BE Aerospace Engineering
Third Semester Syllabus Academic Year 2026-2027

Transforms and Statistics

Course Code	1BMAT301	Scheme	2025
Type of Course	Applied Science Course (ASC)	Semester	III
Teaching Hours/Week (L: T: P)	70 (3 : 2 : 0)	CIE Marks	50
Total Hours of Pedagogy per semester CI (L /T):LI(P):SL&TW:	120 (42 : 28 : 0 : 50)	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Apply Fourier series techniques to represent periodic functions and perform harmonic analysis relevant to engineering applications.

CO2: Utilize Fourier Transforms and Z-Transforms to analyze engineering systems and solve difference equations arising in mechanical and allied engineering problems.

CO3: Formulate and solve partial differential equations and apply numerical methods for the solution of heat, wave, and Laplace equations encountered in engineering practice.

CO4: Employ Laplace Transform techniques to solve ordinary differential equations and engineering problems involving dynamic systems.

CO5: Analyze and interpret engineering data using statistical tools, measures of central tendency, dispersion, and data visualization techniques for informed decision-making.

Module-1: Fourier Series

Definition, Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period 2π and arbitrary period, half range Fourier series. Complex form of Fourier Series. Practical harmonic analysis.

(RBT Levels: LI, L2 and L3) Number of Hours:**08**

Module-2: Fourier Transform & Z-Transform

Infinite Fourier transform, Fourier sine and cosine transforms, properties, Inverse Fourier transform, integral equations and related problems.

Z-Transform: Definition, standard Z-transforms, damping rule, shifting rule, initial value and final value theorems (statements only). Inverse Z- transforms, Problems on difference equations.

(RBT Levels: LI, L2 and L3) Number of Hours:**09**

Module-3: Partial differential equations

Partial Differential Equations: Definitions, Formation of PDE by eliminating arbitrary constants and arbitrary functions, Solution of non-homogeneous PDE by direct integration and Lagrange's multiplier method.

Numerical solution of PDE: Classification of second order PDE. Finite difference approximation to derivatives, Numerical solution of One-dimensional Heat and Wave equations. Numerical solution of two-dimensional Laplace equation.

(RBT Levels: LI, L2 and L3) Number of Hours**:09**

Module-4: Statistics-1

Measures of central tendency: mean, median and mode for grouped and ungrouped data. Measures of dispersion: range, variance, standard deviation, quartile deviation, moments and coefficient of variation. Concept of Skewness and

Kurtosis.

(RBT Levels: LI, L2 and L3) Number of Hours**: 08**

Module-5: Statistics-2

Statistical Methods: Principles of least squares, Curve fitting by the method of least squares in the form: $y = a + bx$, $y = a + bx + cx^2$, and $y = ax^b$.

Correlation and Regression: Karl Pearson's coefficient of correlation and rank correlation (with repetition and without repetition) -problems. Regression analysis- lines of regression –problems.

(RBT Levels: LI, L2 and L3) Number of Hours:**08**

Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):

Textbooks:

1. S.C.Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Publishing.
2. R. K, Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Publishing House.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers.

Reference books / Manuals:

1. B.V. Ramana, Higher Engineering Mathematics, Mc Graw-Hill Education,11th Ed., 2017
2. M.R.Spiegel, J. Schiller, and R.A. Srinivasan, Schaum's Outline of Probability and Statistics, McGraw Hill.
3. S. C. Gupta, Statistical Methods, S. Chand Publishing.
4. V. K. Rohatgi and A. K. Md. Ehsanes Saleh , An Introduction to Probability and Statistics, Wiley.

Web links and e-Resources:

- http://academicearth.org/
- VTUe-ShikshanaProgram
- VTUEDUSATProgram
- https://nptel.ac.in/courses/111105160
- https://nptel.ac.in/courses/127106019
- https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019/

https://ocw.mit.edu/courses/18-330-introduction-to-numerical-analysis-spring-2012/pages/syllabus/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students to learn groups to improve their creative and analytical skills.
6. Show short-related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution of some exercises (post-lecture activity).

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

The CIE Theory component consists of average of TWO IA tests for 25 marks and Continuous Comprehensive Assessments (CCA) for 25 marks.

To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.

To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.

Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Assignment (at RBL3 or RBL4 levels) for Team Work	10
2.	GATE-based Aptitude Test	15

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Seminar on Fourier Series of periodic functions and harmonic analysis	5
2.	MATLAB/Python Simulation of Fourier and Z-Transform problems	5
3.	Mini Project on statistical Models in Engineering Applications	5
4.	Case Study on Signal Processing using Transform Techniques	5

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

1. Sample Rubrics - Mini-Project

Criterion	Exemplary (3)	Proficient (2)	Basic (1)	Weight
Problem definition & data	Clear, relevant civil-engineering questions; data source and limitations documented.	Mostly clear; minor gaps in context or data description.	Vague questions or poorly documented data.	10%
Data processing & descriptive statistics	Correct cleaning, visualization, and computation of key measures; patterns clearly highlighted.	Mostly correct; minor computational errors.	Significant errors, missing key measures or plots.	25%
Probabilistic modelling (distributions, inference)	Appropriate distributions and tests used; assumptions stated; results interpreted in context.	Reasonable choice of models; some assumptions implicit; interpretation mostly sound.	Inappropriate or poorly justified models; limited interpretation.	30%
Civil engineering insight / risk framing	Clear link to design/assessment decisions, safety and uncertainty; limitations	Some discussion of implications; limited treatment of limitations.	Minimal civil engineering interpretation on beyond numbers.	20%

	discussed.			
Report & communication	Well-structured report, clear figures/tables, reproducible calculations; effective brief presentation.	Acceptable structure; some clarity issues; presentation adequate.	Disorganized or incomplete report; weak presentation.	15%

Students' activities for TW/SL under NCrF: Samples only

As per National credit formwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Self learning (TW/Sl-50 hours). Hence, students must complete minimum of two activities as part of NCrF. These learning activities shall be considered as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The course coordinator can also give their own TW/SL activities as per the course outcomes.

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Aerospace Materials			
Course Code	1BAS302 / 1BAE302	Scheme	2026
Type of course	Integrated Professional Core Course (IPCC)	Semester	III
Teaching Hours/Week (L:T:P)	70 (3: 0 : 2)	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL&TW	120 (42: 0 : 28 : 50)	SEE Marks	50
Credits	3	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, and Lab- CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Explain the classification, selection criteria, mechanical behaviour including testing of materials used in aerospace applications.

CO2: Apply the properties and processing characteristics of non-ferrous aerospace materials to select suitable materials for different aircraft components and applications.

CO3: Utilize the properties and characteristics of ferrous materials for appropriate material selection for structural and high-temperature applications.

CO4: Examine the relationship between processing techniques, material properties, and aerospace applications of ceramics and composite materials.

CO5: Apply relevant testing techniques to detect defects in materials, assess corrosion effects, and inspect aerospace components.

Module-1

Mechanical Behaviour of Engineering Materials: Introduction to aerospace materials and their classification, Material selection and design considerations for aircraft, Environmental challenges: High-temperature problems and aerodynamic heating, Toughness-Modules of resilience-Bauchinger's effect-Effect of notches-Testing and flaw detection of materials and components, knowledge of various material testing machines.

Number of Hours: 09

Module-2

Non-ferrous materials in aircraft construction: Aluminium and its alloys: Types and identification. 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, Transparent materials for aircraft canopies, Introduction to glass & carbon composite.

Number of Hours: 09

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.

Number of Hours: 08

Module-4

Ceramics and Composites: Introduction, modern ceramic materials, cermets, glass ceramic, production of semi-fabricated forms, Thermal barrier coatings and ceramic coatings, Carbon/Carbon composites, Fabrication processes and their aerospace applications involved in metal matrix composites, polymer composites.

Number of Hours: 08

Module-5

Material Testing: Corrosion, its detection and prevention. Protective finishes. Testing: Destructive and non - destructive testing techniques. Crack detection, inspection of parts by hot oil and chalk, dye-penetrate, fluorescent and magnetic particles, X-ray, ultrasonic, eddy current and acoustic emission methods.

Number of Hours: 08

PRACTICAL COMPONENTS OF IPCC

PART – A: FIXED SET OF EXPERIMENTS

1. To perform tensile, shear and compression tests of metallic / non-metallic specimens using a Universal Testing Machine.
2. To perform Izod and Charpy Tests on M.S. and C.I. Specimens
3. To perform Hardening and tempering of steel, followed by Hardness testing to evaluate the effects of the treatment.
4. To perform a dye penetration test to study the defects of cast and welded specimens
5. To fabricate a standard aerospace component utilising turning operations.
6. To utilise thread cutting operations during fabrication of a standard aerospace component
7. To employ drilling and boring operations during fabrication of a standard aerospace component

PART – B: OPEN ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.

1. **Additive Manufacturing for UAV Components:** Students must design and 3D print lightweight, high-impact custom bracket by experimenting with infill patterns and layer orientations, destructively testing them to find the highest strength-to-weight ratio.
2. **Heat Treatment Optimization for Typical Aircraft Components:** Students must consider a typical aircraft metallic material and develop a custom hardening and tempering cycle to achieve a specific target hardness (Rockwell/Brinell) while maximizing impact energy absorption (Charpy test).
3. **Fabrication of Composite Laminates and Understanding the Effect of Lay-up Sequence:** Students will fabricate custom GFRP/CFRP laminates by varying fiber orientation or epoxy ratios, then conduct flexural tests to determine the configuration that sustains the highest stress before ply failure.
4. **Defect Propagation & Notch Sensitivity in Machined Alloys:** A scratched aluminum bracket requires safety verification for flight. Students will induce controlled notches of varying depths into aluminium specimens and perform tensile tests to map the strength reduction, determining the critical flaw size that leads to catastrophic failure.
5. **NDT (Non-Destructive Testing) Reliability Assessment:** Microscopic sub-surface cracks are not noticed during visual inspections. Students will inspect a defective welded joint using Dye Penetrant, Ultrasonic, and Magnetic Particle methods, comparing the reliability of each method for different defect types to create a standardized inspection protocol.
6. **Weight Optimization of Aircraft Components:** Since there are various materials/ material combinations that can be used for the construction of aircraft components, a standard aircraft component / sub-system is to be identified and develop a performance index based on strength, stiffness and cost.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. H Buhl, Advanced Aerospace Materials, Springer, Berlin 1992, ISBN-13: 978-3540558880
2. Titterton GF, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition,1998, ISBN-13: 978-8175980136
3. Mouritz, A.P, Introduction to aerospace materials, Oxford 2012, Woodhead Publishing.
4. Avner, S.H, Introduction to physical metallurgy, New York: McGraw-Hill Education 2nd edition, 1997.
5. Campbell, F.C, Manufacturing processes for advanced composites. Oxford: Elsevier Science, 2004
6. Baldev, R., Jayakumar, T. and Thavasimuthu, M, Practical non-destructive testing. 3th edn. New Delhi: Narosa Publishing House, 2013

Reference books / Manuals:

1. Balram Gupta, Aerospace material Vol.1,2,3,4 ARDB, S Chand & Co , 2009, ISBN-13: 978-8121922005.
2. Parker ER, Materials for Missiles and Space, McGraw-Hill Inc., US, 1963.
3. Hill ET, The Materials of Aircraft Construction, Pitman London.
4. CG Krishnadas Nair, Hand book of Aircraft materials, Interline publishers, Bangalore, 1993
5. King and Butler, Principles of Engineering Inspection, Clever Humes Press.

Web links and Video Lectures (e-Resources):

- MIT OpenCourseWare — Unified Engineering: Materials and Structures, MIT OCW 16.001 Fall Portal
- NPTEL - Engineering Materials and Processing Techniques, https://nptel.ac.in/courses/112107086
- NPTEL - Advanced Materials and Processes, https://nptel.ac.in/courses/113105081

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Flipped Classroom
2. Problem-Based Learning (PBL)
3. Case-Based Teaching
4. Simulation and Virtual Labs
5. Partial Delivery of course by Industry expert/ industrial visits
6. ICT-Enabled Teaching
7. Role Play

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.

The CIE Theory component consists of IA tests for 25 marks. The CIE Practical component for continuous assessments will be for 15 marks through rubrics and for lab tests will be for 10 marks.

- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 25 marks**, i.e., **10 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must secure **a minimum of 40% of 25 marks**, i.e., **10 marks**.
- To pass the **SEE**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

CIE Practical component:

The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The summation of all the experiments marks to be scaled down to 15 marks.

The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 10 marks. For laboratory test, the student is required to conduct one experiment each from both Part A and Part B.

Term Work (TW) and Self Learning (SL) components in Number of hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Seminar on topics drawn from different modules	5
2.	Case Study Presentation	5
3.	Tool/Software Exploration	5
4.	Micro Projects	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Online Courses	20
2.	Technical Literature Review and Summarizing	5

Rubrics for a Sample Activity - Case Study [Marking on a scale of 1-5]

	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
Problem Identification (weightage: 20 %)	Define problem clearly with background and objectives	Problem is well defined with minor omissions.	Problem is adequately identified.	Problem is defined vague with no clarity.	Problem is poorly, not defined
Review of Literature (weightage: 20 %)	Extensive, relevant, and current literature is used and summarized	Good use of relevant references.	Adequate literature with limited analysis.	Limited or outdated references	Little or no supporting literature
Critical Analysis (weightage: 15 %)	Demonstrates exceptional reasoning	Good analysis with logical reasoning	Basic analysis with limited depth	Weak analysis with limited critical assessment	No meaningful analysis
Scientific Advancement and Application (weightage: 15 %)	Scientific concepts are accurately applied and integrated effectively	Concepts are applied with minimal deviations	Adequate application of concepts	Limited understanding demonstrated	Concepts incorrectly applied
Innovation and recommendations (weightage: 15%)	Innovative, feasible recommendations	Recommendations are practical	Acceptable recommendations	Poorly justified recommendations	No meaningful recommendations

Support Data Availability and Presentation (weightage: 15 %)	Use of sufficient data, figures, tables, and evidence	Good use of supporting evidence.	Adequate evidence provided.	Limited evidence used	No supporting evidence.

Rubrics for CIE Examination

Performance Indicator	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
PI-1: Theory Tests	90–100%	75–89%	60–74%	40–59%	<40%
PI-2: Assignments & Record	Complete and submitted on time	Minor errors	Satisfactory	Incomplete	Not submitted
PI-3: Laboratory Performance	Independent execution without guidance	Minor guidance required	Moderate guidance required	Significant guidance required	Unable to perform the experiment
PI-4: Viva Voce	Excellent understanding and confident responses	Good understanding with minor errors	Basic understanding	Limited understanding	Unable to answer questions
PI-5: Participation	Excellent participation and initiative	Good participation	Average participation	Poor participation	No participation

Rubrics for SEE Examination

Performance Indicator	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
PI-1: Conceptual Knowledge	Excellent understanding of fundamental concepts and principles.	Good understanding with minor gaps in concepts.	Adequate understanding of basic concepts.	Limited understanding of concepts; requires significant support.	Poor understanding of concepts.
PI-2: Problem Solving	Accurately identifies and solves problems independently using appropriate methods.	Solves problems with minor errors and minimal guidance.	Solves basic problems with acceptable accuracy.	Frequent errors in problem-solving; requires considerable guidance.	Unable to solve the given problems.
PI-3: Analytical Ability	Demonstrates excellent analytical and critical thinking skills.	Demonstrates good analytical ability with minor limitations.	Demonstrates basic analytical skills.	Limited analytical ability; struggles to interpret results.	No evidence of analytical ability.
PI-4: Application	Applies concepts effectively to practical situations and	Applies concepts correctly with minor guidance.	Demonstrates basic application of concepts.	Limited ability to apply concepts in practical situations.	Unable to apply concepts to solve problems.

	engineering problems.				
PI-5: Communication	Excellent communication with clear, organized, and professional presentation.	Good communication with minor improvements needed.	Satisfactory communication of ideas with acceptable clarity.	Poor communication; ideas are not presented clearly.	Communication is incomplete or ineffective.

Continuous Internal Evaluation (CIE)

(i)Theory component

1. The CIE marks of 25 shall be earmarked for two tests.
2. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the rest three modules.
3. Each test shall be conducted for 25 marks. The average of the two tests scaled down to 25 marks shall constitute the test marks for a maximum of 25 marks.

(ii) Laboratory component

1. Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed in the course syllabus.
2. The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined for regular class work and practical test as indicated in the Table – ICs/IPCCs
3. To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

Table – ICs/IPCCs 1 Distribution of marks		
Component	**Description**	**Marks**
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
	Subtotal	**15**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
	Subtotal	**10**
	Total	**25**

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade ‘F’ (Fail).

Mechanics of Materials			
Course Code	1BAS303 / 1BAE303	Scheme	2025
Type of Course	Professional Core Course (PCC)	Semester	III

Teaching Hours/Week (L:T:P)	70 (3 : 2 : 0)	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	120 (42 : 28 : 0 : 50)	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Analyze stress, strain, and deformation in structural members subjected to different loading conditions.

CO2: Evaluate the torsional behavior of structural elements.

CO3: Determine shear and flexural stresses in beams and other engineering members.

CO4: Assess deflection in beams, combined stress conditions and pressure vessel behavior.

CO5: Examine the influence of end conditions and eccentric loading on the stability and load-carrying capacity of columns

Module-1

Stress, Strain and Axial Loading - Introduction to mechanics of materials, assumptions and idealizations, external and internal forces, normal stress and strain, shear stress and strain, stress–strain diagrams, Hooke's law, Poisson's ratio, elastic constants and their relations, factor of safety, thermal stresses and strains, axial deformation of stepped and composite bars, statically indeterminate members under axial loading.

Number of Hours:09

Module-2

Torsion of Circular Shafts - Theory of pure torsion, assumptions in torsion theory, derivation of torsion equation, torsional shear stress distribution, angle of twist, power transmission shafts, hollow and solid circular shafts, composite shafts, torsional rigidity, springs subjected to torsion.

Number of Hours:06

Module-3

Shear Force, Bending Moment and Stresses in Beams - Types of beams and loading, shear force and bending moment diagrams, relation between load, shear force and bending moment, theory of simple bending, flexure formula, section modulus, bending stresses in symmetric and unsymmetric sections, shear stresses in beams, composite beams.

Number of Hours**:**11

Module-4

Beam Deflection, Combined Loading and Pressure Vessels - Slope and deflection by double integration and moment-area methods, Macaulay's method (simple problems), superposition principle, combined loading, stress transformation, principal stresses and maximum shear stresses, Mohr's circle, thin cylindrical and spherical pressure vessels.

Number of Hours**:**08

Module-5

Columns and Stability - Columns and struts, Euler's theory of buckling, effective length for different end conditions, Rankine's formula, eccentric loading on columns, introduction to energy methods: strain energy, resilience, impact loading (basic concepts).

Number of Hours:08

Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):

Text books:

1. Mechanics of Materials - R. C. Hibbeler, *Mechanics of Materials*, Pearson Education, Latest Edition.
2. Strength of Materials - S. S. Rattan, *Strength of Materials*, McGraw Hill Education.

Reference books / Manuals:

1. Mechanics of Materials - Beer, Johnston, DeWolf & Mazurek, McGraw Hill.
2. Strength of Materials - R. K. Rajput, S. Chand Publications.
5. Advanced Mechanics of Materials - Boresi & Schmidt, Wiley.

Web links and Video Lectures (e-Resources):

- NPTEL – Strength of Materials by Prof. S. K. Bhattacharyya, IIT Kharagpur - https://elearn.nptel.ac.in/shop/nptel/strength-of-materials/?utm_source=chatgpt.com
- MIT OCW – Mechanics & Materials - https://ocw.mit.edu/courses/2-001-mechanics-materials-i-fall-2006/?utm_source=chatgpt.com

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Interactive Chalk-and-Talk Sessions supplemented with real engineering and aerospace structural examples.
2. Visualization Through Simulation Tools using software demonstrations for stress distribution, beam deflection, and deformation behavior.
3. Case Studies of Structural Failures in aircraft and engineering structures to relate theoretical concepts with practical applications.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Two Assignments (RBL4) – One individual and One group Assignment (AI-assisted)	15
2.	Solving Numerical Problems Appearing in GATE / other competitive examinations	10

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Case Study on Structural Failures	5
2.	Tool/Software Exploration (FEA Exploration)	5
3.	Micro Projects involving Component analysis and Investigating Material Behavior	10
4.	Industry Visits / Virtual Laboratory Activities	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Exploring Design and Testing Standards	10
2.	Reviewing Research Articles and Summarizing the Findings	10

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Rubrics for a Sample Activity - Case Study [Marking on a scale of 1-5]

	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
Problem Identification (weightage: 20 %)	Define problem clearly with background and objectives	Problem is well defined with minor omissions.	Problem is adequately identified.	Problem is defined vague with no clarity.	Problem is poorly, not defined
Review of Literature (weightage: 20 %)	Extensive, relevant, and current literature is used and summarized	Good use of relevant references.	Adequate literature with limited analysis.	Limited or outdated references	Little or no supporting literature
Critical Analysis (weightage: 15 %)	Demonstrates exceptional reasoning	Good analysis with logical reasoning	Basic analysis with limited depth	Weak analysis with limited critical assessment	No meaningful analysis
Scientific Advancement and Application (weightage: 15 %)	Scientific concepts are accurately applied and integrated effectively	Concepts are applied with minimal deviations	Adequate application of concepts	Limited understanding demonstrated	Concepts incorrectly applied
Innovation and recommendations (weightage: 15%)	Innovative, feasible recommendations	Recommendations are practical	Acceptable recommendations	Poorly justified recommendations	No meaningful recommendations
Support Data Availability and Presentation (weightage: 15 %)	Use of sufficient data, figures, tables, and evidence	Good use of supporting evidence.	Adequate evidence provided.	Limited evidence used	No supporting evidence.

Rubrics for CIE Examination

Performance Indicator	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
PI-1: Theory Tests	90–100%	75–89%	60–74%	40–59%	<40%
PI-2: Assignments & Record	Complete and submitted on time	Minor errors	Satisfactory	Incomplete	Not submitted
PI-3: Laboratory Performance	Independent execution without guidance	Minor guidance required	Moderate guidance required	Significant guidance required	Unable to perform the experiment
PI-4: Viva Voce	Excellent understanding and confident responses	Good understanding with minor errors	Basic understanding	Limited understanding	Unable to answer questions
PI-5: Participation	Excellent participation and initiative	Good participation	Average participation	Poor participation	No participation

Rubrics for SEE Examination

Performance Indicator	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
PI-1: Conceptual Knowledge	Excellent understanding of fundamental concepts and principles.	Good understanding with minor gaps in concepts.	Adequate understanding of basic concepts.	Limited understanding of concepts; requires significant support.	Poor understanding of concepts.
PI-2: Problem Solving	Accurately identifies and solves problems independently using appropriate methods.	Solves problems with minor errors and minimal guidance.	Solves basic problems with acceptable accuracy.	Frequent errors in problem-solving; requires considerable guidance.	Unable to solve the given problems.
PI-3: Analytical Ability	Demonstrates excellent analytical and critical thinking skills.	Demonstrates good analytical ability with minor limitations.	Demonstrates basic analytical skills.	Limited analytical ability; struggles to interpret results.	No evidence of analytical ability.
PI-4: Application	Applies concepts effectively to practical situations and engineering problems.	Applies concepts correctly with minor guidance.	Demonstrates basic application of concepts.	Limited ability to apply concepts in practical situations.	Unable to apply concepts to solve problems.
PI-5: Communication	Excellent communication with clear, organized, and professional presentation.	Good communication with minor improvements needed.	Satisfactory communication of ideas with acceptable clarity.	Poor communication; ideas are not presented clearly.	Communication is incomplete or ineffective.

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Type of Course	Professional Core Course (PCC)	Semester	III
Teaching Hours/Week (L:T:P)	42 (3 : 0 : 0)	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	90 (42 : 0 : 0 : 48)	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

CO1: Explain the basic properties of fluids, pressure measurement, fluid statics on submerged surfaces

CO2: Interpret different types of fluid flow, fluid kinematics, continuity equation, and the governing conservation equations for fluid motion

CO3: Solve engineering problems involving Bernoulli's equation, Euler's equation, momentum equation, dimensional analysis, and similarity principle

CO4: Analyze the characteristics of boundary layer flow, drag and lift forces on immersed bodies, and the aerodynamic behavior of airfoils.

CO5: Apply the principles of compressible flow, shock waves, and boundary layer theory to analyze fluid flow problems.

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.

Number of Hours: 08

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).

Number of Hours: 09

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.

Number of Hours: 08

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.

Number of Hours: 08

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.

Number of Hours: 09

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Bansal, R.K, "Fluid Mechanics and Hydraulics Machines", Laxmi Publications (P) Ltd., New Delhi 2015,ISBN13: 978-8131808153.
2. Radhakrishnan. E, "Fluid Mechanics", Prentice-Hall of India Pvt. Ltd, 2010, ISBN 13: 9788120331839.
3. Frank M White, "Fluid Mechanics", Mc Graw Hill, 2009, ISBN 978-0-07-352934-9

Reference books / Manuals:

1. Ramamrutham. S "Hydraulic Fluid Mechanics and Fluid Machines", Dhanpat Rai&Sons, Delhi, 1988, ISBN 13: 9788187433804.
2. Kumar. K.L., "Engineering Fluid Mechanics" (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 1995, ISBN 13: 9788121901000.
3. Streeter. V. L., and Wylie, E.B., "Fluid Mechanics", McGraw Hill, 1983, ISBN 13: 9780070665781

Web links and Video Lectures (e-Resources):

- NPTEL – Introduction to Fluid Mechanic by Prof. Suman Chakraborty, IIT Kharagpur https://nptel.ac.in/courses/112105269
- MIT OCW – Fluid Mechanics - https://ocw.mit.edu/courses/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/pages/fluid-mechanics/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Interactive Chalk-and-Talk Sessions supplemented with real engineering and aerospace fluid mechanics examples with applications of aerodynamics.
2. Visualization Through Laboratory experiments and simulation tools using software demonstrations for streamlines, Boundary layer separation, Types of flows.
3. Case studies of Slow characteristics on various shapes of the body including cylinder, Flat plate, Airfoil and for aircraft wing.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks

1.	Two Assignments (RBL4) – One individual and One group Assignment / micro project	15
3.	Solving Numerical Problems Appearing in GATE / other competitive examinations	10

Rubrics for a Sample Activity – Micro Project (Scale of 1-5)

	Superior (5)	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
Problem Identification and definition (20 % Weightage)	Problem is clearly identified and objectives are stated	Problem clearly defined and objectives are stated with minor omissions	Problem is identified and objectives are generally clear	Objectives are partially defined or lack clarity	Problem and objectives are unclear or missing
Application of Engineering concepts / Innovative aspects (20 % Weightage)	Demonstrates exceptional understanding and accurate application of engineering principles.	Demonstrates strong understanding with only minor errors.	Demonstrates adequate understanding with some inaccuracies	Demonstrates limited understanding and application	Concepts are incorrectly applied or not demonstrated.
Implementation (25 % Weightage)	Solution is complete, functional, innovative, and fully meets objectives.	Solution is functional and meets most objectives.	Solution is functional but requires improvements.	Solution is partially functional.	Solution is incomplete or non-functional.
Testing and Results (20 % Weightage)	Exceptionally well-organized, technically accurate, and professionally formatted.	Well-written with only minor formatting or language errors	Adequately organized with some inconsistencies.	Basic report with several errors or omissions.	Poorly organized, incomplete, or difficult
Documentation and Presentation (15 % Weightage)	Clear, confident, engaging presentation with excellent demonstration and responses. .	Effective presentation with good demonstration.	Clear presentation with satisfactory explanation	Basic presentation with limited clarity.	Poor presentation or demonstration.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Demonstration of Various types of flows over various shapes	5
2.	Tool/Software Exploration (CFD Related)	5
3.	Micro Projects involving the flow analysis and flow behavior by referring the papers from high quality journals	10
4.	Industry Visits / Virtual Laboratory Activities	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
3.	Recent developments of applications of fluid mechanics in aircraft and aerospace applications	10
4.	Reviewing Research Articles and Summarizing the Findings	10

Rubrics for CIE Examination:

Note: In case Lab Component Not present for the Subject – then the Rubrics can be suitably modified

Performance Indicator	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
PI-1: Theory Tests	90–100%	75–89%	60–74%	40–59%	<40%
PI-2: Assignments & Record	Complete and submitted on time	Minor errors	Satisfactory	Incomplete	Not submitted
PI-3: Laboratory Performance	Independent execution without guidance	Minor guidance required	Moderate guidance required	Significant guidance required	Unable to perform the experiment
PI-4: Viva Voce	Excellent understanding and confident responses	Good understanding with minor errors	Basic understanding	Limited understanding	Unable to answer questions
PI-5: Participation	Excellent participation and initiative	Good participation	Average participation	Poor participation	No participation

Rubrics for SEE Examination

Performance Indicator	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
PI-1: Conceptual Knowledge	Excellent understanding of fundamental concepts and principles.	Good understanding with minor gaps in concepts.	Adequate understanding of basic concepts.	Limited understanding of concepts; requires significant support.	Poor understanding of concepts.
PI-2: Problem Solving	Accurately identifies and solves problems independently using	Solves problems with minor errors and minimal guidance.	Solves basic problems with acceptable accuracy.	Frequent errors in problem-solving; requires considerable guidance.	Unable to solve the given problems.

	appropriate methods.				
PI-3: Analytical Ability	Demonstrates excellent analytical and critical thinking skills.	Demonstrates good analytical ability with minor limitations.	Demonstrates basic analytical skills.	Limited analytical ability; struggles to interpret results.	No evidence of analytical ability.
PI-4: Application	Applies concepts effectively to practical situations and engineering problems.	Applies concepts correctly with minor guidance.	Demonstrates basic application of concepts.	Limited ability to apply concepts in practical situations.	Unable to apply concepts to solve problems.
PI-5: Communication	Excellent communication with clear, organized, and professional presentation.	Good communication with minor improvements needed.	Satisfactory communication of ideas with acceptable clarity.	Poor communication; ideas are not presented clearly.	Communication is incomplete or ineffective.

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade ‘F’ (Fail).

Mechanisms and Machine Theory			
Course Code	1BAS305	Scheme	2025
Type of Course	PCC	Semester	03
Teaching Hours/Week (L:T:P)	42:00:00	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42:00:00:48	SEE Marks	50

Credits	**03**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Explain the fundamentals of mechanisms, kinematic pairs, kinematic chains, inversions of mechanisms, straight-line motion mechanisms, and intermittent motion mechanisms.

CO2: Analyze the velocity, acceleration, and static forces acting on four-bar, slider-crank, and simple mechanisms using graphical methods and principles of equilibrium.

CO3: Apply the principles of spur gears and gear trains to determine gear parameters, motion transmission characteristics, and torque relationships in simple, compound, reverted, and epicyclic gear trains.

CO4: Analyze the balancing of rotating and reciprocating masses in single-plane, multi-plane, multi-cylinder inline, and radial engine systems using graphical methods.

CO5: Evaluate the performance characteristics of governors and gyroscopes, including stability, sensitiveness, controlling force, gyroscopic couple, and their applications in engineering systems and aircraft.

Module-1

Introduction: 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 mechanism.

Number of Hours:09

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

Number of Hours:09

Module-3

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.

Number of Hours:08

Module-4

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)

Number of Hours:08

Module-5

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.

Number of Hours:08

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

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. R.S.Khurmi and J.K.Gupta, "*Theory of Machines*, *Machine Design*, *Thermal Engineering*, *Engineering Mechanics"* S. Chand Publishing, Revised Edition. ISBN 9788121925242
3. J.J. Uicker, G.R. Pennock, J.E. Shigley."Theory of Machines & Mechanisms", OXFORD 5th Ed. 2009, ISBN13: 978-0195371239

Reference books / Manuals:

1. Sadhu Singh by Theory of Machines, Pearson Education India , 2nd Edition
2. Mechanism and Machine Theory, J. S. Rao and R. V. Dukkipati, 2nd Edition, New Age International Publishers.
4. Theory of Machines, Thomas Bevan, 3rd Edition, CBS Publishers & Distributors

Web links and Video Lectures (e-Resources):

1. NPTEL – National Programme on Technology Enhanced Learning Covers Theory of Machines, Kinematics of Machines, Gears, Governors, Gyroscopes, and Balancing., NPTEL Official Website . https://nptel.ac.in/
2. MIT Open Course Ware– Dynamics and Control, Lecture notes, assignments, and videos on kinematics, dynamics, virtual work, and gyroscopic effects. MIT OpenCourseWare: Dynamics and Control I.
3. NPTEL Video Lectures – Theory of Machines Complete lecture series on mechanisms, kinematic chains, gears, balancing, governors, and gyroscopes. https://www.youtube.com/@nptelhrd?utm_source=chatgpt.com.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Interactive Chalk-and-Talk Sessions supplemented with use of animations, videos, and simulations to explain mechanisms, kinematic chains, gears, governors, and gyroscopes.
2. Activity-Based Learning by the demonstration of working models of four-bar mechanisms, slider-crank mechanisms, Scotch yoke, Oldham coupling, and gear trains.
3. Simulation-Based Learning by the use of software tools such as MATLAB, MSC ADAMS, SolidWorks Motion, or ANSYS Motion for: Velocity and acceleration analysis, Gear train simulation Balancing of rotating and reciprocating masses , Gyroscopic motion analysis

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests(IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Two Assignments (RBL4) – One	15

		individual and One group Assignment (AI-assisted)		
	4.	Solving Numerical Problems Appearing in GATE / other competitive examinations	10	

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	**Term Work (TW) Activity**	**Number of Hours / Semester**
1.	Demonstration of Machines and links by various innovative methods	5
2.	Demonstration of Terminology and working of Gear and its	5
3.	Micro Projects involving creation of various machine components	10
4.	Industry Visits / Virtual Laboratory Activities	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Exploring Machines and its mechanisms using various lab components	10
2.	Reviewing Recent Research Articles, Summarizing the Findings and Developments in Mechanisms and Machines	10

Rubrics for CIE Examination

Note: In case Lab Component Not present for the Subject – then the Rubrics can be suitably modified

Performance Indicator	**Superior (5)**	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
PI-1: Theory Tests	90–100%	75–89%	60–74%	40–59%	<40
PI-2: Assignments & Record	Complete and submitted on time	Minor errors	Satisfactory	Incomplete	Not submitted
PI-3: Laboratory Performance	Independent execution without guidance	Minor guidance required	Moderate guidance required	Significant guidance required	Unable to perform the experiment
PI-4: Viva Voce	Excellent understanding and confident responses	Good understanding with minor errors	Basic understanding	Limited understanding	Unable to answer questions
PI-5: Participation	Excellent participation and initiative	Good participation	Average participation	Poor participation	No participation

Rubrics for SEE Examination

Note: for Lab exam, the rubrics may be suitably modified

Performance Indicator	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
PI-1: Conceptual Knowledge	Excellent understanding of fundamental concepts and principles.	Good understanding with minor gaps in concepts.	Adequate understanding of basic concepts.	Limited understanding of concepts; requires significant support.	Poor understanding of concepts.
PI-2: Problem Solving	Accurately identifies and solves problems independently using appropriate methods.	Solves problems with minor errors and minimal guidance.	Solves basic problems with acceptable accuracy.	Frequent errors in problem-solving; requires considerable guidance.	Unable to solve the given problems.
PI-3: Analytical Ability	Demonstrates excellent analytical and critical thinking skills.	Demonstrates good analytical ability with minor limitations.	Demonstrates basic analytical skills.	Limited analytical ability; struggles to interpret results.	No evidence of analytical ability.
PI-4: Application	Applies concepts effectively to practical situations and engineering problems.	Applies concepts correctly with minor guidance.	Demonstrates basic application of concepts.	Limited ability to apply concepts in practical situations.	Unable to apply concepts to solve problems.
PI-5: Communication	Excellent communication with clear, organized, and professional presentation.	Good communication with minor improvements needed.	Satisfactory communication of ideas with acceptable clarity.	Poor communication; ideas are not presented clearly.	Communication is incomplete or ineffective.

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade ‘F’ (Fail).

Computer-Aided Aircraft Drawing

Course Code	1BASL306 / 1BAEL306	Scheme	2025
Type of Course	Professional Core Course Lab (PCCL)	Semester	III
Teaching Hours/Week (L:T:P)	28 (0:0:2)	CIE Marks	50
Total Hours of Pedagogy L:T:P:SLTW	30 (0:0:28:2)	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	Practical	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: To draw and analyze orthographic views, sectional solids as per engineering drawing conventions.

CO2: To draw and analyze standard fasteners, riveted structural connections, and mechanical couplings following engineering drafting conventions.

CO3: To model and draft 2D NACA airfoils, 3D wing surfaces, structural spars, ribs, and fuselage bulkheads using parametric surface modeling techniques.

CO4: To design and assemble complex aircraft propulsion hubs and landing gear assemblies while validating their geometric integration and kinematic operation.

CO5: To formulate and optimize open-ended aerospace projects for specific mission profiles.

Note:

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 9 conventional experiments, PART-B has 6 typical open-ended experiments. The maximum marks for the laboratory course are 100.
2. Both PART-A and PART-B are considered for CIE and SEE.
3. Students have answer 1(one) question from PART-A and 1(one) question from PART-B.
   a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for **70 marks** out of the maximum 100 marks.
   b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for **30 marks.**
4. For Continuous Internal Evaluation (CIE) during the semester, classwork shall typically include open-ended questions from **Part-B**, along with other similar questions designed to enhance the students' skills

PART – A

FIXED SET OF EXPERIMENTS

1. Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedra, 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. Hidden line conventions. Precedence of lines.
3. Standard Fasteners and Threads: Thread terminology, sectional views of ISO Metric, BSW, Square and Acme threads. Assembly of Hexagonal/square-headed bolt and nut, flanged nut, slotted nut, and aerospace counter-sunk/flush screws.
4. Riveted Joints & Structural Connections: Single and double riveted lap joints, butt joints with single/double cover straps using snap head and standard aerospace flush/universal head rivets—Cotter joint and knuckle joint.
5. Power Transmission Components: Parallel key, Taper key, Woodruff key. Protected type flanged coupling, pin (bush) type flexible coupling, and universal coupling.
6. Introduction to Surface Modeling: Generation of 2D airfoil profiles using standard NACA coordinate data, and sweeping/lofting to create 3D wing surfaces.
7. Drafting of Aircraft Structural Components: 2D drafting and 3D modeling of typical aircraft wing ribs, wing spars, and fuselage bulkheads.
8. Design of propeller and hub assembly.
9. Design of Landing Gear Assembly.

PART – B

OPEN ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.

1. **Design of UAV:** Integrate airframe geometry with propulsion and avionics constraints to optimize for a specific mission profile (e.g., endurance vs. payload).
2. **Design of Fuselage:** Develop a monocoque or semi-monocoque fuselage structure that balances aerodynamic efficiency, internal volume, and structural load-path integrity.
3. **Design of Wing:** Parametrically generate a high-lift wing system, incorporating NACA airfoil selection, twist distribution, and spar structural integration to meet defined stall-speed requirements.
4. **Propeller Performance and Hub Optimization:** Design and analyze a variable-pitch propeller hub assembly, focusing on minimizing vibrational torque loads and maximizing thrust efficiency at varying engine RPMs.
5. **Landing Gear Integration and Kinematics:** Formulate the landing gear retraction mechanism and strut geometry to ensure proper weight distribution and ground clearance while maintaining minimal weight penalty.
6. **Adaptive Thermal Management Systems:** Design an active or passive thermal management solution for engine cowlings or electronic bays to mitigate heat soak during high-speed cruise conditions.

Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):

Textbooks:

1. Machine Drawing, N.D. Bhatt and V.M. Panchal, Charotar Publishing House, 55th Edition, 2020.
2. Engineering Graphics and Design, P.S. Gill, S.K. Kataria & Sons, 2019.
3. Airframe Structural Design: Practical Design Information and Data on Aircraft Structures, Michael Chun-Yung Niu, Conmilit Press, 2nd Edition, 1998.

Reference books / Manuals:

1. Fundamentals of Aerospace Engineering: An Introductory Course to Aeronautical Engineering, Manuel Soler, Create space Independent Publishing, 2017.
2. Aircraft Design: A Conceptual Approach, Daniel P. Raymer, AIAA Education Series, 6th Edition, 2018.
3. Machine Drawing: Includes AutoCAD, Ajeet Singh, McGraw-Hill Education, 2012.

Web links and e-Resources:

- NPTEL - Computer Aided Engineering Design by Dr. Anupam Saxena, IIT Kanpur https://nptel.ac.in/courses/112104031
- NPTEL - Computer Aided Engineering Design by Prof. Anoop Chawla, Prof. P.V. Madhusudan Rao, IIT Delhi https://nptel.ac.in/courses/ 112102101
- MIT Open Course Ware - How to CAD Almost Anything: https://ocw.mit.edu/courses/res-16-002-how-to-cad-almost-anything-january-iap-2024/pages/learning-to-use-cad-software/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Flipped Classroom to improve practical understanding of drawing concepts
2. Use of reverse engineering concept - physical measurement of object and convert to drawings
3. AI-assisted interactive sessions

Self-Learning (SL) Activity	Number of Hours / Semester
Online tutorial(s)	02

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying 50% weightage (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Sample Rubrics for Continuous Assessment (Lab Records) – Scale of 1-5

	Superior (5)	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
Completeness of Record (Weightage 25 %)	All sections complete and well-organized report	All sections complete and organized but with minor omissions	Details not sufficient / partially available in some sections	Insufficient details in sections	Report largely incomplete
Technical Content and Accuracy (Weightage 25 %)	Observations, results and plots are properly included and labeled	Minor errors in presenting the content and result accuracy	Some errors in calculations and plots	Significant deviation in results and observations not adequate	Technical content is largely inaccurate
Result Analysis (Weightage 25 %)	Excellent analysis of results, identification of experimental deviations and meaningful conclusions	Adequate analysis of results, listing of conclusions with minor omissions	Basic interpretation with limited discussion of results	Minimal result analysis with unsupported conclusions	No result analysis or presentation of conclusions
Presentation and Timeliness (Weightage 25 %)	Well structured presentation with on time submission	Well prepared presentation with minor deviations but on time	Acceptable presentation with minor time delay	Unclear presentation with omissions and poorly maintained timeline	Not legible, disorganized and difficult to comprehend; not submitted on time

Rubrics for CIE Examination

Note: In case Lab Component Not present for the Subject – then the Rubrics can be suitably modified

Performance Indicator	**Superior (5)**	**Good (4)**	**Fair (3)**	**Needs Improvement (2)**	**Unacceptable (1)**
PI-1: Theory Tests	90–100%	75–89%	60–74%	40–59%	<40
PI-2: Assignments & Record	Complete and submitted on time	Minor errors	Satisfactory	Incomplete	Not submitted
PI-3: Laboratory Performance	Independent execution without guidance	Minor guidance required	Moderate guidance required	Significant guidance required	Unable to perform the experiment
PI-4: Viva Voce	Excellent understanding	Good understanding	Basic understanding	Limited understanding	Unable to answer questions

	and confident responses	with minor errors			
PI-5: Participation	Excellent participation and initiative	Good participation	Average participation	Poor participation	No participation

Rubrics for SEE Examination

Note: for Lab exam, the rubrics may be suitably modified

Performance Indicator	Superior (5)	Good (4)	Fair (3)	Needs Improvement (2)	Unacceptable (1)
PI-1: Conceptual Knowledge	Excellent understanding of fundamental concepts and principles.	Good understanding with minor gaps in concepts.	Adequate understanding of basic concepts.	Limited understanding of concepts; requires significant support.	Poor understanding of concepts.
PI-2: Problem Solving	Accurately identifies and solves problems independently using appropriate methods.	Solves problems with minor errors and minimal guidance.	Solves basic problems with acceptable accuracy.	Frequent errors in problem-solving; requires considerable guidance.	Unable to solve the given problems.
PI-3: Analytical Ability	Demonstrates excellent analytical and critical thinking skills.	Demonstrates good analytical ability with minor limitations.	Demonstrates basic analytical skills.	Limited analytical ability; struggles to interpret results.	No evidence of analytical ability.
PI-4: Application	Applies concepts effectively to practical situations and engineering problems.	Applies concepts correctly with minor guidance.	Demonstrates basic application of concepts.	Limited ability to apply concepts in practical situations.	Unable to apply concepts to solve problems.
PI-5: Communication	Excellent communication with clear, organized, and professional presentation.	Good communication with minor improvements needed.	Satisfactory communication of ideas with acceptable clarity.	Poor communication; ideas are not presented clearly.	Communication is incomplete or ineffective.

Course Code	1BASL307A / 1BAEL307A	Scheme	2025
Type of Course	Ability Enhancement Course Laboratory (AEC)	Semester	III
Teaching Hours/Week (L:T:P)	28 (0: 0: 2)	CIE Marks	50
Total Hours of Pedagogy L:T:P:SLTW	30 (0: 0: 28: 2)	SEE Marks	50
Credits	1	Total Marks	100
Examination type (SEE)	Practical	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Demonstrate the fundamentals of web technologies by creating structured web pages using HTML5 and styling them with CSS3.

CO2: Design and develop responsive and interactive web applications using HTML, CSS, and JavaScript.

CO3: Develop user-friendly mobile applications using Flutter by implementing widgets, layouts, navigation, and user interface components.

CO4: Implement data handling, form validation, and local storage techniques to develop functional mobile applications.

CO5: Design, develop, test, and demonstrate a complete web application and a mobile application to solve simple real-world engineering or personal productivity problems.

SET OF EXPERIMENTS

1. Design and develop a personal profile webpage using basic HTML5 elements.
2. Design and style a responsive webpage using CSS3.
3. Develop a responsive Aerospace Engineering Department website using HTML5 and CSS Flexbox.
4. Install and configure Flutter SDK and Android Studio and develop the first Flutter mobile application.
5. Design and develop a student profile mobile application using Flutter widgets.
6. Develop a multi-screen mobile application using Flutter navigation and routing.
7. Design and validate an online student registration form using HTML5 forms.
8. Develop an interactive web application using JavaScript (CGPA Calculator, Age Calculator, Unit Converter, or Simple Interest Calculator).
9. Design and develop a complete personal portfolio website using HTML5, CSS3, and JavaScript.
10. Develop a student registration mobile application with form validation using Flutter.
11. Develop a mobile application for storing and retrieving data using Shared Preferences in Flutter.
12. Design and develop an Aerospace utility mobile application using Flutter (Aircraft Unit Converter, Flight Checklist, Aircraft Maintenance Logbook, Aerospace Quiz, or CGPA Calculator).

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Jon Duckett, HTML & CSS: Design and Build Websites, John Wiley & Sons, 1st Edition, 2011.
2. Jon Duckett, JavaScript and jQuery: Interactive Front-End Web Development, John Wiley & Sons, 1st Edition, 2014.
3. Marco L. Napoli, Beginning Flutter: A Hands-On Guide to App Development, John Wiley & Sons, 1st Edition, 2019.

Reference books / Manuals:

1. Jennifer Robbins, Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics, O'Reilly Media, 6th Edition, 2025.
2. Thomas Bailey and Alessandro Biessek, Flutter for Beginners: An Introductory Guide to Building Cross-Platform Mobile Applications, Packt Publishing, 2nd Edition, 2022.
3. Google Developers, Flutter Documentation and Dart Language Guide, Google Developers Documentation (Latest Edition).

Web links and Video Lectures (e-Resources):

1. Flutter Official Documentation – https://docs.flutter.dev
2. Dart Programming Language – https://dart.dev
3. MDN Web Docs (HTML, CSS & JavaScript) – https://developer.mozilla.org
4. W3Schools Web Tutorials – https://www.w3schools.com
5. freeCodeCamp – https://www.freecodecamp.org
6. Google Codelabs – https://codelabs.developers.google.com
7. Flutter YouTube Channel – https://www.youtube.com/@flutterdev
8. freeCodeCamp YouTube Channel – https://www.youtube.com/@freecodecamp

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Interactive hands-on laboratory sessions with live coding demonstrations.
2. Project-Based Learning (PBL) through the development of responsive websites and mobile applications.

Self-Learning (SL) Activity	Number of Hours / Semester
Online tutorial(s)	02 (minimum)

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Experimental Fluid Mechanics			
Course Code	1BASL307B / 1BAEL307B	Scheme	2025
Type of Course	Ability Enhancement Course Laboratory (AEC)	Semester	III
Teaching Hours/Week (L :T : P)	28 (0: 0: 2)	CIE Marks	50
Total Hours of Pedagogy L :T:P:SLTW	30 (0: 0: 28: 2)	SEE Marks	50
Credits	01	Total Marks	100
Type of Examination	Practical	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Conduct experiments to calibrate flow measuring devices such as Venturimeter, Orificemeter, and Rectangular Notch, and compare the experimental results with theoretical predictions.

CO2: Determine the hydraulic coefficients of orifices and evaluate fluid properties such as viscosity using standard experimental techniques.

CO3: Verify the fundamental principles of fluid mechanics, including Bernoulli's equation and Reynolds experiment, through laboratory investigations.

CO4: Analyze major and minor head losses in pipe flow systems, including losses due to fittings, sudden contraction, and friction, using experimental data.

CO5: Evaluate the characteristics of fluid flow and jet impact by interpreting experimental observations and comparing them with theoretical concepts.

SET OF EXPERIMENTS

1. Calibration of Venturimeter and Determination of the discharge of water using venturimeter and verify with the theoretical values.
2. Calibration of Orificemeter and Determination of the discharge of water using Orificemeter and verify with the theoretical values.
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. Impact of Jet over a flat surface.
12. Determination of state of flow in a closed conduit using Reynolds Experiment.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. R.K. Rajput, *Fluid Mechanics and Hydraulic Machines*, S. Chand Publishing, Latest Edition
2. P.N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House, Latest Edition.
3. Y.A. Çengel and J.M. Cimbala, Fluid Mechanics: Fundamentals and Applications, McGraw-Hill Education, Latest Edition.

Reference books / Manuals:

1. Frank M. White, *Fluid Mechanics*, McGraw-Hill Education, Latest Edition.
2. John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, and Lynne B. Jack, Fluid Mechanics, Pearson Education.
3. Victor L. Streeter, E. Benjamin Wylie, and Keith W. Bedford, *Fluid Mechanics*, McGraw-Hill Education.

Web links and Video Lectures (e-Resources):

1. NPTEL – Introduction to Fluid Mechanic by Prof. Suman Chakraborty, IIT Kharagpur https://nptel.ac.in/courses/112105269
2. MIT OCW – Fluid Mechanics - https://ocw.mit.edu/courses/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/pages/fluid-mechanics/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Demonstration of fluid mechanics laboratory equipment such as Venturimeter, Orificemeter, Reynolds apparatus, Bernoulli's apparatus, and pipe friction setup, followed by hands-on experimentation.
2. Use of computational tools and simulation software (e.g., MATLAB, ANSYS Fluent, or OpenFOAM) to visualize fluid flow behavior and compare simulation results with experimental observations.
3. Flipped-classroom approach with pre-laboratory video demonstrations, laboratory manuals, and reading materials on flow measurement techniques, Bernoulli's principle, Reynolds number, and head loss before performing experiments.
4. Group-based laboratory exercises and mini-projects involving experimental analysis of flow systems, data acquisition, uncertainty analysis, and technical report preparation to enhance teamwork, analytical, and problem-solving skills.

Self-Learning (SL) Activity	Number of Hours / Semester
Online tutorial(s)	02 (minimum)

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Drone Development and Operations			
Course Code	1BASL307C / 1BAEL307C	Scheme	2025
Type of Course	Ability Enhancement Course Laboratory (AEC)	Semester	III
Teaching Hours/Week (L :T : P)	28 (0: 0: 2)	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	30 (0: 0: 28: 2)	SEE Marks	50
Credits	01	Total Marks	100
Type of Examination	Practical	Exam Hours	03

Course outcome (Course Skill Set)

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

CO1: Identify and classify drone/UAV components, subsystems, configurations, and their applications in aerospace engineering.

CO2: Perform flight simulator training exercises, including simulator familiarization, pre-flight checks, take-off, cruise, advanced manoeuvres, approach, landing, gimbal operations, and abnormal/emergency procedures in accordance with DGCA Remote Pilot Flight Simulator Training requirements.

CO3: Estimate the power, thrust, propulsion, and endurance requirements for drone/UAV systems using fundamental engineering principles.

CO4: Simulate drone flight dynamics, configure flight controller firmware, and calibrate on-board sensors using open-source simulation and ground control software.

CO5: Develop and execute autonomous flight missions, perform mission planning, and process aerial survey data using open-source mission-planning and photogrammetry tools.

SET OF EXPERIMENTS

1. Study and identification of drone/UAV components and subsystems (frame, motors, ESCs, propellers, flight controller, battery, sensors, GCS) and classification of UAVs (fixed-wing, multi-rotor, hybrid VTOL).
2. Assemble a simple quadcopter by integrating the different elements of the quadcopter system for demonstrating basic flying operations
3. Understand either through simulation / experiments drone communication and telemetry analysis by configuring telemetry modules and measurement of flight parameters
4. Demonstrate integration of a lightweight payload such as camera or a sensor to the quadcopter assembled and study the changes in stability, cg and endurance
5. Learn to Fly: Basic Simulator familiarization, controlled take off, hover, climb and descent Flight Maneuvers: Coordinated Left/right turns, rectangular circuit, figure of Eight.
6. Install firmware (PX4/ArduPilot), configure flight controller, calibrate accelerometer, gyroscope, compass, radio, and ESCs.
7. Investigate various aspects of propulsion systems and evaluate their performance such as measurement of motor rpm, thrust, current consumption and efficiency
8. Ground Control Operations: Mission Planning, Waypoint Navigation, Telemetry Monitoring
9. Flight-controller firmware configuration and IMU/compass/accelerometer sensor calibration using the open-source APM Planner 2 / Betaflight Configurator.
10. Autonomous mission programming and MAVLink command scripting using the open-source MAVSDK-Python / DroneKit-Python library with PX4 SITL.
11. Aerial image acquisition, photogrammetry and orthomosaic/3D-map generation using the open- source OpenDroneMap toolchain, with post-processing in QGIS.
12. Develop a report evaluating the performance characteristics of Li-ion and similar batteries measuring the voltage and discharge characteristics, flight endurance and charging procedures

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Reg Austin, "Unmanned Aircraft Systems: UAV Design, Development and Deployment", John Wiley & Sons, 2010.
2. Randal W. Beard and Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, 2012.
3. Quan Quan, "Introduction to Multicopter Design and Control", Springer, 2017.

Reference books / Manuals:

1. ArduPilot Development Team, "ArduPilot Documentation" (Open-source Manual), ardupilot.org.
2. PX4 Development Team, "PX4 User Guide" (Open-source Manual), docs.px4.io.
3. Directorate General of Civil Aviation (DGCA), Government of India, "Remote Pilot Licence Examination & Syllabus – Category 1 (Flight Simulator Training)" (Official Document), Digital Sky Platform, digitalsky.dgca.gov.in.

Web links and Video Lectures (e-Resources):

1. PX4 Autopilot Official Documentation – https://docs.px4.io
2. ArduPilot Official Documentation – https://ardupilot.org/ardupilot
3. QGroundControl User Guide – https://docs.qgroundcontrol.com
4. OpenDroneMap Documentation – https://docs.opendronemap.org
5. NPTEL Online Course: Aeromechanics of Unmanned Aerial Vehicles / Drones by Prof. Abhishek, IIT Kanpur https://nptel.ac.in/courses/101104807
6. DGCA Remote Pilot Licence Syllabus – Flight Simulator Training (Official, DGCA/Digital Sky) – https://www.dgca.gov.in/digigov-portal/?dynamicPage=CivilAviationReqContent/6/256/viewDynamicRuleContLvl2/html&maincivilAviationRequirements/6/0/viewDynamicRulesReq

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Demonstration of drone hardware components followed by hands-on assembly sessions in the laboratory.
2. Use of open-source simulation software (PX4 SITL, Gazebo, QGroundControl) for virtual experimentation prior to hardware trials.
3. Flipped-classroom approach with pre-lab video lectures/reading on drone subsystems and flight principles.
4. Group-based mini-project involving autonomous mission execution and aerial data analysis/reporting.

Self-Learning (SL) Activity	Number of Hours / Semester
Online tutorial(s)	02 (minimum)

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Spreadsheet for Engineers with VBA Basics			
Course Code	1BASL307D / 1BAEL307D	Scheme	2025
Type of Course	Ability Enhancement Course Laboratory (AEC)	Semester	III
Teaching Hours/Week (L :T : P)	28 (0: 0: 2)	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	30 (0: 0: 28: 2)	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2Hrs

Course outcome (Course Skill Set)

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

CO1: Apply spreadsheet functions, formulas, and charting techniques to organize, analyze, and visualize engineering data effectively.

CO2: Develop engineering solutions using logical, conditional, lookup, and mathematical functions in spreadsheets for data analysis and decision-making.

CO3: Analyze engineering datasets using regression analysis, curve fitting, optimization, iterative methods, and matrix operations in spreadsheets.

CO4: Develop VBA programs, user-defined functions, macros, and user forms to automate engineering computations and spreadsheet operations.

CO5: Implement numerical methods such as numerical integration and differential equation solvers using spreadsheets and VBA for solving engineering problems.

SET OF EXPERIMENTS

1. Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, and create a combination chart.
2. Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using the CONVERT Function to Convert Units.
3. Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4. Regression Analysis: Trend line, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multi linear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis Tool Pack.
5. Iterative Solutions Using Excel: Using Goal Seek in Excel, Using the Solver to Find Roots, Finding Multiple Roots, Optimization Using the Solver, Minimization Analysis, Non-Linear Regression Analysis.
6. Matrix Operations Using Excel: Adding Two Matrices, multiplying a Matrix by a Scalar, Multiplying Two Matrices, transposing a Matrix, inverting a Matrix and Solving System of Linear Equations.
7. VBA User-Defined Functions (UDF): The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The for Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function the Excel Object Model, For Each Next Structure.
8. VBA Subroutines or Macros: Recording a Macro, coding a Macro Finding Roots by Bisection, Using Arrays, adding a Control and Creating User Forms.
9. Develop spreadsheets for beam stress, deflection, factor of safety and design of springs. VBA to be used for automation
10. Design and develop a spreadsheet application for engineering analysis (e.g., material selection, cost estimation, project scheduling, flight performance estimation etc.) using formulas, charts, Solver, and VBA.

11. Numerical Integration Using Excel: The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, creating a User-Defined Function Using the Simpson's Rule.
12. Differential Equations: Euler's Method, Modified Euler's Method, The Runge, Kutta Method, Solving a Second Order Differential Equation.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Excel Resources - 600+ Self Study Guides, Articles & Tools (wallstreetmojo.com).
2. Mc Fedries Paul Microsoft Excel 2019 Formulas and Functions Microsoft Press, U.S, 2019 Edition.
3. John Walkenbach, Excel 2019 Bible, Wiley Publications, 2019.

Reference books / Manuals:

1. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, McGraw-Hill Education, 8th Edition, 2021.
2. David M. Bourg, Excel Scientific and Engineering Cookbook, O'Reilly Media, 2006.
3. Michael Alexander and Richard Kusleika, Excel 2019 Power Programming with VBA, Wiley Publications, 2019.

Web links and Video Lectures (e-resources):

1. Microsoft Learn: Excel Training - https://support.microsoft.com/en-us/excel
2. Microsoft Learn: Get Started with VBA in Office - https://learn.microsoft.com/en-us/office/vba/library-reference/concepts/getting-started-with-vba-in-office
3. Excel Easy – Free Excel Tutorials https://www.excel-easy.com/
4. NPTEL: Decision Making with Spreadsheet by Prof. Ramesh Anbanandam, IIT Roorkee - https://nptel.ac.in/courses/110107157

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Hands-on Laboratory Sessions: Students perform spreadsheet-based engineering computations and VBA programming through guided laboratory exercises.
2. Demonstration-Based Learning: Instructor demonstrations of Excel functions, data analysis tools, Solver, Goal Seek, and VBA programming followed by student implementation.
3. Case Study Approach: Analysis of engineering datasets from civil, mechanical, electrical, aerospace, and manufacturing applications using Excel and VBA.

Self-Learning (SL) Activity	Number of Hours / Semester
Online tutorial(s)	02 (minimum)

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

Community Project (Project Based Learning) Societal Project [Common to all disciplines of Engineering]			
Course Code	1BCP308	Scheme	2025
Type of Course	SDC	Semester	III
Teaching Hours/Week (L :T : P)	30 (0:0:0)	CIE Marks	50
Total Hours of Pedagogy CI(L :T):LI(P):SL:TW	30 (0:0:0:30)	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	02

Course objective:

Rapid urbanisation, population growth, environmental concerns, energy demand, water scarcity, waste management, transportation issues and rural development challenges have created practical problems affecting communities and public welfare. This course aims to integrate technical knowledge, field exposure and societal engagement so that students identify real community issues, frame problem statements and attempt appropriate, feasible and sustainable engineering responses within the scope of a one-semester project.

Course outcome (Course Skill Set):

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

CO1 (L2 – Understand): Identify and analyse societal problems through field interaction and technical assessment.

CO2 (L3 – Apply): Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.

CO3 (L4 – Analyse): Formulate feasible engineering problem statements and solutions considering practical constraints and sustainability aspects.

CO4 (L3 – Apply): Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.

CO5 (L4 – Analyse): Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.

CO6 (L5 – Evaluate): Demonstrate teamwork and communication skills while interacting with technical and non-technical stakeholders and reflect on project impact on society.

Restrictions and professional conduct:

Community / Societal Projects shall remain **academic, socially responsible, technically focused, and politically neutral**. Students and faculty shall maintain professionalism, ethical conduct, public respect and institutional integrity while interacting with communities, public groups, organisations and stakeholders.

Students and faculty **shall avoid** the following during project execution:

- Association with political party activities, campaigns or propaganda.
- Participation in activities that may disturb communal harmony, public order or institutional reputation.
- Use of the project platform for personal, political, ideological or commercial promotion.
- Disrespectful, discriminatory or unethical interaction with community members or stakeholders.

Projects must also recognise constraints related to **cost, resources, environment and safety, and stakeholder behaviour/cooperation/acceptance** when planning and implementing activities.

Sustainable Development Goals

The faculty shall encourage students to undertake community projects that align with and contribute towards satisfying the National Board of Accreditation (NBA) Criterion 3.6, namely, Evidence of Addressing Sustainable Development Goals (SDGs), which is a major emphasis of the United Nations (UN). The Sustainable Development Goals (SDGs) are illustrated in the figure shown below:

Methods for project identification:

Students may identify the project topic using one or more of the following methods:

- Interaction with local rural or urban stakeholders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.
- Review of issues highlighted in print and electronic media, and social networks (WhatsApp, Facebook, X, Instagram, etc.).
- After selecting a broad topic, students shall collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and then define the problem statement and objectives clearly.

List of Project Topics and Engineering Outcomes:

The following structured sequence of activities is to be carried out during the semester:

Sl. No.	Project title	Measurable engineering outcome	Mapped POs	SDGs
1	Rural and urban water conservation and management systems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 6, SDG 11, SDG 12
2	Waste management and recycling	Conduct waste audit, classify waste streams, and design a segregation/recycling workflow with measurable reduction in mixed waste.	PO2, PO3, PO4, PO6, PO8, PO10	SDG 11, SDG 12, SDG 13
3	Afforestation	Identify a degraded area, prepare plantation layout, and demonstrate survival-rate tracking and maintenance schedule for saplings.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15

Sl. No.	Project title	Measurable engineering outcome	Mapped POs	SDGs
4	Biogas generation and power generation	Estimate organic waste availability, size a small biogas system, and document expected gas output or energy yield.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 11, SDG 12
5	DPR for solar power rural plant	Prepare a DPR with load assessment, panel sizing, cost estimate, and projected energy generation and payback.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 11
6	DPR for electrification of village/tribal community	Map unserved/underserved households, propose electrification layout, and estimate coverage, losses, and implementation cost.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 7, SDG 9, SDG 10
7	DPR for rural drainage system	Survey drainage bottlenecks, develop a drainage layout, and estimate runoff handling capacity and flood-risk reduction.	PO1, PO2, PO3, PO4, PO6, PO10	SDG 6, SDG 9, SDG 11
8	Sustainability and environmental health projects	Assess local environmental health issues and propose interventions with measurable improvement in hygiene, safety, or resource use.	PO2, PO3, PO4, PO6, PO7, PO8	SDG 3, SDG 6, SDG 11, SDG 12
9	Plastic free campaigns	Measure plastic usage before and after awareness intervention and report percentage reduction or behavioural change.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
10	Health and nutrition awareness	Conduct baseline and post-program awareness survey and document improvement in awareness score or adoption of healthier practices.	PO2, PO6, PO7, PO8, PO9, PO10	SDG 2, SDG 3, SDG 11
11	Societal projects involving health wellness	Identify a community health need and develop an awareness/service module with measurable participation and feedback outcomes.	PO2, PO3, PO6, PO8, PO9, PO10	SDG 3, SDG 11, SDG 17
12	Air quality monitoring system	Collect air-quality data, compare with reference limits, and present trends along with possible mitigation suggestions.	PO2, PO3, PO4, PO5, PO6, PO10	SDG 3, SDG 11, SDG 13
13	Plastic waste reduction campaign	Track collection, segregation, and replacement actions, and quantify reduction in plastic waste generation or littering.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
14	Urban greening projects	Prepare greening plan, identify planting locations, and assess environmental benefits such as shade, aesthetics, or heat mitigation.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
15	Smart agriculture solution	Design a low-cost monitoring or irrigation support solution and estimate improvement in water use efficiency or crop support.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 9
16	Smart irrigation system	Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 12
17		Deliver a structured mentoring activity and measure participation, engagement, and skill/awareness improvement.	PO6, PO8, PO9, PO10, PO11	SDG 4, SDG 10,

	Youth mentoring programmes			SDG 17
Sl. No.	**Project title**	**Measurable engineering outcome**	**Mapped POs**	**SDGs**
18	Adult education	Conduct learner-needs assessment, prepare instructional content, and measure improvement in basic literacy or numeracy indicators.	PO6, PO8, PO9, PO10, PO11	SDG 4, SDG 10, SDG 17
19	Food security initiatives / cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 9, SDG 12
20	Human rights awareness with legal systems	Prepare and deliver an awareness module and assess increase in legal awareness and access-to-rights understanding.	PO6, PO7, PO8, PO9, PO10	SDG 5, SDG 10, SDG 16
21	House tax collection through digital media	Develop a simple digital workflow or awareness support and measure improvement in compliance, convenience, or response time.	PO2, PO3, PO4, PO5, PO10, PO11	SDG 9, SDG 11, SDG 16
22	Use of application / application program	Build or demonstrate a useful community app and measure usability, adoption, or efficiency improvement.	PO1, PO3, PO4, PO5, PO9, PO10	SDG 9, SDG 11, SDG 17
23	Creation of Panchayat library	Plan the library model, catalogue resources, and measure usage, accessibility, or participation outcomes.	PO6, PO8, PO9, PO10, PO11	SDG 4, SDG 10, SDG 11, SDG 17

Suggested Learning Resources:

Textbooks:

1. **Phadke, N. D**. Community Engagement and Social Innovation. 1st ed., Oxford University Press, New Delhi.
2. **Garg, N. R**. Project-Based Learning in Engineering Education. 1st ed., Pearson India Education Services, Noida.
3. **Gupta, A. and P. Singh.** Service Learning and Community Projects. 1st ed., McGraw-Hill Education (India), New Delhi.
4. **Wilson, G.** Practical Guide to Community Development Projects. 2nd ed., Routledge, London.

Reference books:

1. NPTEL courses on Project-Based Learning and Social Innovation.
2. SWAYAM courses on community engagement and sustainability.
3. UN Sustainable Development Goals portal: https://sdgs.un.org
4. MyGov India and local civic body portals for community initiatives.
5. YouTube resources on design thinking, social innovation, and community service learning.
6. NGO and government field-action case studies related to sanitation, water, health, education, and environment.

Web links and Video Lectures (e-Resources):

1. NPTEL courses on Engineering Geology (IIT Roorkee, IIT Kharagpur).
2. NPTEL courses on Soil Mechanics and Foundation Engineering (IIT Delhi, IIT Bombay).
3. Virtual Labs – Geotechnical Engineering Virtual Lab (IIT Kanpur): https://vlab.co.in
4. Geological Survey of India (GSI) – Maps, reports, and publications: https://www.gsi.gov.in
5. YouTube channels: Civil Engineering Essentials, The Engineering Classroom (soil mechanics experiments).
6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards

Teaching Learning Process:

The suggested TLP for Community / Societal Project is as follows;

Week / Phase	Teaching–Learning Activity	Faculty Role	Student Activity	Output / Evidence
1	Course introduction, objectives, ethics, conduct, and assessment briefing	Explain course scope, rules, rubrics, and expected deliverables	Understand course requirements and form teams	Team list, course plan
2	Community problem identification and topic selection	Guide topic framing and feasibility	Identify local issues through discussion and observation	Shortlisted project topic
3	Stakeholder interaction and preliminary survey	Demonstrate survey methods and stakeholder engagement	Collect initial data from community/users	Survey notes, interview record
4	Problem statement and objective formulation	Review and refine problem statement	Prepare problem statement, scope, and objectives	Approved problem statement
5	Literature/case study review and baseline analysis	Suggest relevant references and examples	Study existing solutions and compare approaches	Baseline analysis summary
6	Project planning and role assignment	Help teams organize tasks, timeline, and responsibilities	Plan activities, divide roles, and prepare schedule	Work plan / Gantt chart
7	Feasibility analysis and solution brainstorming	Check technical feasibility and practicality	Generate possible engineering solutions	Solution alternatives sheet
8	Selection of final solution and design approach	Review final concept and design logic	Finalize concept, methods, and expected outcome	Concept note / design outline
9	Data processing / calculations / sizing / mapping	Support computations and technical review	Analyze data, perform calculations, prepare maps/charts	Technical analysis sheet
10	Prototype / model / audit / DPR / app development	Monitor progress and correct technical issues	Develop the selected output	Working model / draft DPR / map / app

Week / Phase	Teaching–Learning Activity	Faculty Role	Student Activity	Output / Evidence
11	Testing, refinement, and implementation planning	Evaluate technical correctness and improvements	Test prototype or validate proposal with users	Test results / revised output
12	Field implementation / demonstration / awareness activity	Facilitate community interaction and documentation	Conduct implementation or demonstration	Photos, attendance, implementation record
13	Documentation of outcomes, feedback, and impact	Review report structure and completeness	Compile findings, stakeholder feedback, and observations	Draft report
14	Presentation preparation and viva practice	Conduct mock presentation and feedback	Prepare slides/poster and rehearse	Presentation deck
15	Final presentation, submission, and reflection	Evaluate performance using rubrics	Present project, submit report, reflect on learning	Final report, presentation, viva

Assessment structure:

A. Continuous Internal Evaluation (CIE) – 50 marks

- Students, in batches of 3–4, shall undertake at least one project (or a combination of two related activities) aiming, as far as possible, at a logical implemented or implementable outcome.
- CIE will be conducted by a departmental committee (HoD/nominee, guide and one senior faculty) using the following rubrics totalling 50 marks:

CIE pass requirement:

- A student shall secure a minimum of 20 marks out of 50 in CIE to become eligible to appear for SEE.
- Students who fail to earn the required CIE marks may be given additional opportunities before closure of the semester; no re-doing of CIE is permitted after the end of the semester.

B. Semester End Examination (SEE) – 100 marks (scaled to 50)

- Examination duration: 2 hours.
- Maximum examination marks: 100 (entered as 100 in the VTU portal; the ITI-SMU module automatically scales 100 → 50 for result processing).
- The SEE shall be conducted batch-wise by a committee of three faculty: project guide, one faculty from the same department and one from a different department.

SEE pass requirement and overall passing rule:

- For a pass in SEE, a student shall secure minimum 35 marks out of 100.
- For declaration of a pass grade, the sum of CIE marks (out of 50) and scaled SEE marks (out of 50) shall be ≥ 40; otherwise, the student is awarded grade F (Fail).

CIE Rubric — Continuous Internal Evaluation (Total 50 marks):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & Relevance to society/industry/community	8	Problem is clearly identified with strong evidence of societal relevance and well-defined scope.	Problem is relevant and scope is clear with adequate supporting evidence.	Problem defined but justification or evidence is weak.	Problem unclear or not relevant; little/no supporting evidence.
Formation of problem statement; Engineering approach, innovation & feasibility	10	Problem statement is precise; approach is sound, innovative and clearly feasible.	Problem statement adequate; approach feasible with minor gaps.	Problem statement partial; approach feasibility is marginal.	Problem statement missing or approach not feasible.
Interaction with stakeholders; Data collection, analysis & interpretation	8	Thorough stakeholder engagement; data collection is comprehensive; analysis is well-interpreted.	Good engagement; data and analysis adequate with minor gaps.	Limited engagement; data incomplete and analysis superficial.	Little/no stakeholder contact; insufficient or no data/ analysis.
Project documentation; Clarity, organization & problem-solving demonstrated	10	Documentation is complete, well-organized, analytical, and shows strong problem-solving.	Documentation complete and clear with some analytical content.	Documentation basic with omissions; problem-solving limited.	Documentation missing/poorly organized; no clear problem-solving .
Communication & Presentation skills	6	Presentation is confident, structured, and answers queries fully; visuals effective.	Presentation clear and satisfactory; responds to most queries.	Presentation acceptable but lacks clarity or confidence; weak responses.	Presentation poor or absent; unable to respond.
Contribution & Benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and sustainability; realistic path to implementation.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear societal benefit; sustainability not well addressed.	No evident benefit or sustainability; project not community-oriented.

Notes for CIE rubric:

- Minimum CIE pass requirement: 20/50 to be eligible for SEE. [Use departmental committee (HoD/guide + senior faculty) to apply the rubric and record marks.]

SEE Rubric — Semester End Examination (Enter marks out of 100; scaled to 50 later):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & Relevance to society/industry/ community	16	Problem and relevance are articulated clearly with strong evidence and context.	Problem relevance clear with reasonable evidence.	Problem stated but evidence/ context weak.	Problem poorly defined or irrelevant.
Formation of problem statement; Engineering approach, innovation & feasibility	20	Problem statement is precise; approach demonstrates engineering depth, novelty and feasibility.	Approach is technically sound and feasible with minor limitations.	Approach basic; limited technical depth or feasibility concerns.	No viable engineering approach or infeasible plan.
Interaction with stakeholders; Data collection, analysis & interpretation	16	Excellent stakeholder engagement; rigorous data collection and insightful analysis.	Good engagement and acceptable analysis.	Superficial data collection and limited analysis.	Inadequate or no data; poor analysis.
Project documentation; Clarity, technical rigor & problem-solving demonstrated	20	Report is comprehensive, technically rigorous, and demonstrates systematic problem-solving.	Report is complete and technically correct with minor gaps.	Report lacks technical depth or has notable omissions.	Report missing key elements or technically incorrect.
Communication, Presentation & Viva-voce responses	12	Candidate presents expertly, defends work persuasively and answers all queries correctly.	Good presentation and satisfactory answers to most queries.	Presentation adequate but fails to answer some technical questions.	Poor presentation and unable to defend work.
Contribution & Benefit to society; Impact assessment & sustainability	16	Clear, evidence-based assessment of social impact and Sustainability with scaling recommendations.	Reasonable impact discussion and sustainability considerations.	Limited evaluation of impactor sustainability.	No coherent assessment of impact or sustainability.

SEE pass rule:

- Student must secure at least 35/100 in SEE itself to be eligible for pass consideration.
- Final passing is based on CIE (out of 50) + SEE (scaled to 50) >= 40. Otherwise, grade F (Fail) is awarded.

Suggested implementation notes (for BoS / exam committees):

- Use numerical scores from the rubric and keep brief evaluator comments for each criterion.
- For team projects: record individual contribution within the documentation and adjust individual marks using a peer-evaluation sheet or guide's assessment.
- Maintain evidence (field notes, photos, questionnaires, DPRs, reports) as annexures for SEE moderation.
- Use standardized score sheet (spreadsheet) mapping rubric items to columns for easy aggregation and archival.

Additional Mathematics -I (Common to all Branches)

Course Code	1BMATDIP310	Scheme	2025
Type of Course	NCMC	Semester	III
Teaching Hours/Week (L: T: P)	28 (2:0:0)	MCQ online exam Marks	50
Total Hours of Pedagogy per semester CI (L /T):LI(P):SL&TW:	42 (3:0:0:0)		
Credits	0	Total Marks	100
Total Hours of Pedagogy	42	Exam Hours	--

Course objectives (COS):

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

CO1: Provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists

CO2: Apply the knowledge of the co-ordinate system to analyze the polar co-ordinate system.

CO3: Familiarize the importance of calculus associated with one variable and multivariable for all branches of the engineering.

CO4: Analyze the importance of the integral calculus and their application to real-world problems.

CO5: Emphasize the knowledge of the vector calculus to all branches of engineering.

CO6: Develop the knowledge of Linear Algebra to solve the system of equations.

Module-1: Polar Curves and Curvature

Polar coordinates, Polar curves, angle between the radius vector and the tangent, angle between two curves. Pedal equations. Indeterminate forms: L'Hospital's rule ($\frac{\infty}{\infty}, \infty - \infty, 0^0, 1^\infty$).

(RBT Levels: L1, L2 and L3) Number of Hours: 08

Module-2: Partial Differentiation

Introduction: Partial derivatives, total derivative - differentiation of composite functions, Jacobian and problems. Taylor's and Maclaurin's series expansion for one variable (Statement only) – problems

(RBT Levels: L1, L2 and L3) Number of Hours: 09

Module-3: Integral Calculus

Statement of reduction formulae for $\sin^n(x), \cos^n(x)$ and $\sin^m(x)\cos^n(x)$ and illustrative problems.

Evaluation of double integrals and triple integrals-Simple examples.

Applications: Area of the region.

(RBT Levels: L1, L2 and L3) Number of Hours: 09

Module-4: Vector Calculus

Differentiation of vector functions: Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence and Curl, Solenoidal and irrotational vector fields-Problems.

(RBT Levels: L1, L2 and L3) Number of Hours: 09

Module-5: Linear Algebra

Introduction to linear algebra:

Elementary row transformation of a matrix, Rank of a matrix. Consistency and Solution of system of linear equations - Gauss-elimination method, Gauss Siedel method. Eigenvalues and Eigenvectors (2×2).

(RBT Levels: L1, L2 and L3) Number of Hours: 09

Suggested Learning Resources

Textbooks:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2021
2. Gilbert Strang, Linear Algebra and its Applications, Cengage Publications, 4th Ed., 2022.
3. Erwin Kreyszig . Advanced Engineering Mathematics, wiley

Reference Books:

1. H K Das and Rajaneesh Varma, Higher Engineering Mathematics, S. Chand.
2. B. V. Ramana, Higher Engineering Mathematics, McGraw Hill.
3. Mangey Ram, Mathematics in Engineering Sciences, CRC Press
4. N. P. Bali, Manish Goyal - A Textbook of Engineering Mathematics, Laxmi Publications
5. David Poole, Linear Algebra, Cengage Learning India Pvt Ltd.

Web links and e-Resources:

- NPTEL (National Programme on Technology Enhanced Learning) – Mathematics: https://nptel.ac.in/..
- SWAYAM learning modules on Engineering mathematics.
- https://www.coursera.org/ Mathematics for Engineering Specialization

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- ICT-Enabled Teaching.

Assessment Structure:

The assessment marks for this course are divided equally between Continuous Internal Evaluation (CIE) and Multiple-Choice Questions (MCQ) based examination. The MCQ examination will be conducted through online mode by the center for online education, Mysore.

The CIE Theory component consists of sum of **TWO CIE** tests for 25 marks each.

- To pass the course, a student must score minimum **40% (20 marks) of 50 marks in CIE and MCQ each**.

Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and MCQ online examination is at least 40 out of 100 marks**.