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||Jai Sri Gurudev||

Sri Adichunchanagiri Shikshana Trust (R.)

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

AICTE Approved, Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF(151-300) in 2023,Gold Rated by QS I-Gauge

P.B. No.20, B.B Road, Chikkaballapur - 562 101, Karnataka

Estd : 1986

IV Semester
Scheme & Syllabus of B.E. Programme
Aeronautical Engineering
(2025 Scheme)

Core Values

Spiritual, **J**udicious, **C**ommitment, **I**ntegrity, **T**rustworthy



NATIONAL INSTITUTIONAL RANKING FRAMEWORK 151-300

NAAC A+

QS I-GAUGE GOLD

INSTITUTION'S INNOVATION COUNCIL (Ministry of HRD Initiative) 4-Star Rating

||jai sri gurudev||
Sri Adichunchanagiri Shikshana Trust (R.)
SJC INSTITUTE OF TECHNOLOGY
(An Autonomus Institute Under VTU Belagavi & Approved by AICTE, New Delhi)
Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF (151-300), QS-I Gauge GOLD Rated
Estd.:1986 Post Box #20, B.B. Road, Chikkaballapur - 562 101, Karnataka

B B.E. in Aeronautical Engineering,
Scheme of Teaching and Examinations -2025

Outcome-Based Education (OBE) and Choice-Based Credit System(CBCS)(Effective from the academic year 2025-26)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Department (TD) / Question Paper Setting Board (PSB)	Teaching and Learning Scheme					Examination				Credits
					CI		LI	TW & SL	Total hours per Sem	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	SL						
1	PCC	1BAE401	Introduction to Drone Technology	AE	42	0	0	48	90	3	50	50	100	3
2	IPCC	1BAE402	Aircraft Propulsion	AE	42	0	28	50	120	3	50	50	100	4
3	PCC	1BAE403	Aerodynamics	AE	42	28	0	50	120	3	50	50	100	4
4	IPCC	1BAS404	Mechanics of Materials	AE/AS	42	0	28	50	120	3	50	50	100	4
5	PCCL	1BAEL405	Aerodynamics Lab	AE	0	0	28	02	30	3	50	50	100	1
6	AEC	1BAEL406	Ability Enhancement Course Laboratory**	AE	0	0	28	02	30	2	50	50	100	1
7	BSC	1BBN407	Biology for Engineers (ME and CV Streams)	BSC	14	0	0	16	30	2	50	50	100	1
8	SDC	1BEP408	Environmental Science Project	Any Department	0	0	0	30	30	2	50	50	100	1
9	HSSM	1BMP409	Metaphysical Science	PSB	14	0	0	16	30	2	50	50	100	1
10	NCMC	1BNS410	National Service Scheme	Campus: NSS Coordinator	0	0	0	28	28	--	100	---	100	PP
		1BPE410	Physical Education	Physical Education Director										
		1BYO410	Yoga	Yoga Teacher										
		1BMU410	Music	Music Teacher										
		1BNC410	National Cadet Corps-II	NCC Coordinator										
11	NCMC	1BCE411	Competency Enhancement Course-2	CDCAC	14	0	0	14	28	--	100	--	100	PP
12	NCMC	1BMATDIP412	Additional Mathematics-II	Mathematics	14	0	0	14	28	3	100	--	100	PP
									Total		**750**	**450**	**1200**	**20**

Ability Enhancement Course (Laboratory) 1BAEL406x

1BAEL406A	Fundamentals of Spreadsheet	1BAEL406C	Drone Pilot Training
1BAEL406B	AR and VR in Aeronautical Engineering		

Semester: IV					
Introduction to Drone Technology (Branch: AE)					
Course Code	:	1BAE401	**Credits**	:	3
Hours/Semester (L:T:P:SL)	:	42:0:0:48	**CIE**	:	50Marks
Total Hours	:	90	**SEE**	:	50Marks
Course Type	:	PCC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	• Elements of Aeronautical Engineering. • Aerodynamics • Introduction to Artificial intelligence
Knowledge on Fundamental Concepts	Flight principles, Aircraft Components, Control mechanisms
Knowledge on Connected Tools (If any)	--

Course Learning Objectives: This course will enable the students to	
CLO1	Gain foundational knowledge of UAV systems and their classifications.
CLO2	Understand drone aerodynamics, propulsion, and control mechanisms.
CLO3	Learn the components and design aspects of drones.
CLO4	Explore drone navigation, communication, and autonomy.
CLO5	Acquire knowledge of applications, regulations, and ethical aspects of drones.

Module – 1	**08 Hrs**
Introduction to Drones and UAV Systems: Definition and classification of drones - Micro, Mini, Tactical, MALE, HALE, etc., History and evolution of drone technology, Civil vs. military applications, Fixed-wing and rotary-wing drones, Introduction to drone architecture: airframe, sensors, propulsion, payload, communication	
Module – 2	**08 Hrs**
Drone Aerodynamics and Flight Mechanics: Basic principles of flight, Lift, drag, thrust, and weight considerations, Aerodynamic differences between fixed-wing and multirotor drones, Stability and control, Flight envelopes and performance metrics.	
Module – 3	**08 Hrs**
Drone Components: Component Selection-Frame, motors, battery, sensors, Assembly-Wiring, soldering, integration, Types of propulsion: Electric motors, internal combustion engines, ESCs (Electronic Speed Controllers), batteries, and power systems, Propeller design and thrust calculation, Frames and materials, Assembly of drone components. Drone Operation-Flight procedures ,Troubleshooting-Power, GPS, ESC, motor issues Maintenance-Pre/post flight checks, calibration	
Module – 4	**08 Hrs**
Control, Navigation and Communication Systems: Basics of drone control: manual vs. autonomous. Flight controllers (e.g., Pixhawk, KK2, APM) Sensors: IMU, GPS, magnetometer, barometer, Accelerometer, Gyro. Communication protocols: RC, telemetry, Wi-Fi, and LoRa, Basics of waypoint navigation and path planning.	
Module – 5	**08 Hrs**

Applications, Regulations and Future Trends: Commercial, industrial, and scientific applications: agriculture, surveillance, delivery, mapping, Overview of DGCA Rules and regulations and UAV policy in India, Ethical and legal issues, Drone safety and fail-safes, Future of drone technology: swarm drones AI, AI Integration Object detection, Beyond Visual Line of Sight operations.

Topics for Self learning	
Module – 1	Evolution of Drone Technology and Modern UAV Platforms
	Classification of UAVs and Their Civil & Military Applications
Module – 2	Aerodynamic Differences Between Fixed-Wing and Multirotor Drones
	Effect of Weather Conditions on Drone Flight Performance
Module – 3	Drone Assembly, Calibration, and Pre-Flight Inspection Procedures
	Drone Testing Standards: Motor, ESC, Battery, and Propeller Testing
Module – 4	Autonomous Flight Using Pixhawk/ArduPilot Flight Controllers
	Flight Testing Procedures and Safe Drone Flying Operations
Module – 5	DGCA Drone Rules, Digital Sky Platform, and UAV Certification Requirements
	AI-Based Drones, Swarm Technology, and BVLOS Operations

Topics for Self learning (Industry-Oriented)	
Module – 1	Drone Industry Ecosystem and Emerging UAV Technologies
	Case Studies of Drone Applications in Agriculture and Surveillance
Module – 2	CFD Applications in Drone Aerodynamics
	Flight Stability and Performance Analysis
Module – 3	Drone Maintenance and Troubleshooting Techniques
	Drone Testing and Airworthiness Evaluation
Module – 4	Sensor Fusion for Drone Navigation
	Communication Protocols (Telemetry, LoRa, Wi-Fi, MAVLink)
Module – 5	International Drone Standards (ISO, ASTM, IEEE)
	Future Trends: AI Integration, Drone Swarms, and Urban Air Mobility

Topics for Self learning (Standards of Drone Testing & Flying)	
Module – 1	International UAV Standards: ISO 21384 Framework for Drone Operations
	Drone Airworthiness Certification Requirements and Standards

Module – 2	Wind Tunnel Testing Methods for UAV Performance Evaluation
	Flight Test Data Analysis and Performance Validation Techniques
Module – 3	Reliability Testing of Drone Components (Motors, ESCs, Batteries)
	Environmental Testing of UAVs (Vibration, Temperature, Humidity)
Module – 4	Flight Safety Assessment and Risk Management in UAV Operations
	Communication Link Testing and Electromagnetic Interference (EMI) Evaluation
Module – 5	Drone Operational Safety Standards and Standard Operating Procedures (SOPs)
	Advanced Flight Operations: BVLOS Testing and UTM Integration

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the types, classifications, and historical evolution of drones.
CO2	Analyze aerodynamics and performance characteristics of various drones.
CO3	Explain propulsion systems and components used in UAVs.
CO4	Describe control mechanisms, communication, and navigation systems.
CO5	Explore current applications and future trends in drone technology.

Text Books	
1	Unmanned Aircraft Systems, Austin.R, UAVS Design, Development and Deployment, Wiley Chapters:1,2,3,4,5
2	Introduction to UAV Systems, Paul G. Fahlstrom and Thomas J. Gleason, Wiley Chapters:1,2,3,4,5

Reference Books	
1	UAV Fundamentals – MIT Open Course Ware, Supplementary.
2	ARDUINO and Drone Programming with Python/ROS – Various Authors

Web links and Video Lectures (e – Resources)	
1	https://onlinecourses.nptel.ac.in/noc22_ae15/preview
2	https://onlinecourses.nptel.ac.in/noc22_ae16/preview

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	2					2	2		1	3	2
CO2	3	3	2			2		2	2	2	1	3	2
CO3	3	3	2		2			2	2		1	3	2
CO4	3	2	2				2	2	2	2	1	3	2
CO5	3	3	2					2	2		1	3	2

Semester: IV					
Aircraft Propulsion (Branch: AE)					
Course Code	**:**	1BAE402	**Credits**	**:**	4
Hours/Semester (L:T:P:SL)	**:**	42:0:28:50	**CIE**	**:**	50 Marks
Total Hours	**:**	120	**SEE**	**:**	50 Marks
Course Type	**:**	IPCC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	• Elements of Aeronautical Engineering. • Aero Engineering Thermodynamics • Fluid Mechanics • Introduction to Artificial intelligence
Knowledge on Fundamental Concepts	Units and dimensions (SI units especially) Review of thermodynamic principles,
Knowledge on Connected Tools (If any)	

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamental principles of aircraft propulsion systems and analyze the working of piston and air-breathing engines.
CLO2	Apply propeller theories and evaluate the performance of aircraft inlets and nozzles under subsonic and supersonic flow conditions.
CLO3	Analyze the operation and performance characteristics of centrifugal and axial flow compressors, including losses, surging, and choking phenomena.
CLO4	Illustrate combustion processes in aircraft engines and evaluate advanced combustion chamber designs, cooling methods, and AI-based combustion optimization techniques.
CLO5	Examine the working and performance of axial and radial turbines and apply the fundamentals of rocket propulsion, including thrust and specific impulse analysis.

Module – 1	**08 Hrs**
Introduction: Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two – stroke and four – stroke piston engines, **Air Breathing Engines:** Turbojet-thrust equation, Turboprop, Turbofan & Turbo shaft engines construction & working principle, Factors affecting thrust, Performance comparison of each with P-V,T-S Diagram, Numerical Calculations on Thrust and SFC, Methods of thrust augmentation. AI-Based Engine Health Monitoring and Fault Diagnosis	
Module – 2	**08 Hrs**
Propeller Theories: Types of propeller, Propeller thrust: momentum theory, Blade Element theories, propeller blade design, and propeller selection. AI-Based Propeller Design Optimization. **Inlets, Nozzles for Jet Engine:** Internal flow and Stall in subsonic inlets , relation between Minimum Area Ratio and external deceleration ratio , diffuser performance, supersonic inlets, starting problem on supersonic inlets, shock swallowing by area variation, Real flow in nozzles and nozzle efficiency, losses in nozzles, Nozzle efficiency, Losses in nozzles. Over-expanded and under-expanded nozzles, Ejector and variable area nozzles, Thrust reversal	
Module – 3	**08 Hrs**
Compressors: Centrifugal Compressor: Principle and working, Work done and pressure rise, Blade Shapes & Velocity Triangles, Diffuser, Volute Casing, Effect of Losses, Compressor Characteristics, Surging and Choking **Axial flow compressor:** Geometry and working, Elementary theory of axial flow compressor, Velocity triangles, Compressor Stage Efficiency, Effect of Losses, Pressure rise calculations,	

Centrifugal and Axial compressor, Performance characteristics.
Module – 4 **08 Hrs**
Combustion Chambers: Classification of combustion chambers, 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 **Advanced Combustion Chamber for Aircraft engines:** Lean Premixed Prevaporized (LPP) Combustion, Rich-Burn, Quick-Quench, Lean-Burn (RQL) Combustors, Annular and Twin-Annular Pre-Swirl (TAPS) Combustors, Supersonic Combustion, Alternative Fuels and Their Impact on Combustor Design, Cooling Technologies for Combustor Liners. AI in Combustion Optimization and Emission Reduction.
Module – 5 **08 Hrs**
Axial Flow Turbines: Introduction, Turbine stage, Multi-staging of turbine, Exit flow conditions, Turbine cooling, Heat transfer in turbine cooling. AI-Based Thermal Management in Turbine Cooling Systems **Radial turbine:** Introduction, Thermodynamics of radial turbines, Losses and efficiency. **Fundamentals of Rocket Propulsion:** Introduction, Classification of chemical rockets, Thrust equation and specific impulse, vehicle acceleration, drag, gravity losses, multi-staging of rockets., performance of solid and liquid propellant rockets.

Practical component	
Module – 1	Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles)
	Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles)
Module – 2	Measurement of nozzle flow.
	Study of free and wall jet.
	Study of performance of a propeller.
Module – 3	Study of free convective heat transfer over a aerofoil plate.
	Study of forced convective heat transfer over a flat plate.
	Cascade testing of a model of axial compressor blade row.
Module – 4	Measurement of burning velocity of a premixed flame
	Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio.
Module – 5	Cascade testing of a model of turbine blade row.
	Virtual Lab Experiments: a. Measurement of Flow Using a Turbine Type Flow Meter for Exhaust Gas Flow Measurement. b. Power Measurement Using a Dynamometer c. Heat Transfer Coefficient in Forced Convection

Topics for Self learning	
Module – 1	**AI-Based Engine Health Monitoring and Fault Diagnosis** • Introduction to Artificial Intelligence (AI) in aircraft propulsion systems. • Predictive maintenance, fault detection, anomaly identification, and real-time health assessment of aero engines.
	Advanced Thrust Augmentation Techniques in Air-Breathing Engines • Emerging technologies for improving engine performance, fuel efficiency, and reducing emissions in military and commercial aircraft.

Module – 2	**Advanced Variable Geometry Inlets and Nozzles for High-Speed Aircraft** • Study of variable-geometry air intakes and nozzles used in modern fighter aircraft and supersonic vehicles. • Variable-area and thrust-vectoring nozzles for enhanced maneuverability and engine efficiency.
	AI-Based Propeller Design Optimization • Introduction to Artificial Intelligence and Machine Learning in propeller design. • Optimization of blade geometry, pitch distribution, and aerodynamic performance using AI techniques.
Module – 3	**AI and Digital Twin Technology for Compressor Performance Monitoring** • Introduction to Digital Twin technology in gas turbine compressors. • AI-based prediction of compressor efficiency, surge, stall, and maintenance requirements.
	Advanced Compressor Aerodynamics and Flow Control Techniques • Modern blade design methods for centrifugal and axial flow compressors. • Active and passive flow control techniques to reduce losses and improve efficiency.
Module – 4	**Sustainable Aviation Fuels (SAF) and Advanced Low-Emission Combustor Technologies** • Characteristics of Sustainable Aviation Fuels and alternative fuels. • Impact of alternative fuels on combustor design and performance.
	AI-Based Combustion Optimization and Emission Reduction in Aircraft Engines • Role of Artificial Intelligence and Machine Learning in combustion control. • Prediction and reduction of emissions such as NOx, CO, and unburned hydrocarbons.
Module – 5	**Reusable Rocket Propulsion Systems and Green Propellants** • Concept of reusable launch vehicles and modern rocket propulsion systems. • Comparison of conventional and green propellants.
	AI-Based Thermal Management and Advanced Cooling Techniques in Gas Turbine Blades • Application of Artificial Intelligence in turbine temperature prediction and cooling optimization. • Digital twin technology for turbine thermal management.

Course Outcomes: After completing the course, the students will be able to	
CO1	Illustrate the working principles of piston engines and air-breathing propulsion systems, classify aircraft power plants, and discuss engine performance.
CO2	Describe propeller momentum and blade element theories, and discuss the operation and performance of aircraft inlets and nozzles under flow conditions.
CO3	Analyze the performance characteristics of centrifugal and axial flow compressors by evaluating pressure rise, velocity triangles, compressor efficiency, losses, surging, and choking phenomena.
CO4	Evaluate aircraft combustion chambers, advanced combustion technologies, cooling methods, and AI-based combustion optimization.
CO5	Analyze the performance of axial and radial turbines and the principles of rocket propulsion, thrust, specific impulse, and rocket staging.

Text Books	
1	Gas Turbines, V. Ganesan, Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929. Chapters:1,2,3,4,5

2	Aircraft propulsion, Bhaskar Roy, Elsevier, 2011, ISBN-13: 9788131214213. Chapters:1,2,3,4,5

Reference Books	
1	Mechanics & Thermodynamics of Propulsion, Hill, P.G. & Peterson, C.R, Addison – Wesley Longman INC,1999, ISBN-13: 978-0201146592.
2	Gas Turbine Theory, Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H**,** Longman, 1989, ISBN 13:9780582236325.
3	Gas Turbine Engine Technology, Irwin E. Treager, GLENCOE Aviation Technology Series, 7th Edition, Tata 09082023 04.08.23 49 McGraw Hill Publishing Co. Ltd. Print 2003, ISBN-13: 978-0028018287.

Web links and Video Lectures (e – Resources)	
1	**http://nptel.ac.in/courses/101106033/**
2	**http://nptel.ac.in/courses/101101001/**
3	**http://nptel.ac.in/courses/101101002/**
4	**http://nptel.ac.in/courses/101104019/**

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3							2	2	2	3	2
CO2	3	3		2			2	2	2	2	2	3	2
CO3	3	3	2	2	2				2	2	2	3	2
CO4	3	3		2		2			2	2	2	3	2
CO5	3	3	2	2					2	2	2	3	2

Semester: IV					
Aerodynamics (Branch: AE)					
Course Code	**:**	1BAE403	**Credits**	**:**	4
Hours/Semester (L:T:P:SL)	**:**	42:28:0:50	**CIE**	**:**	50 Marks
Total Hours	**:**	120	**SEE**	**:**	50 Marks
Course Type	**:**	PCC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	• Fluid Mechanics.
Knowledge on Fundamental Concepts	Basic principles of fluids, Types of flows, Energy and flow equations
Knowledge on Connected Tools (If any)	--

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the characteristics of incompressible and compressible flow conditions.
CLO2	Acquire knowledge of two- and three-dimensional flows using vortex lattice and lifting line theories.
CLO3	Study finite wings and high-lift devices for performance enhancement of Aircrafts.
CLO4	Learn compressible flow principles, and isentropic flow with variable area.
CLO5	Understand shock waves theories to solve supersonic aerodynamic problems.

Module – 1	**10 Hrs**
Two Dimensional Flows & Incompressible Flow Over Airfoil: Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D-Alembert's paradox, Substantial Derivative and its fundamental equation, Numericals. **Incompressible flow over airfoils:** Kelvin's Circulation Theorem and the Starting Vortex, Vortex Sheet, Kutta condition, Classical Thin Airfoil theory for symmetric and cambered airfoils. Numericals.	
Module – 2	**10 Hrs**
Incompressible Flow Over Finite Wings: Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory: Downwash and induced drag. Elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl are lifting line theory. Lifting surface theory: Vortex Lattice Method, Panel Method.	
Module – 3	**10 Hrs**
Applications of Finite Wing Theory & High Lift Systems: Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects. Swept wings: Introduction to swept effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Critical Mach numbers, Lift and drag divergence, shock induced separation, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects.	
Module – 4	**10 Hrs**

Basics of Compressible Flow Basics of thermodynamics-Energy Equation- For flow and non-flow process, adiabatic energy equation, stagnation pressure, temperature, density, reference velocities, Bernoulli's equation, Effect of Mach number on Compressibility, AI for predicting pressure, temperature, and density. **Isentropic flow with variable area**-Area ratio as a function of Mach number, Impulse function, Mass flow rate, Flow through nozzles and diffusers numericals.

Module – 5	**10 Hrs**
Normal Shock Waves: Development of the shock waves, Rarefaction wave, Governing equations, Prandtl-Meyer Relation, Mach Number Downstream of the Normal Shock, Strength of the shock waves, Numericals. **Oblique Shock Wave**: Nature of Flow through oblique Shock waves, Fundamental relations, Prandtl's Equation, Rankine-Hugoniot equation, variation of flow parameters, Mach Waves, Numericals. AI applications in high-speed Aerodynamics.	

Topics for Self learning	
Module – 1	Flow Superposition Techniques and Formation of Complex Flow Fields
	Kutta–Joukowski Theorem and Mathematical Origin of Lift Generation
	Vortex Sheet Theory and Discontinuous Flow Representation
Module – 2	Non-Elliptical Lift Distributions in Practical Aircraft Wings
	Comparison of Lifting Line Theory, VLM and CFD
Module – 3	Formation Flight Aerodynamics and Its Application in Commercial Aviation
	Ground Effect Aerodynamics and Its Application in Wing-in-Ground (WIG) Vehicles
Module – 4	Evolution of High-Speed Aerodynamics: From Subsonic to Hypersonic Flight
	Critical Conditions and Choked Flow in Compressible Fluid Systems
Module – 5	Shock Wave-Boundary Layer Interaction in High-Speed Aerodynamics
	Hodograph, Shock Polars and Their Application in Supersonic Aerodynamic Design.

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe aerodynamic characteristics, and thin airfoil theory for basic flows.
CO2	Apply lifting line theory and vortex lattice methods to finite wings and 3D flows.
CO3	Evaluate aerodynamic performance of high-lift devices and the ground effects.
CO4	Analyze isentropic compressible flow through area variation, stagnation conditions, and Mach number effects.
CO5	Apply Principles of normal and oblique shock waves for high-speed operating conditions.

Text Books	
1	Fundamental of Aerodynamics - Anderson J.D, 5th edition, McGraw-Hill International Edition, New York (2011), ISBN-13: 978-0073398105. Chapters:1,2,3,4,5,7,8,12
2	Fundamentals of Compressible flow - Yahya, S.M Wiley Eastern, 2003. Chapters:2,4,6,7

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

Web links and Video Lectures (e – Resources)	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ae35
2	https://ocw.mit.edu/courses/16-100-aerodynamics-fall-2005/
3	https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ae09

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	2		1	2	1	2	2	1	3	2
CO2	3	3	2	2		1	2	1	2	2	1	3	2
CO3	3	3	2	2		1	2	1	2	2	1	3	3
CO4	3	3	3	3		1	2	1	2	2	1	3	2
CO5	3	3	3	3			2	1	2	2	1	3	3

Semester: IV					
Mechanics of Materials (Common to the Branches: AE &AS)					
Course Code	:	1BAS404	**Credits**	:	4
Hours/Semester (L:T:P:SL)	:	42:0:28:50	**CIE**	:	50 Marks
Total Hours	:	120	**SEE**	:	50 Marks
Course Type	:	IPCC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	• Aircraft Materials & Processes • Introduction to Artificial intelligence
Knowledge on Fundamental Concepts	Basics of Materials, Engineering Materials and its properties. etc.
Knowledge on Connected Tools (If any)	

Course Learning Objectives: This course will enable the students to	
CLO1	Understand basic concepts of strength of materials and Determine the stresses, strains produced by the application of loads.
CLO2	Acquire knowledge of shear force, bending moment diagrams and Shear Stresses for beams subjected to various types of loads.
CLO3	Apply deflection &Slope equations to determine circumferential and hoop stresses in cylinders.
CLO4	Analyze the concepts of torsion of Circular Shafts and Columns subjected to varies forces.
CLO5	Learn Failure theories for different materials and understand fatigue, fracture and creep loads.

Module – 1	**08 Hrs**
Simple Stress & Strain: The concept of stress & strain, state of Stress & Strain at a point, Stress-strain curves for brittle and ductile materials, Allowable stress, and Material selection for structural performance. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections. Elongation due to self-weight. **Elastic Constants:** Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses.	
Module – 2	**08 Hrs**
Shear Force and Bending Moment: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, UVL, UDL, couple Pin support and roller supported beams subjected to concentrated loads, uniformly distributed constant / varying loads. **Bending and Shear Stresses in Beams:** The Euler-Bernoulli theory derivation, assumptions, bending stress equation, moment carrying capacity of section, Bending and shear stress distribution in rectangular, I and T section beams.	
Module – 3	**08 Hrs**
Deflection of Beams: Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method. **Cylinders:** Stresses in thin cylinders, Lame's equation for thick cylinders subjected to internal and external pressures, Changes in dimensions of cylinder (diameter, length and volume), and simple numerical.	

Module – 4	**08 Hrs**
Torsion of Circular shafts: Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Thin-walled sections. **Stability of Columns:** Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns, Secant formula for columns.	
Module – 5	**08 Hrs**
Theories of Failure : Maximum Principal Stress Theory (Rankine's Theory), Maximum Shear Stress Theory (Tresca or Guest's Theory), Maximum Principal Strain Theory (St.Venant's Theory), Maximum Distortion Energy Theory (Von Mises or Hencky's Theory)(No Numericals) **Failure of Materials:** Fracture: Type-I, II, III, Creep: Stages, properties stress relaxation, Fatigue: fatigue types, S-N diagram, mechanism, properties, testing.	

Practical component	
Module – 1	To determine the hardness values of different materials by Brinell hardness/Rockwell hardness (MS,CI,CU,AL & Brass
	Tensile and compression tests of metallic specimens using Universal Testing Machine
Module – 2	Shear tests of metallic specimens using Universal Testing Machine
	Bending test for metallic and non-metallic materials using Universal Testing Machine
Module – 3	Impact test: Izod and Charpy Tests on M.S, C.I Specimen
	Liquid Dye penetration testing. To study the defects of Cast and Welded specimens
Module – 4	Torsion Testing
	To conduct a wear test on Mild steel/ Cast Iron/Aluminium/ Copper to find the volumetric wear rate and coefficient of friction
Module – 5	Magnetic crack detection
	Ultrasonic flaw detection (Demonstration)

Topics for Self learning	
Module – 1	Advanced Material selection for structural performance.
	Material behavior under loading.
Module – 2	Stress components at a point subjected to combined loading.
	Assess the adequacy of allowable stress and factor of safety for safe design.
Module – 3	Deflection of cantilever beam subjected to concentrated load.
	Riveted cylinders.
Module – 4	Strain energy in torsion.
	Formula used by Indian standard code

Module – 5	Creep types.
	Different types of stress concentration.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the mechanical behavior and elastic constants of materials, and stress-strain relationships.
CO2	Determine the simple, compound, thermal stresses and strains induced on various Mechanical elements
CO3	Draw SFD and BMD for different types of beams subjected to different loads and shear stresses in beams.
CO4	Evaluate the torsional equation to find power transmitted by circular shafts under various loading conditions to estimate stability.
CO5	Apply Failure theories for different types of materials and Mechanical properties of materials.

Text Books	
1	Mechanics of Materials, S.I. Units, Ferdinand Beer & Russell Johnston, 7th Ed, TATA McGraw Hill-2014. Chapters:1,3,5,8,10
2	Mechanics of Materials, K. V. Rao, G. C. Raju, Subhash Stores, 2012 Edition Chapters:2,3,6,7,9

Reference Books	
1	Strength of Materials, S. S. Bhavikatti, Vikas Publishing House-Pvt. Ltd., 4th Ed. 2013.
2	A Text book of Strength of Materials, R. K. Bansal, Laxmi Publications, 2010
3	Structural Analysis,O.A. Bauchau and J.I. Craig,Springer Dordrecht Heidelberg London New York,ISBN978-90-481-2515-9, e-ISBN 978-90-481-2516-6

Web links and Video Lectures (e – Resources)	
1	https://onlinecourses.nptel.ac.in/noc23_me140/preview
2	https://www.youtube.com/supported_browsers?next_url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DuA_HqCGo8Pg

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	2					2	3	2	2	2	1
CO2	3	2	2	2		2		2	3	2	2	2	1
CO3	3	2	2		2		1	2	3	2	2	2	1
CO4	3	2	2	2			1	2	3	2	2	2	1
CO5	3	2	2					2	3	2	2	2	1

Semester: IV					
Aerodynamics Lab (Branch: AE)					
Course Code	**:**	1BAEL405	**Credit**	**:**	1
Hours/Semester (L:T:P:SL)	**:**	0:0:28:02	**CIE**	**:**	50 Marks
Total Hours	**:**	30	**SEE**	**:**	50 Marks
Course Type	**:**	PCCL	**SEE Duration**	**:**	2 Hours

Prerequisites:	
Courses	• Elements of Aeronautical Engineering • Fluid Mechanics • Aerodynamics
Knowledge on Fundamental Concepts	• Basics of fluid flow and Bernoulli's principle • Lift, drag, and boundary layer concepts • Airfoil basics and pressure measurement
Knowledge on Connected Tools (If any)	Subsonic Wind Tunnel, Pitot-Static Tube, Multi-manometer, Wind Tunnel Balance, Smoke Generator, Tuft Flow Visualization Kit, Pressure Scanner/Data Acquisition System, Velocity Measurement Instruments.

Course Learning Objectives: This course will enable the students to	
CLO1	Be acquainted with the operation and calibration of subsonic wind tunnels and aerodynamic measurement instruments.
CLO2	Acquire knowledge of flow visualization techniques such as smoke flow and tuft flow methods for studying aerodynamic behavior.
CLO3	Understand the procedures used for measuring pressure distribution over airfoils and bluff bodies and evaluating aerodynamic characteristics.
CLO4	Develop the ability to determine lift, drag, and aerodynamic coefficients using wind tunnel experiments and wake survey methods.
CLO5	Analyze boundary layer characteristics and interpret experimental aerodynamic data for aircraft performance assessment.

Experiments	
Sl. No.	**List of Experiments**
1.	Calibration of a subsonic wind tunnel: test section static pressure and total head distributions.
2.	Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.
3.	Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds
4.	Smoke flow visualization studies on a two dimensional multi element airfoil with flaps and slats at different angles of incidence at low speeds
5.	Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows.
6.	Surface pressure distributions on a two-dimensional symmetric airfoil at different angles of incidence at low speeds.
7.	Surface pressure distribution on a two-dimensional cambered airfoil at different

	angles of incidence and calculation of lift and pressure drag.
8.	Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey.
9.	Calculation of total drag of a two-dimensional cambered airfoil at low speeds at incidence using pitot-static probe wake survey.
10.	Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.
11.	Calculation of aerodynamic coefficients and forces acting on a model aircraft at various Angle of Attack and speeds using wind tunnel balance (With and Without Yaw).
12.	Pressure measurements on aerofoil for a case of reverse flow.

Open Ended Experiments	
1	Surface pressure distributions on a two-dimensional Smooth circular cylinder at low speeds and calculation of pressure drag.
2	Surface pressure distributions on a two-dimensional Rough circular cylinder at low speeds and calculation of pressure drag.
3	Calculation of aerodynamic coefficients and forces acting on a model Jeep and Car using wind tunnel balance (With and Without Yaw).
4	Calculation of aerodynamic coefficients and forces acting on a model Bluff & wedge bodies using wind tunnel balance (With and Without Yaw).
5	Surface pressure distribution on a two-dimensional symmetrical, supercritical airfoil(NACA 65-218) at different angles of incidence and calculation of lift and pressure drag.
6	Surface pressure distribution on a two-dimensional cambered airfoil(NACA 23012 model) at different angles of incidence and calculation of lift and pressure drag.

Course Outcomes: After completing the course, the students will be able to	
CO1	Calibrate the wind tunnel for various motor speeds
CO2	Analyze the results of smoke and tuft flow visualization techniques
CO3	Calculate and Plot the pressure distribution around different airfoils and circular cylinders using pitot-static probes
CO4	Estimate the drag co-efficient for 2-D and 3-D models using pitot-static wake survey method
CO5	Predict the boundary layer velocity profile on wind tunnel wall and on the airfoil using pitot-static wake survey method

Text Books	
1	Fundamental of Aerodynamics, Anderson J.D, 5th edition, McGraw-Hill International Edition, New York 2011, ISBN-13: 978-0073398105 Chapters:1,2,3,4,5,6,7,8,9,10,11,12

2	AD Lab Manual Chapters:1,2,3,4,5,6,7,8,9,10,11,12

Web links and Video Lectures (e-Resources) – Virtual Lab	
1.	**https://vlabs.iitkgp.ac.in/aero/loe.html**

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2		2	3		2	1	1	1		3	2
CO2	3	3	2	3	3			1	2	2	1	3	2
CO3	3	3	3	3	3	2		2	2	2	2	3	3
CO4	3	3	3	3	3	2		2	2	2	2	3	3
CO5	3	3	3	3	3			2	2	2	2	3	3

Semester: IV					
Fundamentals of Spreadsheet (Branch: AE)					
Course Code	:	1BAEL406A	**Credit**	:	1
Hours/Semester (L:T:P:SL)	:	0:0:28:02	**CIE**	:	50 Marks
Total Hours	:	30	**SEE**	:	50 Marks
Course Type	:	AEC	**SEE Duration**	:	2 Hours

Prerequisites:	
Courses	Basic computer.
Knowledge on Fundamental Concepts	• Understanding of rows, columns and cells. • Basic math operations (addition, subtraction, multiplication, division). • Awareness of data types (numbers, text, dates). • Introductory understanding of data organization (e.g., tables/lists).
Knowledge on Connected Tools (If any)	Basic experience with local file systems for saving/opening spreadsheet files.

Course Learning Objectives: This course will enable the students to	
CLO1	Apply spreadsheet tools for engineering computations, data visualization, mathematical and logical functions, matrix operations, and data analysis.
CLO2	Utilize Excel functions, regression techniques, and optimization tools to solve algebraic, statistical, and engineering problems.
CLO3	Develop VBA-based automation solutions, including user-defined functions, macros, and aerospace engineering applications for analysis and decision-making.

Experiments	
Sl. No.	**List of Experiments**
1.	Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, 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

Open Ended Experiments	
1.	Aircraft Performance Analysis Using Excel
2.	Propeller Efficiency Prediction Model Using Excel
3.	Aircraft Weight and Balance Calculator Using Excel
4.	Jet Engine Thrust Estimation System Using Excel
5.	Runway Length Estimation for Aircraft Take-off and Landing
6.	Aircraft Fuel Consumption and Mission Planning Tool
7.	Wing Loading and Power Loading Analysis for Aircraft Design
8.	Atmospheric Properties Calculator (ISA Model) Using Excel
9.	UAV Flight Endurance and Payload Optimization Using Solver
10.	Aircraft Stability and Control Derivative Analysis
11.	Missile Trajectory Simulation Using Excel VBA
12.	Airport Traffic Movement Data Analysis and Forecasting

Course Outcomes: After completing the course, the students will be able to	
CO1	Create engineering data using charts, mathematical functions, logical functions, unit conversions, and matrix operations in Excel.
CO2	Perform regression analysis, forecasting, interpolation, and statistical modeling using Excel functions and the Analysis Tool Pak.
CO3	Apply Goal Seek, Solver, and iterative techniques to solve engineering problems involving optimization, root finding, and nonlinear analysis.
CO4	Develop VBA-based user-defined functions, macros, and automated spreadsheet applications for aerospace engineering problems such as aircraft performance, propulsion, stability, trajectory, and mission analysis.

Text Books	
1	**Spreadsheet Tools for Engineers Using Excel**, Byron S. Gottfried, 4th Edition, 2018, McGraw-Hill Education, ISBN: 978-1260116410. Experiments:1,2,3,4,5,6,7,8
2	**Excel Crash Course for Engineers**, Eklas Hossain, 1st Edition, 2021, Springer Nature, ISBN: 978-3030710354. Experiments:1,2,3,4,5,6,7,8

Reference Books	
1	A Guide to Microsoft Excel for Scientists and Engineers, Bernard V. Liengme, 6th Edition, 2015, Academic Press (Elsevier), ISBN: 978-0128028179.
2	Excel for Engineers and Scientists, S. C. Bloch, 2nd Edition, 2000, John Wiley & Sons, ISBN: 978-0471345671.

Web links and Video Lectures (e – Resources)	
1	https://www.microsoftpressstore.com/store/microsoft-excel-2019-formulas-and-functions-9781509306190
2	https://paulmcfedries.com/books/excel-2019-formulas-and-functions/
3	https://ptgmedia.pearsoncmg.com/images/9781509306190/samplepages/9781509306190_Sample.pdf

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	1	-	3							1	2
CO2	3	3	2	2	3							2	3
CO3	3	3	3	1	3						1	2	3
CO4	3	3	3	2	3				2	2	2	2	3

Semester: IV					
AR and VR in Aerospace Engineering (Branch: AE)					
Course Code	**:**	1BAEL406B	**Credit**	**:**	1
Hours/Semester (L:T:P:SL)	**:**	0:0:28:02	**CIE**	**:**	50 Marks
Total Hours	**:**	30L	**SEE**	**:**	50 Marks
Course Type	**:**	PCCL	**SEE Duration**	**:**	3 Hours

Pre requisites:	
Courses	AR and VR in Aerospace Engineering
Knowledge on Fundamental Concepts	IoT, Simulation software, AI Integration
Knowledge on Connected Tools (If any)	--

Course Learning Objectives: This course will enable the students to	
CLO1	Understand aircraft performance and stability under various flight conditions.
CLO2	Acquire the ability to operate aircraft controls, cockpit instruments, and navigation systems using a virtual simulator.
CLO3	Study aerodynamic principles by observing lift, drag, stall, approach, landing, and cruise performance in virtual flight experiments.

Sl No	**EXPERIMENT**
1	Familiarization with Aircraft Controls and Cockpit Instruments: Understanding primary and secondary controls, and the basic cockpit layout.
2	Straight and Level Flight Performance Analysis: Maintaining constant altitude and speed while observing trim conditions.
3	Effect of Angle of Attack on Lift and Stall Behaviour: Studying lift variation and identifying the critical angle.
4	Stall Identification and Recovery Techniques: Simulating a stall and applying recovery procedures.
5	Take-off Performance under Different Wind Conditions: Analysing the effect of headwind and tailwind on take-off distance.
6	Climb and Descent Performance Characteristics: Evaluating the rate of climb, glide slope, and descent control.
7	Turning Flight and Bank Angle Effects: Studying the load factor, turn radius, and coordinated turns.
8	Effect of Weight and Center of Gravity on Stability: Observing the aircraft's response to a shift in the center of gravity.
9	Cruise Flight Performance and Fuel Estimation: Determining the optimum cruise conditions.
10	Aircraft Response to Turbulence and Wind Gusts: Understanding the aircraft's stability in disturbed airflow.
11	Basic Navigation and Waypoint Tracking: Utilizing heading, GPS, and navigation aids.
12	Approach and Landing Performance Analysis: Studying the glide path, flare, and touchdown behavior.
13	Study of Ground Effect on Lift and Drag

Open Ended Experiments	
1	Design a VR Flight Scenario-Create a custom flight simulation environment using VR tools.
2	AR-Based Maintenance Overlay-Develop an AR application that overlays repair instructions on aircraft components.
3	Human Factors in VR Cockpit-Investigate pilot workload and situational awareness in a VR cockpit environment.
4	AR Visualization of Aerodynamics-Use AR to visualize airflow patterns around aircraft models.
5	Collaborative VR Design Lab-Create a shared VR workspace for aeronautical design projects.

Course Outcomes: After completing the course, the students will be able to	
CO1	Demonstrate knowledge of aircraft systems, flight mechanics, and control principles.
CO2	Analyze and evaluate aircraft performance, stability, and handling characteristics under different conditions.
CO3	Apply theoretical aerodynamic concepts to practical flight scenarios using simulation tools.

Text Books	
1	Navigating the Augmented and Virtual Frontiers in Engineering Authors: R. Siva Subramanian, M. Nalini, J. AswiniIGI Global (2024).

Reference Books	
1	Smart VR/AR/MR Systems for Professionals, Karupppasamy Subburaj, Sunpreet Singh, Saša Ćuković, Kamalpreet Sandhu, Gerrit Meixner, Radu Petruse, Springer/Amazon (2024)

Web links and Video Lectures (e – Resources)	
1	https://www.sciencedirect.com/search?qs=AR%20VR%20aerospace%20engineering

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2		2	3				1	1		3	2
CO2	3	3	2	3	3				2	2	1	3	2
CO3	3	3	3	3	3				2	2	2	3	3

Semester: IV					
Drone Pilot Training (Branch: AE)					
Course Code	:	1BAEL406C	**Credits**	:	1
Hours/Semester (L:T:P:SL)	:	0:28:2	**CIE**	:	50 Marks
Total Hours	:	30	**SEE**	:	50 Marks
Course Type	:	AEC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	• Elements of Aeronautical Engineering • Fluid Mechanics
Knowledge on Fundamental Concepts	• Basics of fluid flow and Bernoulli's principle • Lift, Drag, Thrust and Weight concepts • Airfoil basics
Knowledge on Connected Tools (If any)	

Course Learning Objectives: This course will enable the students to	
CLO1	Acquainted with the fundamentals of UAV systems and ArduPilot-based drone operations.
CLO2	Gained understanding of AI-assisted autonomous take-off, hovering, landing, and navigation functions.
CLO3	Recognized the influence of flight modes, battery performance, payload, and wind conditions on drone stability.
CLO4	Gained knowledge of waypoint mission planning, aerial surveying, and mapping using ArduPilot.
CLO5	Understood obstacle avoidance, emergency handling, and fail-safe mechanisms for safe UAV operations.

Experiments	
Sl. No.	**List of Experiments**
1.	AI-Assisted Pre-Flight Inspection using ArduPilot
2.	AI-Based Autonomous Take-off, Hovering, and Landing
3.	Stable Hovering Performance Test
4.	GPS Mode vs ATTI Mode Flight Comparison
5.	AI-Driven Waypoint Mission Planning
6.	Return-to-Home (RTH) Function Testing
7.	Battery Performance and Flight Time Analysis
8.	Payload Carrying and Stability Evaluation
9.	Effect of Wind on Drone Flight Stability
10.	Aerial Survey and Mapping using ArduPilot
11.	Obstacle Avoidance Integration with ArduPilot
12.	Emergency Handling and Fail-Safe Simulation

Open Ended Experiments	
1	AI-Based Precision Landing Enhancement Using Vision Sensors
2	Intelligent Energy Management for Extended Flight Endurance
3	Autonomous Search-and-Locate Mission Using Computer Vision
4	Adaptive Flight Control Under Varying Wind Conditions
5	Multi-Objective Autonomous Mission Planning Using AI

Course Outcomes: After completing the course, the students will be able to	
CO1	Configure and inspect UAV systems using ArduPilot and AI-based pre-flight checks for safe operation.
CO2	Execute autonomous take-off, hovering, navigation, and landing missions using ArduPilot.
CO3	Analyze UAV performance under varying battery, payload, flight mode, and environmental conditions.
CO4	Evaluate return-to-home, fail-safe, and emergency recovery functions during simulated failures.
CO5	Perform aerial mapping, obstacle avoidance, and AI-driven mission planning using flight data analysis.

Text Books	
1	Beard, R.W. and McLain, T.W., Small Unmanned Aircraft: Theory and Practice, 1st Edition, Princeton University Press, Princeton, New Jersey, USA, 2012, ISBN-13: 978-0691149219.
2	K. Nonami, F. Kendoul, S. Suzuki, W. Wang, and D. Nakazawa, Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles, Springer, Berlin, Heidelberg, 2010, ISBN: 978-4-431-53854-5.
3	P. G. Fahlstrom and T. J. Gleason, Introduction to UAV Systems, 4th ed., Hoboken, NJ, USA: John Wiley & Sons, 2012. ISBN-13: 978-1119993241

Web links and Video Lectures (e-Resources) – Virtual Lab	
1.	**https://ardupilot.org/dev/docs/sitl-simulator-software-in-the-loop.html**

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	2		2			1	1	1	2	3	2
CO2	3	3	3		2			1	1	1	2	3	2
CO3	3	2	3	2	2			1	1	1	3	3	2
CO4	2	2	3	2	2	2	2	1	1	1	2	3	2
CO5	3	3	3	2	3	2		1	2	2	3	3	2

Semester: IV					
Biology for Engineers (ME and CV Streams)					
Course Code	:	1BBN404	**Credit**	:	1
Hours/Semester (L:T:P:SL)	:	14:0:0:16	**CIE**	:	50 Marks
Total Hours	:	30	**SEE**	:	50 Marks
Course Type	:	BSC	**SEE Duration**	:	2 Hour

Prerequisites:	
Courses	Biology and Chemistry
Knowledge on Fundamental Concepts	-
Knowledge on Connected Tools (If any)	NA

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the structure and functions of cells, biomolecules, stem cells, enzymes, vitamins, and hormones, and their significance in engineering.
CLO2	Relate human organ systems to engineered devices such as prosthetics, bionic eyes, pacemakers, ventilators, and dialysis systems.
CLO3	Understand bio-inspired designs and emerging bioengineering technologies, including tissue engineering, bioprinting, self-healing materials, and bioremediation.

Module – 1	**05 Hrs**
Fundamentals of Biology and Biomolecules: Cell structure and functions, Plant and Animal cells, Prokaryotic and Eukaryotic cells, Stem cells and applications, Biomolecules: Carbohydrates, Proteins, Lipids and Nucleic acids, Enzymes, Vitamins and Hormones. **Textbook -1, Ch-1 and Textbook -2, Ch-1.**	
Module – 2	**05 Hrs**
Human Organ Systems and Engineering Designs: Brain as CPU and prosthetic devices,Eye as camera and bionic eye, Heart as pump: ECG, pacemakers and stents, Lungs as purification system: Ventilators and spirometer, Kidney as filtration system: Dialysis technologies.G-Forces, Effects of Positive and Negative G-forces, Microgravity Effects on Bones, Muscles and Blood Circulation **Textbook -1, Ch-2-3 and Textbook -2, Ch-2-3.**	
Module – 3	**04 Hrs**
Nature-Inspired Engineering and Bioengineering Trends: Echolocation and Sonar, Photosynthesis and Solar Cells, Lotus Leaf Effect and Self-cleaning Surfaces, Bird Flight and Aircraft Design, Velcro inspired by Plant Burrs, Kingfisher Beak and Bullet Train Design, Tissue Engineering and Bio printing, Self-healing Bio concrete and Bioremediation. Applications of Bio mimic in UAVs and Modern Aircraft. **Textbook -1, Ch-4-5 and Textbook -2, Ch-4-5.**	

Topics for Self-learning	
Module – 1	Stem Cells and Their Applications in Regenerative Medicine
	Role of Biomolecules in Healthcare and Industrial Applications
Module – 2	Prosthetic Devices and Recent Advances in Bionic Organs
	Bionic Eye and Advanced Vision Restoration Technologies
Module – 3	Tissue Engineering and Bio printing
	Self-Healing Bio concrete

Course Outcomes: After completing the course, the students will be able to	
CO1	Interpret the fundamental concepts of biology, biomolecules, and their engineering applications.
CO2	Relate the structure and functions of human organ systems to biomedical devices and engineering solutions.
CO3	Apply bio-inspired principles and discuss emerging bioengineering technologies for sustainable and innovative engineering applications.

Text Books	
1	**Biology for Engineers** – Rajendra Singh C. and Rathnakar Rao N., Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.
2	**Biology for Engineers** – S. Thyagarajan, N. Selvamurugan, M.P. Rajesh, R.A. Nazeer, W. Thilagaraj, S. Barathi and M.K. Jaganathan, Tata McGraw-Hill Education, New Delhi, 2012.

Reference Books	
1	**Biology for Engineers** – Arthur T. Johnson, CRC Press, Taylor & Francis Group, 2011.
2	**Biomimetics: Nature-Based Innovation** – Yoseph Bar-Cohen, CRC Press, 2012.

Web links and Video Lectures (e – Resources)	
1	https://nptel.ac.in/courses/121106008?utm_source=chatgpt.com
2	https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009/?utm_source=chatgpt.com
3	https://onlinecourses.nptel.ac.in/noc22_bt18/preview?utm_source=chatgpt.com

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3				1	2					1
CO2	3				3	3	2				2
CO3	3				3	3					3

Semester: IV					
Environmental Science Project					
Course Code	:	1BEP408	**Credit**	:	1
Hours/Semester (L:T:P:SL)	:	0:0:0:30	**CIE**	:	50 Marks
Total Hours	:	30	**SEE**	:	50 Marks
Course Type	:	SDC	**SEE Duration**	:	2 Hours

Course Learning Objectives: This course will enable the students to	
CLO1	Understand complex, real-world environmental issues, including climate change, biodiversity loss, and pollution dynamics.
CLO2	Apply scientific, technological, and engineering principles to analyze structural environmental problems.
CLO3	Train in field-based methodologies, including site surveys, environmental auditing, and data collection protocols.
CLO4	Instill critical thinking and interdisciplinary problem-solving skills required to design sustainable, preventive, or remedial solutions.
CLO5	Develop professional competencies in teamwork, collaborative project management, and effective communication of environmental findings.
Restrictions and professional conduct: Environmental Science Projects should be academic, socially responsible, technically focused, and politically neutral. Students and faculty must maintain professionalism, ethical conduct, and respect while working with communities and stake holders, and avoid any political, ideological, commercial, or disruptive activities. Projects should also consider practical constraints such as cost, resources, safety, environmental impact, and stake holder cooperation.	

Methods for project identification: Students may identify the project topic using one or more of the following methods: interaction with local rural or urban stake holders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.; review of issues highlighted in print and electronic media, and social networks; and, after selecting a broad topic, collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and 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	SDG6, SDG11, SDG12
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	SDG11, SDG12, SDG13
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	SDG11, SDG13, SDG15

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	SDG7, SDG11, SDG12
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	SDG7, SDG9, SDG11
6	DPR for electrification of village /tribal community	Map unserved /underserved house holds, propose electrification layout, and estimate coverage, losses, and implementation cost.	PO1,PO2, PO3,PO4, PO10,PO11	SDG7, SDG9, SDG10
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	SDG6, SDG9, SDG11
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	SDG3, SDG6, SDG11, SDG12
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	SDG11, SDG12, SDG13
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	SDG2, SDG3, SDG11
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	SDG3, SDG11, SDG17
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	SDG3, SDG11, SDG13
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	SDG11, SDG12, SDG13
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	SDG11, SDG13, SDG15

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	SDG2,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	SDG2,SDG 6,SDG12
17	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	SDG2,SDG 9,SDG12

Suggested Learning Resources

Textbooks

1. Benny Joseph, Environmental Studies, Tata McGraw-Hill, 2nd Edition.
2. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2005.
3. ErachBharucha, Textbook of Environmental Studies, University Press, latest edition as available in library.
4. M. P. Poonia and S. C. Sharma, Environmental Studies, Vikas Publishing House, latest edition as available Garg,N.R., Project-Based Learning in Engineering Education, Pearson India Education Services, Noida.

Reference books

1. R. Sivakumar, Principles of Environmental Science and Engineering, Cengage Learning, 2nd Edition.
2. G. Tyler Miller Jr., Environmental Science: Working with the Earth, Thomson Brooks/Cole, 11th Edition.
3. Pratibha Singh, Anoop Singh, and PiyushMalaviya, Text Book of Environmental and Ecology, Acme Learnin 1st Edition.
4. S. M. Prakash, Environmental Studies, Elite Publishing House, Mangalore, 3rd Edition, 2018.

Teaching Learning Process:

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

Week	**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	Short listed project topic
3	Stake holder 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 out line
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
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, stake holder 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)–50marks

- Students, in batches of 3–4, shall under take 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 totaling 50 marks:

CIE pass requirement:

- A student shall secure a minimum of 20 marks out of 50 in CIE to become eligibleto appear for SEE.
- Students who fail to earn the required CIE marks may be given additional opportunities before closure of the semester; nore-doing of CIE is permitted after the end of the semester.

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

- Examination duration: 2hours.
- Maximum examination marks:100 (scaled to 50).
- The SEE shall be conducted batch-wise by two examiners, one faculty from the same department and one from a different department appointed by the Principal.

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) 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/environment	8	Problem clearly identified with strong evidence of relevance and well-defined scope.	Relevant problem with clear scope and adequate evidence.	Problem defined but justification is weak.	Problem unclear or not relevant.
Formation of problem statement; engineering approach, innovation & feasibility	10	Precise statement; sound, innovative, feasible approach.	Adequate statement; feasible with minor gaps.	Partial statement; marginal feasibility.	Missing or infeasible.
Interaction with stakeholders; data collection, analysis & interpretation	8	Thorough engagement; comprehensive data and well-interpreted analysis.	Good engagement; adequate data and analysis.	Limited engagement; incomplete data and superficial analysis.	Little or no stake holder contact; no data/analysis.
Project documentation; clarity, organization & problem- solving demonstrated	10	Complete, well-organized, analytical, and strong problem-solving.	Complete and clear with some analytical content.	Basic with omissions; problem-solving limited.	Missing/ Poorly organized; no clear problem-solving.
Communication & presentation skills	6	Confident, structured, and answer squeries fully;	Clear and satisfactory; responds to most queries.	Acceptable but lacks clarity or confidence; weak responses.	Poor or absent; unable to respond.

		visuals effective.			
Contribution & benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and realistic sustainability path.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear benefit; sustainability weak.	No evident benefit or sustainability.

SEE Rubric—Semester End Examination (Will be conducted for 100 marks; later scaled to 50 marks):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & relevance to society/ Environment	16	Clearly articulated with strong evidence and context.	Clear with reasonable evidence.	Problem stated but evidence/context weak.	Poorly defined or irrelevant.
Formation of problem statement; engineering approach, innovation & feasibility	20	Precise; demonstrates engineering depth, novelty and feasibility.	Technically sound and feasible with minor limitations.	Basic; limited technical depth or feasibility concerns.	Noviable engineering approach or infeasible plan.
Interaction with stake holders; data collection, analysis & interpretation	16	Excellent 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	Comprehensive, technically rigorous, and systematic.	Complete and technically correct with minor gaps.	Lacks technical depth or has not able missions.	Missing key elements or technically incorrect.
Communication, presentation & viva-voce responses	12	Presents expertly, defends work persuasively and answers all queries correctly.	Good presentation and satisfactory answers to most queries.	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 impact assessment with scaling recommendations.	Reasonable impact discussion and sustainability considerations.	Limited evaluation of impact or sustainability.	No coherent assessment of impact or sustainability.

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify and analyse environmental problems through field interaction and technical assessment.
CO2	Develop skills in project planning, field survey, data collection, implementation, documentation, teamwork and communication.
CO3	Formulate feasible environmental problem statements and solutions considering practical constraints and sustainability aspects.
CO4	Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.
CO5	Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	3		3	1	2	2					2	1
CO2				2	2				3	3	3	2	1
CO3	2	2	3			2	3				1	2	1
CO4						3	3	3				2	1
CO5	2	3	2	2		2	2		2			2	1

Semester: IV						
Metaphysical Science **Streams: CSE/ECE/CV/ME**						
Course Code	**:**	1BMP409		**Credits**	**:**	1
Hours/Week(L:T:P:SL)	**:**	14:0:0:16		**CIE**	**:**	50 Marks
Total Hours	**:**	30		**SEE**	**:**	50 Marks
Course Type	**:**	HSSMC		**SEE Duration**	**:**	2 Hr

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the basic concepts of metaphysics, ontology, and epistemology.
CLO2	Explain metaphysical perspectives on the universe, mind, and consciousness.
CLO3	Explore the relationship between quantum metaphysics, healing and modern science.

Module 1	**05 Hrs**

Foundations of Metaphysics, Ontology and Epistemology

Introduction to Metaphysics: Definition, scope and historical roots (Aristotle, Plato, Kant). Distinction between Metaphysics, Physics and Spirituality.

Branches of Metaphysics: Ontology, Cosmology and Epistemology.

Fundamental metaphysical questions: Reality, existence, abstract entities, morality.

Ontology (Study of Being): Materialism, Idealism and Dualism, Problem of Universals: Realism vs. Nominalism

Epistemology (Study of Knowledge): Rationalism (Descartes) and Empiricism (Locke, Hume), Theories of Truth: Correspondence, Coherence and Pragmatic, Skepticism and Constructivism, Simulation Theory and Descartes' Evil Demon

Textbook2, Ch.1-5

Module 2	**05 Hrs**

Cosmology, Mind and Consciousness

Metaphysical Cosmology: Philosophical and Physical Cosmology, Time, Space and Origin of the Universe, Anthropic Principle and Fine-Tuning Debate, Creation, Causality and Infinite Regress, Multiverse Theory and its Metaphysical Implications, Ancient Cosmologies: Vedic, Taoist and Indigenous Perspectives.

Mind and Consciousness: Nature of Mind and Consciousness, Mind-Body Problem: Dualism vs. Physicalism, Theories of Consciousness: Integrated Information Theory (IIT), Global Workspace Theory and Panpsychism, Eastern and Western Perspectives on Self and Consciousness, Artificial Intelligence and Machine Consciousness, Role of Consciousness in Observation and Decision Making

Textbook1, Ch.1-2, Textbook2, Ch.6-8

Module 3	**05 Hrs**

Quantum Metaphysics, Healing and Engineering Perspectives

Basics of quantum mechanics (superposition, entanglement, observer effect), Quantum Theory and Consciousness, Quantum Healing: Deepak Chopra's Model, Biofield Theory, Chakras and Subtle Energy Systems, Placebo Effect, Intention and Non-local Healing, Applications and Engineering Perspectives of Bio-resonant Technologies, Scientific evidence, limitations and ethical considerations in Quantum Healing.

Textbook1, Ch. 3-15

Topics for Self-learning	
Module – 1	• Indian Perspectives on Metaphysics (Advaita Vedanta, Buddhism and Jainism) • Philosophy of science and scientific realism
Module – 2	• Consciousness in meditation and mindfulness practices • AI ethics and machine consciousness • Latest developments in neuroscience and consciousness research
Module – 3	• Emerging biofeedback and wearable health technologies • Engineering applications of meditation and Neuro technology

Course Outcomes: After completing the course, the students will be able to	
CO1	Interpret the fundamental concepts of metaphysics, ontology and epistemology in understanding reality and existence.
CO2	Analyze metaphysical perspectives on cosmology, consciousness and the nature of the universe.
CO3	Evaluate the relationship between quantum theory, consciousness, healing practices and their relevance to emerging engineering applications.

Text Books	
1	Quantum Metaphysics, Tarja Kallio-Tamminen, ISBN 952-10-1927-1 Otamedia, Oy 2004.
2	Metaphysics-A Very Short Introduction, Stephen Mumford, Sl. No. 20129780191640261, 0191640263, OUP Oxford, 2012

Reference Books	
1	Deepak Chopra M.D., Quantum Healing (Revised and Updated): Exploring the Frontiers of Mind/Body Medicine, 2015.
2	Deepak Chopra M.D., Quantum Body: The New Science of Living a Longer, Healthier, More Vital Life, 2023.

Web links and Video Lectures (e – Resources)	
1	https://www.yogajournal.com/meditation/
2	https://youtube.com/shorts/JgCVh6wwgNg?si=R87-PGIrUSII774w
3	https://www.youtube.com/watch?v=XvyuUqlX7fE
4	https://core.ac.uk/download/pdf/14914967.pdf
5	https://www.youtube.com/watch?v=_ba0yIAZ9ok
6	https://www.youtube.com/watch?app=desktop&v=fzxohf49loU
7	https://www.youtube.com/watch?v=SSGKowtXS3Y
8	https://www.youtube.com/watch?v=r_piRatnFlY

CO–PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2				2		2	1		3	1	
CO2	2	3				2		2	1		3	1	
CO3	2	2				2	2	2	1		3	1	

Semester: IV					
NATIONAL SERVICE SCHEME (Common to the Branches)					
Course Code	**:**	1BNS410	**Credit**	**:**	0
Hours/Semester (L:T:P:SL)	**:**	0:0:0:28	**CIE**	**:**	100 Marks
Total Hours	**:**	28	**SEE**	**:**	-
Course Type	**:**	NCMC	**SEE Duration**	**:**	-

Prerequisites:	
Courses	**---**
Knowledge on Fundamental Concepts	Basic understanding of social responsibility, environmental awareness, community welfare, sustainable development, ethics, teamwork, and communication skills.
Knowledge on Connected Tools (If any)	Basic use of Smart phones, internet, digital communication tools (email, WhatsApp, Google Forms), presentation software (PowerPoint/Canva), video recording tools, and office productivity software (MS Word/Google Docs) for documentation and report preparation.

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the community, identify its needs and problems, and apply knowledge to develop practical solutions for sustainable community development and welfare.
CLO2	Develop social and civic responsibility, leadership, teamwork, communication, and community participation skills through collaborative and service-oriented activities.
CLO3	Demonstrate ethical values, democratic attitudes, effective group-living skills, and responsible citizenship while contributing to social service and community development.

Activity– 1	**10 Hrs**
Environmental Sustainability: Plantation and adoption of plants (Know Your Plants), water conservation techniques, role of stakeholders, and implementation of sustainable environmental practices.	
Activity – 2	**09 Hrs**
Community Development and Rural Entrepreneurship: Organize National Integration and Social Harmony programs (minimum two), prepare actionable business proposals to enhance village income, and support community-based development initiatives.	
Activity – 3	**09 Hrs**
Educational and Social Welfare Initiatives: Government school rejuvenation, improving infrastructure, enhancing student academic performance and enrolment in higher/technical/vocational education through awareness and mentoring activities.	

Topics for Self learning	
Activity – 1	Plantation, biodiversity conservation, and sustainable water management practices.
	Climate change, environmental protection, and the role of citizens in conservation.

Activity– 2	National integration, social harmony, and community leadership.
	Rural entrepreneurship, village development, and government support schemes.
Activity – 3	School development, educational awareness, and mentoring for higher education.
	Social responsibility, volunteerism, and community engagement for sustainable development.

Pedagogy – Guidelines, it may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution

Sl. No.	Topic	Group Size	Location	Activity Execution	Reporting	Evaluation of the Topic
1.	Water conservation techniques – Role of different stakeholders– Implementation.	May be individual al or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…..	Site selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
2.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual al or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…..	Group selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
3.	Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Local government / private/ aided schools/Government Schemes officers/ etc…..	School selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer

Plan of Action (Execution of Activities for 4th Semester)

Sl. No.	Practice Session Description
1.	Lecture session by NSS Officer
2.	Selection of topic, Commencement of activity and its progress
3.	Execution of Activity
4.	Case study based Assessment, Individual performance
5.	Sector wise study and its consolidation
6.	Video based seminar for 10 minutes by each student At the end of semester with Report.

- In the 4th semester, each student should do activities according to the scheme and syllabus.
- At the end of the semester student performance has to be evaluated by the NSS Officer for

the assigned activity progress and its completion.

- At the end of the 4th semester, consolidated report of all activities compiled report should be submitted as per the instructions.

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze environmental and societal issues and propose practical, sustainable solutions by demonstrating social responsibility and civic awareness.
CO2	Evaluate and implement government and community-driven initiatives to address societal challenges and promote community development and welfare.
CO3	Demonstrate ethical values, teamwork, leadership, effective communication, and civic responsibility while participating in social service and community engagement activities.

Assessment Details for CIE (100 Marks)

Weightage	**CIE- 100 Marks**
Selection of Topic, Commencement of activity and its progress	**40 Marks**
Case study based Assessment	**20 Marks**
Sector wise study and its consolidation	**20 Marks**
Video based seminar for 10 minutes by each student at the end of semester with Report	**20 Marks**
Total Marks for the course in each semester	**100 Marks**

Suggested Learning Resources: **Books:**	
1	NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2	Government of Karnataka, NSS cell, activities reports and its manual.
3	Government of India, NSS cell, Activities reports and its manual.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1						3	2	2	1		3	1	
CO2						3	3	2	1		3	1	
CO3						3	3	3	1	3	3	1	

Semester: IV					
Physical Education **Common to All Branches**					
Course Code	:	1BPE410	**Credits**	:	0
Hours/Week(L:T:P:SL)	:	0:0:0:28	**CIE**	:	100 Marks
Total Hours	:	28	**SEE**	:	-
Course Type	:	NCMC	**SEE Duration**	:	-

Course Learning Objectives: This course will enable the students to	
CLO1	Develop an understanding of ethical principles and moral values and their importance in sportsmanship, fair play, and personal conduct in games and athletic activities.
CLO2	Acquire practical skills and demonstrate technical proficiency in selected sports or athletic events through structured physical training and performance.
CLO3	Understand the role of effective organization, administration, and management in the successful conduct of sports events and athletic programs.

Module – 1	**4 Hrs**
Ethics and Moral Values: A. Ethics in Sports B. Moral Values in Sports and Games	
Module – 2	**16 Hrs**
Specific Games (Any one to be selected by the student) A. Volleyball – Attack, Block, Service, Upper Hand Pass and Lower hand Pass. B. Athletics (Track Events) – Any event as per availability of Ground	
Module-3	**4 Hrs**
Role of Organization and administration	

Topics for Self-learning	
Module – 1	Sportsmanship, Fair Play and Ethical Decision-Making in Sports
Module – 2	Rules, Techniques and Performance Analysis of Volleyball / Track Events
Module – 3	Planning, Organization and Management of Sports Events

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the ethical principles, moral values, and sportsmanship essential for responsible participation in sports and games.
CO2	Perform the fundamental skills and techniques of the selected game or athletic event with discipline and teamwork.
CO3	Discuss the role of sports organizations and administration in the promotion and management of sports activities.

Scheme and Assessment for auditing the course and Grades:

Sl.No.	Activity	Marks
1.	Participation of student in all the modules	20
2.	Quizzes–2,each of 15marks	30
3.	Final presentation / exhibition / Participation in competitions/ practical on specific tasks assigned to the students	50
	Total	**100**

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						2		3	2		2
CO2						2		2	2		2
CO3						2		2	2	2	3

Semester: IV					
Yoga **Streams: CSE/ECE/CV/ME**					
Course Code	**:**	1BYO410	**Credit**	**:**	0
Hours/Semester (L:T:P:SL)	**:**	0:0:0:28	**CIE**	**:**	100 Marks
Total Hours	**:**	28	**SEE**	**:**	---
Course Type	**:**	NCMC	**SEE Duration**	**:**	---

Prerequisites:	
Courses	**--**
Knowledge on Fundamental Concepts	• Basic understanding of physical fitness, health and personal hygiene. • Awareness of body posture, breathing, and general wellness practices.
Knowledge on Connected Tools (If any)	**--**

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the philosophy and principles of Patanjali's Ashtanga Yoga for holistic well-being.
CLO2	Demonstrate the correct techniques of Surya Namaskar, Yogasanas, Kriyas, and Pranayama with appropriate safety measures.
CLO3	Practice Yogic techniques to enhance physical fitness, mental wellness, and healthy lifestyle habits.

Module - 1	**04 Hrs**
Foundations of Ashtanga Yoga: Patanjali's Ashtanga Yoga: Introduction, need and importance, Eight Limbs of Yoga – Overview, Yama: Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha, Niyama: Shoucha, Santosha, Tapa, Svaadhyaya, Eshvarapranidhana. **T-1: Ch. 4**	
Module - 2	**05 Hrs**
Surya Namaskar and Yogasanas: Surya Namaskar: Concept, significance, 12-step sequence, breathing coordination, posture alignment, and practice of four rounds, Asanas: Meaning, need, importance, classification, Practice of Sitting, Standing, Prone, and Supine Asanas (Sukhasana, Paschimottanasana, Ardhakati Chakrasana, Parshva Chakrasana, Dhanurasana, Halasana, Karna Peedasana) with techniques, precautions and benefits. **T-1: Ch. 3, 4**	
Module - 3	**05 Hrs**
Kriyas and Pranayama: Kriyas: Introduction to Shatkarmas, Kapalabhati – meaning, importance, technique, precautions, and benefits, Pranayama: Meaning, need, importance, techniques, precautions, and benefits, Types of Pranayama: Suryanuloma–Viloma, Chandranuloma–Viloma, Suryabhedana, Chandrabhedana, Nadishodhana. **T-1: Ch. 5, T-2: Ch. 2**	

Topics for Self learning	
Module – 1	Role of Yama and Niyama in personal and professional ethics
Module – 2	Scientific benefits of Surya Namaskar and Yogasanas in stress management and lifestyle disorders
Module – 3	Advanced Pranayama, Meditation, and Yoga for mental health and holistic wellness

Course Outcomes: After completing the course, the students will be able to	
CO1	Summarize the philosophy, principles, and significance of Patanjali's Ashtanga Yoga and its role in healthy living.
CO2	Demonstrate Surya Namaskar, selected Yogasanas, Kapalabhati and Pranayama using proper techniques and precautions.
CO3	Practice appropriate Yogic techniques to improve physical fitness, mental concentration, emotional balance, and overall wellness.

Text Book	
1	Light on Yoga, B.K.S. Iyengar, HarperCollins Publishers India, 2006, ISBN: 978-81-7223-501-7.
2	Asana Pranayama Mudra Bandha, Swami Satyananda Saraswati, Yoga Publications Trust, Bihar School of Yoga, Munger, 2008, ISBN: 978-81-86336-14-4

Reference Books	
1	Teaching Methods for Yogic practices by Dr. M L Gharote & Dr. S K Ganguly, 4th Edition, Kaivalyadhama Publishers, ISBN-10 : 9788189485245
2	Yoga Instructor Course hand book published by SVYASA University, Bengaluru
3	Raja Yoga, Swami Vivekananda, Advaita Ashrama, Kolkata, 2018, ISBN: 978-81-7505-151-5.

Web links and Video Lectures (e – Resources)	
1	https://www.youtube.com/playlist?list=PLzF4lOyPf_Z9yQ_Gphjh1wZ5fEhMg6hmP
2	https://www.youtube.com/playlist?list=PLOzRYVm0a65cCcY4qKX5MIyJxBt7hJgQY
3	https://youtu.be/KB-TYlgd1wE
4	https://youtu.be/aa-TG0Wg1Ls

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1						2	2				2	1	
CO2						3	2	1			2	1	
CO3						3	2	2			2	1	

Semester: IV					
Music **Stream: CSE/ECE/ME/CV**					
Course Code	**:**	1BMU410	**Credit**	**:**	0
Hours/Semester (L:T:P:SL)	**:**	0:0:0:28	**CIE**	**:**	100 Marks
Total Hours	**:**	28	**SEE**	**:**	-
Course Type	**:**	NCMC	**SEE Duration**	**:**	-

Prerequisites:	
Courses	Familiarity with school-level cultural or music activities is beneficial
Knowledge on Fundamental Concepts	Basic awareness of vocal music and musical instruments.
Knowledge on Connected Tools (If any)	Metronome or Tala application for rhythm practice. Audio playback device (mobile phone/laptop) for listening to compositions.

Course Learning Objectives: This course will enable the students to	
CLO1	Interpret the contributions of key composers like Purandaradasa, Thyagaraja and Mysore Vasudevacharya to Indian music and understand their musical legacy.
CLO2	Contrast the classification and basic construction of traditional Indian musical instruments, including string, wind, percussion and idiophones, with appropriate examples.
CLO3	Demonstrate basic vocal proficiency through the practice of Sarale Varase exercises, notations for SuladiSapta Tala in Mayamalavagowla raga and performance of selected compositions such as Geethe, Jathi Swara and Krithi.

Module – 1	**05 Hrs**
Composers: Biography and contributions of Purandaradasaru, Thyagarajaru, Mysuru vasudevacharyaru, Kanakadasaru. **T-3** Ch. 2-5	
Module – 2	**05 Hrs**
Music Instruments: Classification and construction of string instruments, wind instruments, percussion Instruments, Idiophones (Ghana Vaadya), Examples of each class of instruments. **T-1**,V-4 – Ch. 2-6	
Module – 3	**04 Hrs**
Abhyasa Gana : Singing the swara exercises (Sarale Varase Only), Botatio writing for saralevaraseandsulafisapta tala (Only in mayamalavagowla raga), singing 4 geethe in malahari and one jathiswara, oekrithi in a mela raga. **T-1**, V-1&2 **T-2** Ch.2-4	

Topics for Self learning	
Module – 1	Contributions of the trinity of Carnatic music (Thyagaraja, Muthuswami Dikshitar, Syama Sastri)
	Women composers and their contributions to Indian Classical Music
Module – 2	Modern electronic musical instruments used in Indian Music
	Evolution and global influence of traditional Indian musical instruments
Module – 3	Voice culture techniques and vocal health for singers
	Introduction to digital music learning tools (Shruthi Box, Tala Apps, and Online Music Platforms)

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend the contributions of composers.
CO2	Classify Indian musical instruments and describe their construction and use.

CO3	Illustrate basic Carnatic vocal skills through selected exercises and compositions.

Text Books	
1	South Indian Music – Vol. I to VI, Prof. P. Sambamoorthy, 2019thEdition,2021.The Indian Music Publishing House, Chennai, ASIN : B093Y3TL52 Chapters:2,3,4,5,6
2	A Textbook of Carnatic Music, Dr. S. Bhagyalekshmy, 4th Edition ,2008,CBH Publications , ISBN 81 85 381 50 Chapters:2,3,4
3	Karnataka Sangeetha Charitre, Dr. V. S. Sampathkumaracharya, Kannada University, Hampi Chapters:2,3,4,5

Reference Books	
1	History of South Indian (Carnatic) Music (From Vedic Times to the Present) , R Rangaramanujaayyangar ,2019 edition ,Vipanchi charitable trust publisher ISBN: 9788187723158.
2	Music of India, B. Chaitanya Deva, 2nd edition , 1995MunshiramManoharlal Publishers.ISBN-10 : 8121501954
3	Essentials of Musicology in South Indian Music, Prof. S. R. Janakiraman, 2013 Edition, Asian Educational Services
Web links and Video Lectures (e – Resources)	
1	https://youtu.be/DZA_cSb0Zo8?si=55M6QAC2T8VqZN39
2	https://www.youtube.com/live/RfM4lAJQgCc?si=xfK0b6exvkBujugr
3	https://youtu.be/DZA_cSb0Zo8?si=55M6QAC2T8VqZN39

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1				1	1	1		1				
CO2	2		2		3	1	1	1	1		1		
CO3	3			1	2	1	1	1	1		1		

Semester: IV					
National Cadet Corps– II (Common to all Branches)					
Course Code	**:**	1BNC410	**Credit**	**:**	0
Hours/Semester (L:T:P:SL)	**:**	0:0:0:28	**CIE**	**:**	100 Marks
Total Hours	**:**	28	**SEE**	**:**	--
Course Type	**:**	NCMC	**SEE Duration**	**:**	--

Prerequisites:	
Courses	National Cadet Corps (NCC) – I (1BNC309), if NCC was the option chosen in III Semester
Knowledge on Fundamental Concepts	NCC, National Integration, Disaster Management, Social Awareness
Knowledge on Connected Tools (If any)	**-**

Course Learning Objectives: This course will enable the students to	
CLO1	Acquire general knowledge of health, hygiene and preventive well-being practices prescribed for NCC cadets
CLO2	Gain awareness of environmental conservation and natural-resource management as taught to NCC cadets
CLO3	Understand the elements of personality development and leadership traits expected of a responsible citizen

Module – 1	**05 Hrs**
Health and Hygiene – General Awareness: Structure and Functioning of the Human Body; Hygiene and Sanitation (Personal and Food Hygiene). Physical and Mental Health (general awareness); Infectious and Contagious Diseases and their Prevention. First Aid in Common Medical Emergencies (awareness only); Introduction to Yoga Exercises.	
Module – 2	**05 Hrs**
Environment Awareness and Conservation – General Awareness: Natural Resources – Conservation and Management; Water Conservation and Rain Water Harvesting. Waste Management; Pollution Control – Water, Air, Noise and Soil. Energy Conservation; Wildlife Conservation and Projects in India.	
Module – 3	**04 Hrs**
Personality Development and Leadership – General Awareness: Introduction to Personality Development; Factors Influencing Personality (Physical, Social, Psychological and Philosophical); Self-Awareness. Interpersonal Relationship and Communication Skills; Leadership Traits and Types of Leadership. Attitude – Assertiveness and Negotiation; Time Management; Stress Management Skills; Interview Skills.	

Topics for Self learning	
Module – 1	Reading on personal hygiene/sanitation practices; a short note on common infectious diseases and their prevention
Module – 2	Short report on a local water-conservation or waste-management initiative; awareness reading on a wildlife conservation project in India
Module – 3	Preparation of a short self-awareness/communication-skills reflection note; practice of a mock interview with peers

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the structure and functioning of the human body and describe common health, hygiene and preventive practices
CO2	Describe key concepts of environmental conservation, natural-resource management and pollution control

CO3	Exhibit an understanding of personality development, leadership traits, communication and stress/time-management skills

Text Books	
1	Cadet's Handbook – Common Subjects (SD/SW), Directorate General NCC, Ministry of Defence, Government of India, Edition dated 06 May 2013 (or latest edition).
2	NCC Handbook for 'A', 'B' and 'C' Certificate Examinations, Upkar Prakashan, Latest Edition.

Reference Books	
1	Personality Development and Leadership – A Cadet's Guide, published by DGNCC, Latest Edition.
2	Ministry of Environment, Forest and Climate Change – awareness publications on conservation, Latest Edition.
3	NCC Directorate/Group HQ training literature and circulars, as issued from time to time.

Web links and Video Lectures (e – Resources)	
1	Directorate General National Cadet Corps – https://www.nccindia.gov.in/
2	Ministry of Environment, Forest and Climate Change – https://moef.gov.in

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1						2		1	1				
CO2						2	3						
CO3								2	3	3			

Semester: IV					
Competency Enhancement Course-2 **Stream: CSE/ECE/ME/CV**					
Course Code	**:**	1BCE411	**Credits**	**:**	0
Hours/Week(L:T:P: SL)	**:**	14:0:0:14	**CIE**	**:**	100Marks
Total Hours	**:**	28	**SEE**	**:**	-
Course Type	**:**	NCMC	**SEE Duration**	**:**	-

Prerequisites:	
Courses	Competency enhancement course-1
Knowledge on Fundamental Concepts	Arithmetic operations, fractions, decimals and elementary algebra. comprehension of basic English
Knowledge on Connected Tools (If any)	NA

Course Learning Objectives: This course will enable the students to	
CLO1	Enhance Quantitative Problem-Solving Skills
CLO2	Master Data Interpretation and Visual Analysis
CLO3	Strengthen Logical Reasoning and Spatial Intelligence
CLO4	Develop Advanced Verbal Aptitude and Communication Accuracy
CLO5	Sharpen Critical Thinking through Assumptions and Analytical Judgement

Module – 1	**6 Hrs**
Data Interpretation: Approach to interpretation - simple arithmetic, rules for comparing fractions, Calculating (approximation) fractions, short cut ways to find the percentages, Classification of data– Tables, Bar graph, line graph, Cumulative bar graph, Pie graph, Combination of graphs. Combination of table and graphs **T-1, C-36**	
Module – 2	**6 Hrs**
Pipes & Cisterns: Speed, Time, and Distance, Core concepts of speed, time, and distance with formula-based problem-solving techniques. Understanding the relationships between speed, time, and distance, and applying them to real-world scenarios. **Relative Speed:** Calculating relative speed in scenarios involving objects moving in the same or opposite directions. Application of relative speed in solving problems on overtaking, crossing, and meeting points. **Average Speed:** Techniques for calculating average speed over multiple journeys or varying speeds. Application in mixed-distance and mixed-speed problems. **Problems on Trains:** Solving problems involving trains, including crossing stationary and moving objects. Concepts of platform length, tunnel length, and calculating crossing times for accurate results. **Boats and Streams:** Understanding upstream and downstream speeds, including the effect of current on boat movement. Solving problems based on effective speed in both still water and flowing water scenarios. **Races:** Concepts of time, distance, and lead in competitive races. Analyzing head-starts, leads, and gaps between racers, and calculating who wins and by how much. **T-1, C-14-18**	

Module-3	**6 Hrs**

Cubes and Dice: Introduction to the properties and visualizations of cubes and dice. Understanding different orientations and views of cubes and dice, including adjacent and opposite faces. Solving problems related to numbering, coloring, and arranging cubes and dice. Techniques to quickly analyze and answer questions on folding/unfolding and rotation. Application in spatial reasoning and enhancing 3D visualization skills.

Puzzles: Developing logical thinking and problem-solving skills through a variety of puzzles. Types of puzzles, including number puzzles, pattern recognition, arrangement, and logical deduction. Strategies for approaching and solving puzzles efficiently. Practice with common puzzle formats found in competitive exams and aptitude tests. Enhancing analytical abilities, critical thinking, and creative problem-solving through diverse puzzle exercises.

Verbal Aptitude

Reading Comprehension: Introduction to Reading Skills, Emphasizing the importance of regular reading for comprehension, vocabulary, and overall verbal aptitude. Understanding how strong reading skills benefit areas beyond comprehension, like analytical thinking and verbal reasoning. Establishing a daily reading habit to improve focus and retention.

Para Jumbles: Techniques for logically ordering jumbled sentences into a coherent paragraph. Understanding linkages between sentences, transitional words, and thematic flow.

Sentence Completion: Strategies for filling in the blanks with appropriate words or phrases. Developing skills to recognize context, tone, and logical flow for accurate sentence completion.

Antonyms/Synonyms: Building a strong vocabulary by mastering antonyms and synonyms. Practice with context-based word selection to improve vocabulary and precision in language.

T-2, C6-9,13-16

Module-4	**6 Hrs**

Verbal Aptitude

Error in Sentences: Identifying common grammatical errors in sentences, including subject-verb agreement, tense consistency, and pronoun usage. Understanding sentence structure and common pitfalls in grammar for error detection.

Sentence Rearrangement: Techniques to rearrange words or phrases to form coherent and grammatically correct sentences. Focus on grammar, context, and logical structure for rearrangement accuracy.

Idioms and Phrases: Understanding and correctly using idioms and phrases in context. Building familiarity with common idioms to enhance comprehension and verbal accuracy.

Verbal Analogies: Solving analogies by identifying the relationships between words or phrases. Developing logical thinking to understand and complete analogy-based questions.

T-1, C28-29

Module-5	**6 Hrs**

Permutation and Combination: Understanding the difference between the permutation and combination, Rules of Counting-rule of addition, rule of multiplication, factorial function, Concept of step arrangement, Permutation of things when some of them are identical, Concept of 2n, Arrangement in a circle.

Probability: Single event probability, multi event probability, independent events and dependent events, mutually exclusive events, non-mutually exclusive events, combination method for finding the outcomes.

Crypt arithmetic: Basic concepts, addition, subtraction, multiplication of coded alphabets, Types of cryptarithm.

Statements and Assumptions: Identifying implicit assumptions within a statement. Developing the ability to read between the lines and recognize underlying premises.

Statements and Conclusions: Analyzing a given statement to derive logical conclusions. Differentiating between valid and invalid inferences based on the provided information.

Cause and Effect: Understanding cause-effect relationships and identifying causation or correlation between events. Analyzing statements to determine whether one event directly influences another.

R-1, C1-6

Topics for Self learning	
Module – 1	Data sufficiency, caselet DI and interpretation of radar/scatter graphs.
Module – 2	Circular track problems, unit conversions and applications in transportation and logistics.
Module – 3	Mirror images, paper folding, advanced puzzles and vocabulary building through reading.
Module – 4	Cloze tests, critical reasoning, workplace vocabulary and commonly confused words.
Module – 5	Set theory, Venn diagrams, conditional probability and decision-making case studies.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply arithmetic and logical reasoning to solve problems.
CO2	Develop spatial and logical skills to solve cube, dice, puzzle and seating arrangement questions.
CO3	Improve reading, vocabulary, and grammar through para jumbles, sentence completion and idioms.
CO4	Enhance verbal reasoning by solving analogies, rearranging sentences and identifying assumptions and conclusions.
CO5	Apply combinatorics and probability to solve permutation, combination and crypt arithmetic problems.

Text Books	
1	**Quantitative Aptitude for Competitive Examinations** by R.S. Aggarwal Chand Publishing.–2023.
2	**Word Power Made Easy** by Norman Lewis (ISBN-978-0143424680),, Published by PENGUIN INDIA- 2015
3	**How to Prepare for Quantitative Aptitude for the CAT** by Arun Sharma (ISBN-978-9339205126), 6th Edition, McGraw-Hill Education- 2014

Reference Books	
1	**Puzzle Test & Seating Arrangements** by K. Kundan (ISBN: 9789394666023),1st Edition, BSC Publishing Company Pvt Ltd. - 2023
2	**A Modern Approach to Verbal & Non-Verbal Reasoning** by R.S. Aggarwal,2025-26 Edition, S. Chand Publishing -2024

Web links and Video Lectures (e – Resources)	
1	https://youtu.be/KWZ0lR8cCwc
2	https://youtu.be/mBtBD1N7ywQ
3	https://youtu.be/B9MhxmcwnpQ
4	https://youtu.be/VaEbefWFIlc
5	https://youtu.be/3AL_6EQmnkY

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2									1	1	
CO2	2	2										1	
CO3	1	1								3		1	
CO4	2	2								2	1	1	
CO5	3	3									1	1	

Semester: IV					
Additional Mathematics-II (For Lateral Entry Students of all the Branches)					
Course Code	**:**	1BMATDIP412	**Credits**	**:**	0
Hours/Semester (L:T:P:SL)	**:**	14:0:0:14	**CIE**	**:**	100 Marks
Total Hours	**:**	28 Hrs	**SEE**	**:**	0
Course Type	**:**	NCMC	**SEE Duration**	**:**	-

Prerequisites:	
Courses	Basic Mathematics
Knowledge on Fundamental Concepts	Basic differentiation and integration
Knowledge on Connected Tools (If any)	Basic computer knowledge.

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the geometric properties of curves using differential calculus.
CLO2	Describe the concepts of probability to understand and use probability theory for analyzing uncertainty and solving related problems.
CLO3	Demonstrate the numerical methods for modeling and solving complex engineering and scientific problems where analytical solutions are difficult to obtain.

Module – 1	**05 Hrs.**
Differential Calculus: Successive differentiation-problems. Taylor's & Maclaurin's series expansions-problems. Total derivatives-differentiation of composite functions. Jacobians of order two-Problems.	
Module – 2	**05 Hrs.**
Basic Probability Theory: Introduction, Sample space and Events, Axioms of Probability. Addition and Multiplication theorem. Conditional Probability. Independent events. Baye's theorem, Problems.	
Module – 3	**05 Hrs.**
Numerical Method -II: Numerical solution of first-order ordinary differential equations: Taylor's series method, Modified Euler's method, Runge-Kutta method of order 4, Milne's predictor-corrector method. Problems.	

Topics for Self learning	
Module – 1	**Applications:** Maxima and minima for function of two variables.
	Self-study: Method of Lagrange's undetermined multipliers.
Module – 2	**Applications**: Analyze the performance of the algorithms.
	Self-Study: Random Variables
Module – 3	**Applications:** Estimating the approximate solutions of ODE.
	Self-Study: Adam-Bashforth method.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply and interpret the geometric properties of curves in polar coordinates by applying the principles of differential calculus.
CO2	Apply concepts of probability theory and to solve related problems.
CO3	Analyze the numerical techniques to solve numerical solution of first-order ordinary differential equations.

Text Books	
1	Higher Engineering Mathematics", B. S. Grewal,44thEdition, 2021, Khanna Publishers, ISBN:978-81-933284-9-1. Chapter. 4,5,26,32.
Reference Books	
1	Advanced Engineering Mathematics", Kreyszig, E., Kreyszig, H.&Norminton, E. J. 2025. 11th Edition, Wiley India Pvt. Ltd. ISBN: 9789373329949
2	Higher Engineering Mathematics", Ramana, B. V. 2025. 1st Edition, McGraw Hill Education (India) Pvt. Ltd., ISBN: 9780070634190

Web links and Video Lectures (e – Resources)	
1	http://nptel.ac.in/courses.php?disciplineID=111
2	http://www.class-central.com/subject/math(MOOCs)
3	http://academicearth.org/

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	3	3								1
CO2	3	3	3								1
CO3	3	3	2								1

CSE Stream			**ECE Stream**		**CIVILStream**		**Mechanical Stream**	
	PSO1	**PSO2**	**PSO1**	**PSO2**	**PSO1**	**PSO2**	**PSO1**	**PSO2**
CO1	1			1		1	2	1
CO2	1			1		1	2	1
CO3	1			1		1	2	1

Institute Vision

Preparing Competent Engineering and Management Professionals to Serve the Society

Institute Mission

- Providing Students with a Sound Knowledge in Fundamentals of their branch of Study.
- Promoting Excellence in Teaching, Training, Research and Consultancy.
- Exposing Students to Emerging Frontiers in various domains enabling Continuous Learning.
- Developing Entrepreneurial acumen to venture into Innovative areas.
- Imparting Value based Professional Education with a sense of Social Responsibility.

Department Vision

Preparing Competent Aeronautical Engineers To Serve the Society

Department Mission

- Strengthening the Fundamental concepts in Aeronautical Engineering.
- Building Analytical ability among students with innovative problem-solving techniques.
- Training students in multidisciplinary research areas in collaboration with Industries embedding the culture of continuous learning.
- Imparting skillset in line with emerging industrial needs with leadership qualities
- Making students responsible citizens to serve society with ethics and values.

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

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