

Course Title	COMPLEX VARIABLES AND NUMERICAL METHODS	Semester	IV
Course Code	MVJ19MAE41 /MAS41/MME41	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1 : 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course enables students to:

- Understand the concepts of Complex variables and transformation for solving Engineering Problems
- Understand the concepts of complex integration, Poles and Residuals in the stability analysis of engineering problems
- Apply the concept to find extremal of functionals.
- Solve initial value problems using appropriate numerical methods
- Students learn to obtain solutions of ordinary and partial differential equations numerically.

#### Module-1

L2,L3,L4

8 Hours

##### Complex variables - 1:

Functions of complex variables, Analytic function, Cauchy-Riemann Equations in cartesian and polar coordinates, Consequences of Cauchy-Riemann Equations, Construction of analytic functions (Using Milne-Thomson method).

##### Transformations:

Bilinear Transformation, Conformal transformation, Discussion of the transformations,  $w = z^2$ ,  $w = e^z$  and  $w = z + \frac{a}{z}$ , ( $z \neq 0$ ).

Experiential Learning: (Experiments which can be conducted on the concepts of contents)

Video Links:[https://youtu.be/cp7\\_ZF2kNi4](https://youtu.be/cp7_ZF2kNi4)

#### Module-2

L2,L3,L4

8 Hours

##### Complex variables-2:

Complex integration - Cauchy theorem, Cauchy's Integral Theorem-Problems, Taylor & Laurent series- Problems, Singularities, Types of Singularities, Poles, Residues-definitions, Cauchy residue theorem - Problems.

Experiential Learning: (Experiments which can be conducted on the concepts of contents)

Video Links:<https://youtu.be/WZiyL6pcItY>

<b>Module-3</b>	<b>L2,L3</b>	<b>8 Hours</b>
<b>Numerical methods-1:</b> Numerical solution of Ordinary Differential Equations of first order and first degree, Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order, Milne's and Adam Bashforth Predictor and Corrector method. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links: <a href="https://youtu.be/b5VUnapu-qs">https://youtu.be/b5VUnapu-qs</a>		
<b>Module-4</b>	<b>L2,L3</b>	<b>8 Hours</b>
<b>Numerical methods-2:</b> Numerical solution of Ordinary Differential Equations of second order : Runge-Kutta method of fourth order, Milne's Predictor and Corrector method.(Text Book 1- Chapter 32-32.12) <b>Calculus of variations:</b> Variation of function and Functional, variational problems. Euler's equation, Geodesics and hanging chain problem. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links: <a href="https://youtu.be/qTDDFMA7j4">https://youtu.be/qTDDFMA7j4</a>		
<b>Module-5</b>	<b>RBT Level</b>	<b>8 Hours</b>
<b>Numerical methods-3:</b> Numerical solution of Partial Differential Equations: Introduction, Finite difference approximations to derivatives, Numerical Solution of Laplace Equation, Numerical solution of one-dimensional heat equation by Bendre - Schmidt's method and by Crank-Nicholson Method. Numerical solution of one-dimensional wave equation Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links: <a href="https://youtu.be/nNnnBMF03II">https://youtu.be/nNnnBMF03II</a>		
<b>Course outcomes:</b>		
CO1	State and prove Cauchy - Riemann equation with its consequences and demonstrate Con-formal Transformation.	
CO2	Illustrate Complex Integration using Cauchy's Integral theorem, Cauchy's Integral formula and Cauchy's Residue theorem.	
CO3	Identify appropriate numerical methods to solve ODE.	
CO4	Determine the extremals of functionals and solve the simple problems of the calculus of variations.	
CO5	Choose appropriate numerical methods to solve Partial Differential Equations.	

Text Books:	
1	Prof G.B.Gururajachar "Engineering Mathematics-III , Academic Excellent series Publications, 2016-17
2	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43 <sup>rd</sup> Edition, 2013.
Reference Books:	
1	B.V.Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill, 2006
2	N.P. Bali & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8 <sup>th</sup> Edition.
3	H K Dass: " <b>Advanced Engineering Mathematics</b> "- S Chand & Company Ltd.12 <sup>th</sup> edition.

CIE Assessment:	
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests	
<ul style="list-style-type: none"> <li>- Quizzes/mini tests (10 marks)</li> <li>- Assignment (10 marks)</li> </ul>	
SEE Assessment:	
xxi. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.	
xxii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.	
xxiii. One question must be set from each unit. The duration of examination is 3 hours.	

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	INCOMPRESSIBLE AERODYNAMICS	Semester	IV
Course Code	MVJ19AE42/AS42	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3 : 2 : 0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hours

**Course objective is to:**

- Understand the basics of fluid mechanics as a prerequisite to Aerodynamics
- Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil
- Acquire knowledge of incompressible flows over airfoil
- Understand the fundamentals of incompressible flow over finite wings
- Assimilate the understanding of application of finite wing theory and high lift systems

**Module-1**

L1,L2,L3

10Hours

**Review of Basic Fluid Mechanics**

Continuity, momentum and energy equation, Control volume approach to Continuity, momentum and energy equation, Types of flow, pathlines, streamlines, and streaklines, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes. Vorticity, Angular velocity, Stream function, velocity potential function, Circulation, Numericals, Mach cone and Mach angle, Speed of sound.

Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds

Applications: provides a proper understanding of the flow properties and their characteristics features which helps in the study of flow over airfoils

Video link / Additional online information (related to module if any):

<https://nptel.ac.in/courses/101105059/>

**Module-2**

L1,L2,L3

10Hours

**Airfoil Characteristics**

Fundamental aerodynamic variables, Airfoil nomenclature, airfoil characteristics. wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, aerodynamic center, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. Types of drag-Definitions.

Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds

Applications: understand the characteristics and the distribution of pressure over the airfoil Video link / Additional online information (related to module if any): <https://nptel.ac.in/courses/101105059/>

<b>Module-3</b>	<b>L1,L2,L3</b>	<b>10Hours</b>
<p><b>Two Dimensional Flows &amp; Incompressible Flow Over Airfoil</b></p> <p>Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D'Alembert's paradox, Numericals, Incompressible flow over airfoils: Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. KuttaJoukowski theorem. and generation of Lift, Numerical.</p> <p>Laboratory Sessions/ Experimental learning: Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey.</p> <p>Applications: study the lifting and non lifting flows over cylinders and arbitrary bodies and understanding the theory behind lift generation</p> <p>Video link / Additional online information (related to module if any): <a href="https://nptel.ac.in/courses/101105059/">https://nptel.ac.in/courses/101105059/</a></p>		

<b>Module-4</b>	<b>L1,L2,L3</b>	<b>10Hours</b>
<p><b>IncompressibleFlowOverFiniteWings</b></p> <p>Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory: Downwash and induced drag. Elliptical and modified elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory-lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane</p> <p>Laboratory Sessions/ Experimental learning: Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.</p> <p>Applications: understanding the theory of lift generation over finite wings and their flow patterns</p> <p>Video link / Additional online information (related to module if any): <a href="http://web.iaa.ncku.edu.tw/~aeromems/Aerodynamics/Ch5.pdf">http://web.iaa.ncku.edu.tw/~aeromems/Aerodynamics/Ch5.pdf</a></p>		

<b>Module-5</b>	<b>L1,L2,L3</b>	<b>10Hours</b>
<p><b>Applications of Finite Wing Theory &amp; High Lift Systems</b></p> <p>Simplified horse-shoe vortex model, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, and typical aerodynamic characteristics. Introduction to high-lift systems, flaps, leading-edge slats and typical high – lift characteristics. Effects of thickness, camber and aspect ratio of wings, tip effects. Introduction to</p>		

Source panel & vortex lattice method

Laboratory Sessions/ Experimental learning: Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various angles of incidence, speed.

Applications: study the typical aerodynamics characteristics of swept wings and different types of high lift devices

Video link / Additional online information (related to module if any):

<https://nptel.ac.in/courses/101/106/101106035/>

**Course outcomes:**

CO211.1	Describe the fundamental equations of continuity, momentum & energy of fluid flow.
CO211.2	Evaluate typical airfoil characteristics and two-dimensional flows over airfoil
CO211.3	Analyze the incompressible flow over airfoil
CO211.4	Compute and analyze the incompressible flow over finite wings
CO211.5	Apply finite wing theory and analyze high lift systems

**Reference Books:**

1	Anderson J.D, Fundamental of Aerodynamics, 5th edition, McGraw-Hill International Edition, New York (2011), ISBN-13: 978-0073398105.
2	E. L. Houghton, P.W. Carpenter, Aerodynamics for Engineering Students, 5th edition, Elsevier, New York. (2010), ISBN-13: 978-0080966328
3	Clancy L. J., Aerodynamics, Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804
4	Louis M. Milne-Thomson, Theoretical Aerodynamics, Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804.

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

xxiv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xxv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxvi. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	0	1	1	0	1	1	0	11
CO2	3	3	2	3	0	1	1	0	1	1	0	1
CO3	3	3	3	3	1	1	1	0	1	1	0	1
CO4	3	3	3	3	1	1	1	0	1	1	0	1
CO5	3	3	3	2	1	1	1	0	1	1	0	1

High-3, Medium-2, Low-1

Course Title	FUNDAMENTALS OF AIRCRAFT STRUCTURES	Semester	IV
Course Code	MVJ19AE43	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1 : 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

1. Comprehend the basic concepts of stress strain and understand the different failure theories and to learn the concept of static strength
2. Illustrate the methods to design a structure against impact and fatigue loads.
3. Acquire the knowledge of types of loads on aerospace vehicles.
4. Understand the theory of elasticity.
5. Apply different Energy methods in calculations related to structural components and to understand the different methods to analyse columns

#### Module-1

L1,L2,L3

8Hours

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

Laboratory Sessions/ Experimental learning:

1. Determination of Stress concentration factor for static load.
2. Determine the strain in x-y-z directions using strain gauge for a given beam

Applications: Stress Analysis, Theory of failures

Video link / Additional online information (related to module if any):

<https://www.youtube.com/watch?v=NnvImUMfyyc>

#### Module-2

L1,L2,L3

8Hours

Design for Impact and Fatigue Strength: Impact Strength: Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Fatigue Strength: Introduction, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, modifying factors: size effect, surface effect, Stress



concentration effects, Fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

Laboratory Sessions/ Experimental learning:

1. Determine the notch sensitivity and impact toughness of engineering materials.
2. Demonstrate how fatigue tests are conducted and how to interpret results

Applications: Fatigue Testing, Combined Loading

Video link / Additional online information (related to module if any):

<https://www.youtube.com/watch?v=ZsIwEp574ho>

<https://www.youtube.com/watch?v=X-qUQ3xaTA>

### Module-3

L1,L2,L3

8Hours

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

**Spacecraft Structures:** Statically Determinate and Indeterminate structures, Analysis of plane truss, Method of joints, 3D Truss, Plane frames, Composite beam, Clapeyron's Three Moment Equation.

Laboratory Sessions/ Experimental learning:

1. Determination of Deflection in a beam by applying point load and combined loading.
2. Determine the deflection of composite beam

Applications: Analysis of Loads, Determinate and Indeterminate structures.

Video link / Additional online information (related to module if any):

[https://nptel.ac.in/courses/105105166/https://www.youtube.com/watch?v=q0\\_piF4-eNc](https://nptel.ac.in/courses/105105166/https://www.youtube.com/watch?v=q0_piF4-eNc)

### Module-4

L1,L2,L3

8Hours

**Theory of Elasticity:** Theory of Elasticity: Concept of stress and strain, derivation of Equilibrium equations, strain displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity. Principle Stresses and Orientation of Principle Directions.

**Columns:** Columns with various end conditions, Euler's Column curve, Rankine's formula, Column with initial curvature, Eccentric loading, southwell plot, Beam-column.

Laboratory Sessions/ Experimental learning:

1. Determine the Spring Stiffness for the given spring.
2. Buckling load of slender Eccentric Columns and Construction of Southwell Plot

Applications: Stress and Strain displacement, Columns

Video link / Additional online information (related to module if any):

<http://www.digimat.in/nptel/courses/video/112101095/L02.html><https://www.digimat.in/nptel/courses/video/105105177/L01.html>

### Module-5

L1,L2,L3

8Hours

**Energy Methods:** Strain Energy due to axial, bending and Torsional loads. Castigliano's theorem, Maxwell's Reciprocal theorem.

**Introduction to Shear Flow:** Symmetrical and Unsymmetrical bending Concept of shear flow – The shear centre and its determination – Shear flow distribution in symmetrical and unsymmetrical thin-walled sections.

Laboratory Sessions/ Experimental learning:

1. Verify Maxwell's Reciprocal theorem
2. Determining of Shear centre location for open sections-unsymmetrical bending

Applications: Maxwell's Theorem, Shear Flow and Shear Center

Video link / Additional online information (related to module if any):

<https://www.youtube.com/watch?v=149j7Ys0F58><http://www.nptelvideos.com/video.php?id=1637>

**Course outcomes:**

CO212.1	Apply the different failure theories to understand the concept of static strength.
CO212.2	Design a structure against fatigue loads and to design a material for impact load.
CO212.3	Analyze various loads experienced by an aircraft in flight and to understand the usage of different materials.
CO212.4	Assess compatibility conditions and boundary conditions to find the stress and strain of an elastic material.
CO212.5	Formulate different Energy methods in calculations related to structural components and to understand the different methods to analyse columns.

**Reference Books:**

1	Megson, T.H.G., "Aircraft Structures for Engineering Students", Edward Arnold, 6 <sup>th</sup> Edition 2017, Elsevier Aerospace Engineering series, ISBN-13: 978-0081009147, ISBN10: 9780081009147.
2	Bruhn E.F., "Analysis and Design of Flight Vehicles Structures", Tri-State offset Co.USA,1985
3	Bruce K Donaldson, "Analysis of Aircraft structures", Cambridge Aerospace Series, reprint 2012, ISBN- 9780511801631
4	Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw, Hill, N.Y, 2nd edition, 1993

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

xxvii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xxviii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxix. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	1	1	0	1	1	0	1
CO2	3	2	2	1	1	1	1	1	1	1	0	1
CO3	3	2	2	1	1	1	1	0	1	1	0	1
CO4	3	2	2	1	1	1	1	0	1	1	0	1
CO5	3	2	2	1	1	1	1	1	1	1	0	1

High-3, Medium-2, Low-1

Course Title	AIRCRAFT PROPULSION	Semester	IV
Course Code	MVJ19AE44	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1 : 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

**Course objective is to:**

- Understand and apply the basic thermodynamic principles in aircraft propulsion.
- Understand and solve the problems on turboprop, turbojet and turbofan engines.
- Acquire knowledge on subsonic and supersonic inlets.
- Describe the working of combustion chambers and nozzles.
- Understand the fundamentals of rocket propulsion.

**Module-1**

L1,L2

8Hours

Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two stroke and four stroke piston engines, Gas, turbine engines, Cycle analysis of reciprocating engines and jet engines , advantages and disadvantages, numerical problems

Laboratory Sessions/ Experimental learning:

1. Identify and demonstrate the various components of Guiberson T-1020 (9 cylinder radial engine) and Tumansky R-25-300 R-26 (Jet engine)

Applications: Automobile industries , Gas turbine industries and Power plants

Video link / Additional online information (related to module if any):

1. <https://youtu.be/XKcRf2R5h4o>
2. <https://youtu.be/fTAUq6G9apg>
3. [https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-enginesspring-2017/lecture-notes/MIT2\\_61S17\\_lec1.pdf](https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-enginesspring-2017/lecture-notes/MIT2_61S17_lec1.pdf)
4. <https://nptel.ac.in/courses/101106033/>

**Module-2**

L1,L2

8Hours

**Propeller Theories & Jet propulsion**

**Propeller Theories & Jet propulsion:** Types of propeller, Propeller thrust: momentum theory, Blade element theories, propeller blade design, and propeller selection.

**Jet Propulsion:** Illustration of working of gas turbine engine, the thrust equation, Factors affecting thrust, Effect of pressure, velocity and temperature changes of air entering compressor Methods of thrust augmentation, Characteristics of turboprop, turbofan and turbojet, Performance characteristics. Ramjet and Scramjet Engines.

**Laboratory Sessions/ Experimental learning:**

1. Analyze the performance of a 2 blade fixed pick propeller and plot the performance

**Applications:** Gas turbine and aircraft engine design industries

**Video link / Additional online information (related to module if any):**

1. <https://youtu.be/0bP2MH3LqvI>
2. <https://youtu.be/KjiUUJdPGX0>
3. <https://youtu.be/vq54Tn9djsY>

**Module-3**

L1,L2

8Hours

**Inlets**

**Subsonic Inlets**

Internal flow and Stall in Subsonic inlets, Boundary layer separation. Major features of external flow near a subsonic inlet. Relation between minimum area ratio and external deceleration ratio.

**Diffuser performance.**

Supersonic inlets: Supersonic inlets, starting problem in supersonic inlets, Shock swallowing by area variation, External deceleration. Modes of inlet operation.

**Laboratory Sessions/ Experimental learning:**

Visualize the external and internal deceleration (pre compression and diffusion) over inlet using wind tunnel

Learn NASA's EngineSim Applet Version 1.8a (latest edition) by using [Beginner's Guide to Propulsion](https://www.grc.nasa.gov/WWW/K-12/airplane/ngnsim.html)<https://www.grc.nasa.gov/WWW/K-12/airplane/ngnsim.html>

Calculate and draw the performance curves using EngineSim Applet Version 1.8a

**Applications:** gas turbine engine design industries

**Video link / Additional online information (related to module if any):**

<https://youtu.be/ZoObIZfLa94>

[https://youtu.be/hFO\\_n44Uv\\_Y](https://youtu.be/hFO_n44Uv_Y)

**Module-4**

L1,L2

8Hours

**Combustion chambers & Nozzles**

**Combustion chambers**

Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance , Flame tube cooling , Flame stabilization , Use of flame holders

**Nozzles:** Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions. Nozzle efficiency, Losses in nozzles. Over,expanded and under,expandednozzles, Ejector and variable area nozzles, Thrust reversal.

**Laboratory Sessions/ Experimental learning:**

Make a model and explain thrust reversal technique

Learn NASA's Range Games Version 1.3 (latest edition) by using [Beginner's Guide to Propulsion](https://www.grc.nasa.gov/WWW/K-12/airplane/ngnsimr.html)<https://www.grc.nasa.gov/WWW/K-12/airplane/ngnsimr.html>

Calculate and understand the aircraft motion and performance using Range Games Version

**Applications:** Gas turbine industries

**Video link / Additional online information (related to module if any):**

<https://youtu.be/3u7d-IlvRqs>

<https://youtu.be/LPXLFY-WR-4>

<https://youtu.be/E4wFJCHEwW4>

**Module-5**

L1,L2

8Hours

**Rocket Propulsion**

Classification of rockets, Principle of rocket propulsion, Analysis of ideal chemical rocket, The chemical rocket, Solid propellant rockets, Liquid propellant rockets, Hybrid rockets, Cryogenic rockets nuclear propulsion, Electrodynamics propulsion, Photon propulsion, Propulsive efficiency.

**Laboratory Sessions/ Experimental learning:**

Make Sugar rocket by using potassium nitrate (small size)

Find the specific impulse of the sugar rocket

**Applications:** Rockets and missile manufacturing industries

**Video link / Additional online information (related to module if any):**

[https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsion-systems-spring-2012/lecture-notes/MIT16\\_50S12\\_lec9.pdf](https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsion-systems-spring-2012/lecture-notes/MIT16_50S12_lec9.pdf)

<https://nptel.ac.in/courses/101106033/>

**Course outcomes:**

CO213.1 Apply the basic thermodynamic principles and theories in aircraft propulsion.

CO213.2 Understand the thrust generation and performance of turbojets, turbofans and turboprops.

CO213.3 Analyze the performance of inlet for subsonic and supersonic applications

CO213.4 Demonstrate the principle of combustion and distinguish between different types of combustion chambers

CO213.5 Explain the basic principles of rocket propulsion.

**Reference Books:**

1	Bhaskar Roy, Aircraft propulsion, Elsevier (2011), ISBN,13: 9788131214213
2	V. Ganesan, Gas Turbines, Tata McGraw,Hill, 2010, New Delhi, India, ISBN: 0070681929.
3	Hill, Philip G., and Carl R. Peterson. "Mechanics and Thermodynamics of Propulsion, 0201146592." (2010).
4	Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman, 1989, ISBN 13: 9780582236325.

#### CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

#### SEE Assessment:

xxx. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xxxi. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxxii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	1	2	1	0	0	0	0	1
CO2	3	2	1	1	1	1	1	0	0	0	0	1
CO3	3	1	1	1	1	1	1	0	0	0	0	1
CO4	3	3	1	1	1	1	1	0	0	0	0	1
CO5	3	1	1	1	1	1	1	0	0	0	0	1

Course Title	TURBOMACHINES	Semester	IV
Course Code	MVJ19AE45/AS45	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1 : 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

- Understand the basics of turbomachines
- Understanding the concept of energy transfer taking place in turbomachines
- Acquire the knowledge on design of centrifugal and axial compressors
- Acquire the knowledge on design of centrifugal and axial turbines
- Assimilate the understanding of hydraulic pumps and turbines

#### Module-1

L1,L2

8Hours

Introduction to turbomachines:

Classification and parts of a turbo machines; comparison with positive displacement machines; dimensionless parameters and their physical significance; specific speed; illustrative examples on dimensional analysis and model studies.

Energy transfer in turbomachines:

Basic Euler turbine equation and its alternate form; components of energy transfer; general expression for degree of reaction; construction of velocity triangles for different values of degree of reaction.

Laboratory Sessions/ Experimental learning: Aircraft propulsion lab for acquiring knowledge of Gas turbine engine.

Applications: Study of Turbomachines, components of gas turbine engines.

Video link / Additional online information:

<https://nptel.ac.in/courses/112/106/112106200/>

#### Module-2

L1,L2,L3

8Hours

**General analysis of Turbomachines**

**Axial flow machines**-general analysis, degree of reaction, velocity triangles, diagram efficiency, maximum utilization factor for different R values, Numerical Problems

**Radial flow machines** –general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade



discharge angle on performance.

**Laboratory Sessions/ Experimental learning:** Aircraft Propulsion lab and Fluid Mechanics lab for compressor and turbines.

**Applications:** Compressors and Turbines in Aircraft engines.

**Video link / Additional online information:** <https://nptel.ac.in/courses/101/101/101101058/>  
<https://www.youtube.com/watch?v=oitC03G-QYE>

<b>Module-3</b>	<b>L1,L2,L3</b>	<b>8Hours</b>
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**Compression process:**

Overall isentropic efficiency of compression; stage efficiency; comparison and relation between overall efficiency and stage efficiency; polytropic efficiency; preheat factor.

**Expansion process:**

Over all isentropic efficiency for a turbine; stage efficiency for a turbine; comparison and relation between stage efficiency and overall efficiency, polytropic efficiency; reheat factor for expansion process.

**Laboratory Sessions/ Experimental learning:** Fluid Mechanics lab for compressor and turbines and Aircraft propulsion lab: Study of gas turbine turbojet engine

**Applications:** Turbojet, turbofan, turbo shaft engines.

**Video link / Additional online information:**

<https://youtu.be/8y5KX4kzt0A>

<b>Module-4</b>	<b>L1,L2,L3</b>	<b>8Hours</b>
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**DesignandperformanceanalysisofCentrifugal compressors:** Types, design parameters, flow analysis in impeller blades, volutes and diffusers, losses, slip factor, characteristic curves, surging, choking. Construction details.

**Designandperformanceanalysisofaxial fans and compressors:** Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, simple stage design problems, performance characteristics, instability in axial compressors. Construction details.

**Laboratory Sessions/ Experimental learning:** Aircraft propulsion lab: Study of gas turbine turbojet engine

**Applications:** Turbojet, turbofan, turbo shaft engines.

**Video link / Additional online information:**

[http://www.infocobuild.com/education/audio-video-courses/aeronautics-and-](http://www.infocobuild.com/education/audio-video-courses/aeronautics-and-astronautics/TurbomachineryAerodynamics-IIT-Bombay/lecture-31.html)

[astronautics/TurbomachineryAerodynamics-IIT-Bombay/lecture-31.html](http://www.infocobuild.com/education/audio-video-courses/aeronautics-and-astronautics/TurbomachineryAerodynamics-IIT-Bombay/lecture-31.html)

<https://www.youtube.com/watch?v=3bhoVSI6VoI>

<https://www.youtube.com/watch?v=b1dyUVA19kQ>

<b>Module-5</b>	<b>L1,L2</b>	<b>8Hours</b>
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**Design and performance analysis of axial flow turbines:**

Turbine stage, work done, degree of reaction, losses and efficiency, flow passage; subsonic, transonic and supersonic turbines, multi-staging of turbine; exit flow conditions; turbine cooling

**Design and performance analysis of radial turbines:**

Thermodynamics and aerodynamics of radial turbines; radial turbine characteristics; losses and efficiency; design of radial turbine.

Laboratory Sessions/ Experimental learning: Aircraft propulsion lab and Fluid mechanics lab.

Applications: Turbojet, turbofan, turbo shaft engines.

**Video link / Additional online information:**

<http://www.infocobuild.com/education/audio-video-courses/aeronautics-and-astronautics/TurbomachineryAerodynamics-IIT-Bombay/lecture-22.html>

<https://www.youtube.com/watch?v=h4LYyUOtQow>

**Course outcomes:**

CO214.1	Compute the energy transfer and energy transformation in turbomachines.
CO214.2	Analyse the design of turbomachine blades.
CO214.3	Apply hydraulic pumps and turbines for specific requirements
CO214.4	Apply dimensionless parameters for turbomachines
CO214.5	Analyse Compression and Expansion process

**Reference Books:**

1	S.M.Yahya, Turbines, Compressors & Fans, Tata-McGrawHill Co., 2 <sup>nd</sup> Edition (2002), ISBN 13: 9780070707023.
2	D.G.Shepherd, Principles of Turbo Machinery, The Macmillan Company (1964), ISBN-13: 978-0024096609.
3	V. Kadambi and Manohar Prasad, An introduction to Energy conversion, Volume III, Turbo machinery, Wiley Eastern Ltd, 1977, ISBN: 9780852264539

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

xxxiii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xxxiv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxxv. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	0	0	0	0	0	0	0	0	0
CO2	3	3	3	3	0	0	0	0	0	0	0	0
CO3	3	3	3	2	0	0	0	0	0	0	0	0
CO4	3	3	2	1	0	0	0	0	0	0	0	0
CO5	3	3	2	0	0	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

Course Title	MECHANICS OF MACHINE THEORY	Semester	IV
Course Code	MVJ19AE46/AS46	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1 : 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

**Course objective is to:**

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

<b>Module-1</b>	<b>L1,L2,L3</b>	<b>8Hours</b>
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**Introduction to Mechanisms:**

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

Laboratory Sessions/ Experimental learning: Whitworth quick return motion mechanism. (Machine Shop)

Applications: Ackerman steering gear mechanism.

Video link / Additional online information:

<https://www.youtube.com/watch?v=g8uqeru2LQw>

<b>Module-2</b>	<b>L1,L2,L3</b>	<b>8Hours</b>
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**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,

<p>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</p> <p>Video link / Additional online information:  <a href="https://www.youtube.com/watch?v=CTcdQzH5e04">https://www.youtube.com/watch?v=CTcdQzH5e04</a></p>		
<b>Module-3</b>	<b>L1,L2,L3</b>	<b>8Hours</b>
<p><b>Spur Gears and Gear Trains</b></p> <p>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.</p> <p>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.</p> <p>Applications: Design Of spur Gear</p> <p>Video link / Additional online information:  <a href="https://www.youtube.com/watch?v=N0hTFnvIE7A">https://www.youtube.com/watch?v=N0hTFnvIE7A</a></p>		
<b>Module-4</b>	<b>L1,L2,L3</b>	<b>8Hours</b>
<p><b>Balancing of Rotating and Reciprocating Masses</b> 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)</p> <p>Video link / Additional online information:  <a href="https://www.youtube.com/watch?v=N0hTFnvIE7A">https://www.youtube.com/watch?v=N0hTFnvIE7A</a></p>		
<b>Module-5</b>	<b>L1,L2,L3</b>	<b>8Hours</b>
<p>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</p> <p>Laboratory Sessions/ Experimental learning: Porter and Hartnell governors (Design lab)</p> <p>Applications:: Working Of Governors</p> <p>Links <a href="https://www.youtube.com/watch?v=FydJu1A1oeM">https://www.youtube.com/watch?v=FydJu1A1oeM</a></p>		
<b>Course outcomes:</b>		
CO215.1	Apply the theory of velocity, acceleration and static force analysis to design of mechanisms.	
CO215.2	Analyze static and dynamic force analysis of mechanisms.	



CO2	3	3	3	3	0	0	0	0	0	0	0	0
CO3	3	3	2	3	0	0	0	0	0	0	0	0
CO4	3	3	3	2	0	0	0	0	0	0	0	0
CO5	3	3	3	1	0	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

Course Title	MATERIAL TESTING LAB	Semester	IV
Course Code	MVJ19AEL47A	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	02	Exam. Duration	3 Hours

Course objective is to:

- Understand the relations among materials and their properties.
- Comprehend the formation, properties and significance of the alloys through different experiments.
- Acquire the practical knowledge of metallographic testing of engineering materials.
- Understand the various heat treatment process of metals.
- Know the types, advantages and applications of various NDT methods.

Sl No	Experiment Name	RBT Level	Hours
1	Hardness Testing – Vicker's, Brinell, Rockwel	L1,L2,L3	03
2	Tensile Test	L1,L2,L3	03
3	Flexural Test	L1,L2,L3	03
4	Torsional Test	L1,L2,L3	03
5	Impact Test	L1,L2,L3	03
6	Shear Test	L1,L2,L3	03
7	Fatigue Test	L1,L2,L3	03
8	Preparation of specimen for metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & metal matrix composites	L1,L2,L3	03
9	Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.	L1,L2,L3	03
10	To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.	L1,L2,L3	03



11	Visual Testing Technique, Dye penetration testing. To study the defects of Cast and Welded specimens.	L1,L2,L3	03
12	Magnetic Particle Inspection.	L1,L2,L3	03
13	Ultrasonic Inspection.	L1,L2,L3	03

**Course outcomes:**

CO1	Examine the relations among materials properties.
CO2	Differentiate the formation, properties and significance of the alloys through different experiments.
CO3	Apply the knowledge of metallographic testing in aircraft materials.
CO4	Examine the heat treatment process to improve the properties of aircraft materials.
CO5	Analyze the types, advantages and applications of various NDT methods.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	0	2	0	0	0	0	0	1	0	0	0
CO2	3	0	1	0	0	0	0	0	1	0	0	0
CO3	3	1	3	0	0	0	0	0	1	0	1	1
CO4	3	0	1	0	0	0	0	0	0	0	1	1
CO5	3	0	2	0	0	0	0	0	1	0	0	0

High-3, Medium-2, Low-1

Course Title	MEASUREMENT AND METROLOGY LAB	Semester	IV
Course Code	MVJ19AEL47B	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	02	Exam. Duration	3 Hours

Course objective is to:

- Learn the concepts of mechanical measurements and metrology
- Use the concept of accuracy, error and calibration
- Acquire the knowledge of basic metrological instruments

Sl No	Experiment Name	RBT Level	Hours
1	Calibration of Pressure Gauge	L1,L2,L3	03
2	Calibration of Thermocouple	L1,L2,L3	03
3	Calibration of LVDT	L1,L2,L3	03
4	Calibration of Load cell	L1,L2,L3	03
5	Determination of modulus of elasticity of a mild steel specimen using strain gauges.	L1,L2,L3	03
6	Comparison and measurements using vernier caliper and micrometer	L1,L2,L3	03
7	Measurement of vibration parameters using vibration setup.	L1,L2,L3	03
8	Measurements using Optical Projector / Toolmaker Microscope.	L1,L2,L3	03
9	Measurement of angle using Sine Center / Sine bar / bevel protractor	L1,L2,L3	03
10	Measurement of alignment using Autocollimator / Roller set	L1,L2,L3	03
11	Measurement of Screw threads Parameters using Two-wire or Three-wire method.	L1,L2,L3	03
12	Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator	L1,L2,L3	03

13	Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer	L1,L2,L3	03
14	Calibration of Micrometer using slip gauges	L1,L2,L3	03

**Course outcomes:**

CO1	Use different measuring tools related to experiments
CO2	Identify, define, and explain accuracy, precision, and some additional terminology.
CO3	Conduct, Analyse, interpret, and present measurement data from measurements Identify, define, and explain accuracy, precision, and some additional terminology

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	0	2	0	0	0	0	0	1	0	0	0
CO2	3	0	1	0	0	0	0	0	1	0	0	0
CO3	3	1	3	0	0	0	0	0	1	0	1	1

High-3, Medium-2, Low-1

Course Title	COMPUTER AIDED AIRCRAFT DRAWING	Semester	IV
Course Code	MVJ19AEL48/ASL48	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	02	Exam. Duration	3 Hours
Course objective is to:			
<ul style="list-style-type: none"> <li>• Understand and interpret drawings of machine and aircraft components</li> <li>• Prepare assembly drawings either manually or by using standard CAD packages.</li> <li>• Familiarize with standard components and their assembly of an aircraft</li> </ul>			
Sl No	Experiment Name	L1,L2,L3,L4	20Hours
	PART A		
	<p>Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.</p> <p>Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.</p> <p>Laboratory Sessions/ Experimental learning: CAAD Lab</p> <p>Applications: Helps to understand Engineering Drawing.</p> <p>Video link / Additional online information (related to module if any):  <a href="https://www.youtube.com/watch?v=f1Hdtf_iAWk">https://www.youtube.com/watch?v=f1Hdtf_iAWk</a></p>		
	PART B	L1,L2,L3,L4	10Hours
	<p><b>Thread Forms:</b> Thread terminology, sectional views of threads. ISO Metric (Internal &amp; External) BSW (Internal &amp; External) square and Acme. Sellers thread, American Standard thread.</p> <p><b>Fasteners:</b> Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.</p> <p><b>Keys &amp; Joints:</b> Parallel key, Taper key, Feather key, Gibhead key and Woodruff key.</p> <p><b>Riveted Joints:</b> Single and double riveted lap joints, butt joints with single/double cover strap.</p>		

	<p><b>Couplings:</b> Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)</p> <p>Laboratory Sessions/ Experimental learning: CAAD Lab</p> <p>Applications: For Manufacturing Aerospace Components.</p> <p>Video link / Additional online information (related to module if any):</p> <p><a href="https://www.youtube.com/watch?v=70hESLwUhME">https://www.youtube.com/watch?v=70hESLwUhME</a></p> <p><a href="https://www.youtube.com/watch?v=Gdvtw0pTAOs">https://www.youtube.com/watch?v=Gdvtw0pTAOs</a></p>		
	PART C	L1,L2,L3,L4	20Hours
1	Modeling of propeller and hub assembly		
2	Modeling of wing assembly		
3	Modeling of fuselage assembly		
4	Modeling of Engine Mounts		
5	Modeling of main rotor blade assembly of helicopter		
6	Modeling of UAV assembly		
7	Modeling of Landing Gear Assembly		
	<p>Laboratory Sessions/ Experimental learning: CAAD Lab Applications: To Design an Aircraft Model.</p> <p>Video link / Additional online information (related to module if any):</p> <p><a href="https://www.youtube.com/watch?v=rmlUXhvJHt0">https://www.youtube.com/watch?v=rmlUXhvJHt0</a></p>		
<b>Course outcomes:</b>			
CO1	Distinguish drawings of machine and aircraft components		
CO2	Identify assembly drawings either manually or by using standard CAD packages.		
CO3	Practice with standard components and their assembly of an aircraft.		

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	1	0	2	0	0	2
CO2	3	3	2	2	3	2	1	0	2	0	0	2
CO3	3	3	2	3	3	2	2	1	3	0	0	3

Course Title	CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW	Semester	IV
Course Code	MVJ19CPH39/49	CIE	50
Total No. of Contact Hours	20 L : T : P :: 1 : 0 : 0	SEE	50
No. of Contact Hours/Week	01	Total	100
Credits	01	Exam. Duration	2 hrs

Course objective is to:

- To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.
- To provide overall legal literacy to the young technocrats to manage complex societal issues in the present scenario.
- To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.

<b>Module-1</b>	<b>RBT Level</b> L1,L2,L3	03 Hours
<p><b>Introduction to Indian Constitution</b> The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.</p>		
<b>Module – II</b>	<b>RBT Level</b> L1,L2,L3	03 Hours
<p><b>Union Executive and State Executive</b> Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism.</p>		

State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.

<b>Module – III</b>	<b>RBT Level</b>	03
	L1,L2,L3	Hours

**Elections, Amendments and Emergency Provisions**

Elections, Electoral Process, and Election Commission of India, Election Laws.

Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements).

Emergency Provisions, types of Emergencies and it's consequences.

**Constitutional Special Provisions:**

Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.

<b>Module – IV</b>	<b>RBT Level</b>	03
	L1,L2,L3	Hours

**Professional / Engineering Ethics**

Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India) : Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. **Responsibilities in Engineering** - Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.

<b>Module – V</b>	<b>RBT Level</b>	03
	L1,L2,L3	Hours

**Internet Laws, Cyber Crimes and Cyber Laws:**

Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.

**Course Outcomes:** On completion of this course, students will be able to

CO1	Have constitutional knowledge and legal literacy
CO2	Understand Engineering and Professional ethics and responsibilities of Engineers.
CO3	Understand the cyber crimes and cyber laws for cyber safety measure.

<b>Text Books:</b>	
1.	Constitution of India and Professional Ethics, T.S. Anupama, Sunstar Publisher

<b>Reference Books:</b>	
1.	Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19 <sup>th</sup> /20 <sup>th</sup> Edn., (Latest Edition) or 2008.
2.	Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018.
3	M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice –Hall of India Pvt. Ltd. New Delhi, 2004.
4.	M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
5.	Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi.

<b>CIE Assessment:</b>
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (40 marks each), the final IA marks to be awarded will be the average of three tests <ul style="list-style-type: none"> <li>- Assignment (10 marks)</li> </ul>
<b>SEE Assessment:</b>
xxxix. Question paper for the SEE consists one part. It is compulsory and consists of objective type 1 mark each for total of 50 marks covering the whole syllabus.
xl. Ten questions must be set from each unit. The duration of examination is 3 hours.



Course Title	BALIKE KANNADA	Semester	IV
Course Code	MVJ19BK49	CIE	50
Total No. of Contact Hours	20 L: T: P 1:0:0	SEE	50
No. of Contact Hours/Week	1	Total	100
Credits	1	Exam. Duration	3Hrs

**Course objective :**This course will enable students to understand Kannada and communicate in Kannada language

- Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada )
- Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronunciation.
- Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).
- Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)
- Activities in Kannada

#### CHAPTER-1

Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada )

#### CHAPTER-2

Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronunciation

#### CHAPTER-3

Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication)

#### CHAPTER-4

Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)

#### CHAPTER-5

Activities in Kannada

Scheme of Evaluation:		
Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. $\Sigma$ (Marks Obtained in each test) / 3	CIE(50)	30
ASSIGNMENT		20
Semester End Examination	SEE (50)	50
<b>Total</b>		<b>100</b>

Course Title	SAMSKRUTHIKA KANNADA	Semester	IV
Course Code	MVJ19SK49	CIE	50
Total No. of Contact Hours	20 L: T: P 1:0:0	SEE	50
No. of Contact Hours/week	1	Total	100
Credits	1	Exam. Duration	3Hrs

**Course objective :** This course will enable students to understand Kannada and communicate in Kannada language

- Samskruthika Kannada –Parichaya (Introduction to Adalitha kannada )
- Kannada Kavyagala parichaya (Kannada D Ra Bendre, Siddalingaiha)
- Adalithdalli Kannada Padagalu (Kannada Kagunitha Balake, Patra Lekhana, Prabhandha)
- Kannada Computer Gnyana (Kannada Shabdha Sangraha, Computer Paribashika padagalu)
- Activities in Kannada.

CzsÁâAiÄÄ -1

PAÉÁßqÄ " sÁµÉ-, ÄAQëÏÄÜ «ªÄgÄuÉ.

CzsÁâAiÄÄ -2

" sÁµÄ ÏÄæAiÉ/ÉÄÜÄ ÄèUÄÄªÄ É/ÉÄÏÄzÉ/ÉÄµÄUÄ¼ÄÄªÄªÄÄvÄÄÜ CªÄÄUÄ¼ÄªÄªÄÄgÄuÉ.

CzsÁâAiÄÄ -3

ÉÄREÄ aºÉßUÄ¼ÄÄªÄªÄÄvÄÄÜ CªÄÄUÄ¼ÄªÄªÄÄGÏÄAiÉ/ÉÄÜ.Ä

CzsÁâAiÄÄ -4

ÏÄvÄæªÄªÄªÄªÄgÄ.

CzsÁâAiÄÄ -5

DqÄ½vÄ ÏÄvÄæUÄ¼ÄÄªÄ.

CzsÁâAiÄÄ -6

, ÄPÄðgÄzÄ DzÉÄ±Ä ÏÄvÄæUÄ¼ÄÄªÄ

CzsÁâAiÄÄ -7

, ÄAQÄÏÄÜ ÏÄæÏÄzÄ gÄZÄÉÉ, ÏÄæÏÄzÄªÄªÄvÄÄÜ " sÁµÄÄvÄgÄ

CzsÁâAiÄÄ -8

PAÉÁßqÄ ±ÄÏÏ, ÄAUÄæºÄ

CzsÁâAiÄÄ -9

PÄÄÏÄ/Éälgì ºÄUÄ/ÉªÄiÄ»w vÄÄvÄæÄÖÉÄ

CzsÁâAiÄÄ -10

ÏÄj " sÄÏPÄ DqÄ½vÄ PAÉÁßqÄ ÏÄzÄUÄ¼ÄÄªÄªÄªÄvÄÄÜ vÄÄwæPÄ/PÄÄÏÄ/Éälgì ÏÄj " sÄÏPÄ ÏÄzÄUÄ¼ÄÄªÄ.

Scheme of Evaluation:

Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. $\Sigma$ (Marks Obtained in each test) / 3	CIE(50)	30
ASSIGNMENT		20
Semester End Examination	SEE (50)	50
	Total	100

Course Title	ADDITIONAL MATHEMATICS-II	Semester	II
Course Code	MVJ19MATDIP41	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	-	Exam. Duration	3 Hours

Course objective is to: This course viz., aims to prepare the students:

- To familiarize the important and basic concepts of Differential calculus and Differential Equation, ordinary/partial differential equations and Vector calculus and analyse the engineering problems.

#### Module-1

L1,L2

8Hrs.

#### Linear Algebra:

Introduction, Rank of a matrix-echelon form. Solution of system of linear equations – consistency. Gauss-elimination method and problems. Eigen values and Eigen vectors of square matrix and Problems.

Video Link:

<https://www.math.ust.hk/~machas/matrix-algebra-for-engineers.pdf>

<https://nptel.ac.in/content/storage2/courses/122104018/node18.html>

#### Module-2

L1,L2

8 Hrs.

#### Differential calculus:

Tangent and normal, sub tangent and subnormal both Cartesian and polar forms. Increasing and decreasing functions, Maxima and Minima for a function of one variable. Point of inflections and Problems

#### Beta and Gamma functions:

Beta functions, Properties of Beta function and Gamma function, Relation Between beta and Gamma function-simple problems.

Video Link:

<https://www.youtube.com/watch?v=6RwOoPN2zqE>

<https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWIUqBoTCQDtYlloI-o-9hxp11>

<http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx>

Module-3	L1,L2	8Hrs.
<p><b>Analytical solid geometry :</b></p> <p>Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems.</p> <p>Video Link:  <a href="https://www.toppr.com/guides/maths/three-dimensional-geometry/">https://www.toppr.com/guides/maths/three-dimensional-geometry/</a>  <a href="https://www.toppr.com/guides/maths/three-dimensional-geometry/distance-between-skew-lines/">https://www.toppr.com/guides/maths/three-dimensional-geometry/distance-between-skew-lines/</a></p>		
Module-4	L1,L2,L3	8 Hrs.
<p><b>Probability:</b></p> <p>Random variable, Discrete probability distribution, Mean and variance of Random Variable, Theoretical distribution-Binomial distribution, Mean and variance Binomial distribution - Problems. Poisson distribution as a limiting case of Binomial distribution, Mean and variance of Poisson distribution. Normal Distribution-Basic properties of Normal distribution –standard form of normal distribution and Problems.</p> <p>Video Link:  <a href="https://nptel.ac.in/courses/111/105/111105041/">https://nptel.ac.in/courses/111/105/111105041/</a>  <a href="https://www.mathsisfun.com/data/probability.html">https://www.mathsisfun.com/data/probability.html</a></p>		
Module-5	L1,L2,L3	8 Hrs.
<p><b>Partial differential equation:</b>Formation of PDE's by elimination of arbitrary constants and functions.</p> <p>Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.</p> <p>Video Link:  <a href="http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx">http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx</a>  <a href="https://www.studyyaar.com/index.php/module-video/watch/233-cauchys-legendres-de-a-method-of-variation-of-parameters">https://www.studyyaar.com/index.php/module-video/watch/233-cauchys-legendres-de-a-method-of-variation-of-parameters</a></p>		
<b>Course outcomes:</b>		
CO1	Apply the knowledge of Matrices to solve the system of linear equations and to	

	understand the concepts of Eigen value and Eigen vectors for engineering problems.
CO2	Demonstrate various physical models ,find Maxima and Minima for a function of one variable., Point of inflections and Problems .Understand Beta and Gamma function
CO3	Understand the 3-Dimensional geometry basic, Equation of line in space- different forms, Angle between two line and studying the shortest distance .
CO4	Concepts OF Probability related to engineering applications.
CO5	Construct a variety of partial differential equations and solution by exact methods.

#### Text Books:

1	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43 <sup>rd</sup> Edition, 2013.
2	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.

#### Reference Books:

1	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10 <sup>th</sup> edition, 2014.
2	G. B. Gururajachar: Calculus and Linear Algebra, Academic Excellent Series Publication, 2018-19

#### CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (8 marks)

#### SEE Assessment:

xli. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xlii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xliii. One question must be set from each unit. The duration of examination is 3 hours.