Aircraft Performance Engineering			
Course Code	MAE104	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03 Hrs

Course Learning objectives:

- Understand the fundamentals of Engine Performance.
- Acquire knowledge on Aircraft Performance
- Acquire knowledge on Aero engine off design performance and analysis

Module-1(8 Hours)

Introduction to Aero Engine Performance Analysis: Fundamentals of Aero Engine Performance: Overview of thermodynamic cycles, efficiency, and performance metrics.Gas Turbine Engines: Analysis of various gas turbine cycles (Brayton cycle, turbojet, turbofan, etc.).Performance Parameters: Specific thrust, specific fuel consumption (SFC), thermal efficiency, and propulsive efficiency.

Module-2(8 Hours)

Component-Level Performance Analysis: Compressor and Turbine Performance: Characteristics, efficiency, and matching of components.Combustion Chamber Analysis: Heat addition, pressure loss, and efficiencyEngine Performance Modeling: Integration of component performance to predict overall engine performance.

Module-3(8 Hours)

Advanced Topics in Aero Engine Performance: Off-Design Performance: Analysis of engine performance at different operating conditions (altitude, speed, etc.).Transient Performance: Engine behavior during start-up, acceleration, and deceleration.Case Studies: Performance analysis of modern aero engines, including afterburning turbojets and high-bypass turbofans.

Module-4(8 Hours)

Aircraft Performance: Fundamentals and Steady-Level Flight: Basics of Aircraft Performance: Forces acting on an aircraft, equations of motion, and energy methods.Steady-Level Flight: Lift-to-drag ratio, minimum drag, and maximum range and endurance.Power Required and Available: Thrust, power curves, and flight envelope.

Module-5(8 Hours)

Aircraft Performance: Maneuvering and High-Speed Flight: Climb Performance: Rate of climb, ceiling, and climb optimization.Takeoff and Landing Performance: Factors affecting takeoff and landing distances, performance under different conditions. High-Speed Flight: Performance analysis in transonic, supersonic, and hypersonic regimes.

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text books:

1. "Mechanics and Thermodynamics of Propulsion" by Philip G. Hill and Carl R. Peterson, Pearson, ISBN: 978-0201146592.
2. "Aircraft Performance & Design" by John D. Anderson Jr., McGraw-Hill Education, ISBN: 978-0070019715.

Reference Books

1. "Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamic Design and Performance of Jet Engines" by Nicholas Cumpsty, Cambridge University Press.
2. "Gas Turbine Theory" by H.I.H. Saravanamuttoo, G.F.C. Rogers, and H. Cohen, Pearson.
3. "Flight Performance of Fixed and Rotary Wing Aircraft" by Antonio Filippone, Butterworth-Heinemann.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/101/104/101104061/
- https://www.digimat.in/nptel/courses/video/101101002/L01.html

Skill Development Activities Suggested

- Research lab visit at NAL/AFTC/GTRE
- Conducting Tutorials classes
- Group discussions on advancement in aircraft performance
- Technical Quiz and Seminars
- Assignments
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the aero engine performance	**L1,L2**
CO2	Apply the knowledge of engine performance in off design aero engines	**L3,L4**
CO3	Understand and apply the aircraft performance	**L4**
CO4	Analyse the Component-Level Performance Analysis	**L5**

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Acquire technical competence, comprehensive knowledge and understanding the methodologies and technologies associated with Aerospace Engineering. Apply knowledge to identify, formulate and analyse complex engineering problems	PO4
5	Having an ability to apply knowledge of science, mathematics, engineering & technology for development of Aerospace Propulsion technologies.	PO5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**	**1**	**2**	**2**	**2**	**-**	**-**	**-**
CO2	**2**	**1**	**1**	**1**	**1**	**-**	**-**	**-**
CO3	**3**	**1**	**2**	**1**	**3**	**-**	**-**	**-**
CO4	**2**	**2**	**3**	**2**	**2**	**-**	**-**	**-**

Semester- 1

AIRFRAME STRUCTURAL ANALYSIS AND MATERIALS			
Course Code	MAE105	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:01	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03 Hrs

Course Learning objectives:

- Understand the mechanical behaviour of different materials
- Acquire the knowledge for structural loads & design consideration.
- Understand the Statically determinate and indeterminate structures
- Gain knowledge on materials & tooling concept
- Realize the various material processing techniques

Module-1 (6 Hours)

Overview of structural design process: Structural integrity. Load, deformation, corrosion and fatigue/long life. Materials and their mechanical properties. Elastic, inelastic, homogenous, non-homogenous, isotropic andanisotropic materials.

Module-2(6 Hours)

Loads and design considerations: Aircraft wheel reactions. Factor of safety. Definitions of stress and strain. Equilibrium and compatibility of displacements. Tensor notation. Constitutive relations in one, two and three dimensional structures.

Module-3(12 Hours)

Statically determinate and indeterminate structures: Strain energy, complementary strain energy, Equations of elasticity; Engineering constants:Young's modulus, Poisson's ratio, Shear modulus, Curved beams. Analysis of rings under diametrical compression and analysis ofarches. Energy methods of structural analysis.

Module-4(8 Hours)

Aircraft Materials: Desirable properties, Metallic materials and alloys, nonmetallic materials & consumables, Composites and Introduction to smartmaterials,
Aircraft Tooling Concepts: Purpose of tools, classification of tools, design, build and proving tools including financial aspects Machining Processes: Theory of metal cutting, Types of machining processes including tool materials, tool geometry and associated economics for each.

Module-5(8 Hours)

Composite Materials and Honeycomb Structures: Manufacturing processes and environmental requirements for manufacturing of composite components, NDT methods and quality control, sandwich structures and adhesive bonding. Heat Treatment Processes: Purpose of heat treatment and theory of heat treatment processes, heat treatment of alloys of aluminum, magnesium, titanium, steel and case hardening.

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Aircraft Structures for Engineering Students - Megson, T.M.G.Edward Arnold, 1995.
2. Aircraft Structure, 2nd edition - D.J. Perry, MC.Graw-Hill.bookcompany, Inc. 1993.
3. Analysis and Design of Flight Vehicle Structures - E.F. BRUHN,Tri state off set company, USA, 1985.
4. Aircraft Production Technology and Management – ChennaKeshu S and Ganapathy K K, Interline Publishing, Bangalore, 1993.

Reference books:

1. Strength of Materials - F.R. Shenley.
2. Strength of Materials - S. Timoshanko, CBS Publishers &Distributors.
3. Theory of Elasticity, 3rd edition - S. Timoshenko and J.N. Goodier.MC.Graw-Hill.book company, 1970.
4. Aircraft Production Technology - Horne, DF., Cambridge university press, Cambridge, London, 1986.

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc24_ae11/preview

Skill Development Activities Suggested

- To understand the different coatings, coating processes and Testing of different component of gas turbine in the material testing lab to understand their failure analysis due to corrosion as skill activity.
- Conducting Tutorials classes
- Group discussions on newer aerospace Materials
- Technical Quiz and Seminars
- Assignments
- Exploration – gathering knowledge and attaining skills through active investigation.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyse mechanical behaviour & structural integrity on various materials	L1,L2
CO2	Apply the structural load & design consideration on 1D, 2D & 3D	L3,L4
CO3	Understand & Analysis on Statically determinate and indeterminate structures	L3,L4
CO4	Understand the aircraft materials and its tooling concepts	L1,L2
CO5	Apply various material processing techniques	L2

Program Outcome of this course

Sl. No.	Description	POs
01	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
02	An ability to write and present a substantial technical report/document.	PO2
03	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
04	Acquire technical competence, comprehensive knowledge and understanding the methodologies and technologies associated with Aerospace Engineering. Apply knowledge to identify, formulate and analyse complex engineering problems	PO4
05	Having an ability to apply knowledge of science, mathematics, engineering & technology for development of Aerospace Propulsion technologies.	PO5
06	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	PO7

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	2	3	-	1	-
CO2	2	2	3	2	3	-	2	-
CO3	1	1	1	1	1	-	1	-
CO4	1	2	1	1	1	-	2	-
CO5	3	1	3	3	2	-	3	-

Propulsion Laboratory			
Course Code	MAEL106	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	01:02:00	SEE Marks	50
Credits	02	Exam Hours	03 Hrs

Course objectives:

- Familiarization with various propulsion experimental facilities
- Familiarize with different propulsion experiments and measurement techniques
- Conduct the test, acquire the data and analyse and document

Sl.NO	Experiments
1	Cascade testing of a model of turbine blade row and study of wake survey.
2	Estimation of propeller performance
3	Forced Convective heat transfer on a flat surface and
4	Measurement of Burning Velocity of a Premixed Flame
5	Determination of heat of combustion of aviation fuels
6	Measurement of static overall pressure rise & rotor static pressure rise & fan overall efficiency through axial flow fan unit
7	Effect of inlet flow distortion on measurement of static overall pressure rise & rotor static pressure rise & fan overall efficiency through axial flow fan unit .
8	Study of Jet Engine characteristics (thrust, static and total pressures, temperatures, exhaust velocity & fuel consumption)
	Demonstration Experiments (For CIE) if any
9	Performance studies on 2 dimensional diffuser (Stable flow and separated flow)
10	Free and wall jet experimental studies
11	Natural convective heat transfer over an aerofoil wing model
12	Measurement of Nozzle flow setup

Course outcomes (Course Skill Set):

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

Sl. No.	Description	Blooms Level
CO1	Demonstrate various experimental facilities	**L1,L2**
CO2	Apply the knowledge to use of different sensors and measurement techniques	**L3**
CO3	Perform the test, acquire the data and analyse and document	**L4**

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 50% of the maximum 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 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

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 an 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 down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marksis scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test 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 10% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours
Suggested Learning Resources: • Propulsion lab Manual