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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

VI Semester
Scheme & Syllabus of B.E. Programme
Aeronautical Engineering
(2024 Scheme)

Core Values

Spiritual, Judicious, Commitment, Integrity, Trustworthy



AICTE | NATIONAL INSTITUTIONAL RANKING FRAMEWORK nirf 151-300 | NBA | NAAC A+ | QS I-GAUGE GOLD | INSTITUTION'S INNOVATION COUNCIL (Ministry of HRD Initiative) 4-Star Rating

SJC INSTITUTE OF TECHNOLOGY, CHIKKABALLAPURA

An Autonomous institution Under VTU from 2024 – 2025

AICTE Approved, Accredited by NBA(CSE, ISE, ECE, ME, CV, AE) and NAAC with 'A+' grade, QS – I Gauge Gold Rated

SCHEME OF TEACHING AND EXAMINATION – B.E. – Aeronautical Engineering

(Applicable for students admitted from the Academic Year 2024-25 and onwards)

6th Semester

Aeronautical Engineering

Sl. No.	Course Code	Course Title	Course Type	TD/ PSB	Teaching Hours / Week			Examination				
					L	T	P	SEE Duration (Hrs)	CIE Marks	SEE Marks	Total Marks	Credits
1	BAE601	Aircraft Performance and Stability	PCC	AE	3	2	0	**3**	**50**	**50**	**100**	**4**
2	BAE602	Aircraft Structures-II	IPCC	AE	3	0	2	**3**	**50**	**50**	**100**	**4**
3	BAE623x	Professional Elective Course – II	PEC	AE	3	0	0	**3**	**50**	**50**	**100**	**3**
4	BAE624x	Professional Elective Course – III	PEC	AE	3	0	0	**3**	**50**	**50**	**100**	**3**
5	BAE645x	Open Elective Course – I	OEC	AE	3	0	0	**3**	**50**	**50**	**100**	**3**
6	BAE636	Major Project Phase – I	PROJ	AE	0	0	4	**-**	**100**	**-**	**100**	**2**
7	BAEL607	Flight Simulation Lab	PCCL	AE	0	0	2	**3**	**50**	**50**	**100**	**1**
8	BCE608	Competency Enhancement Course-4	NCMC	CDCAC	0	2	0	**-**	**100**	**-**	**100**	**0**
9	BIK609	Indian Knowledge System	NCMC	Any Dept.	1	0	0	**-**	**100**	**-**	**100**	**0**
10	BNS610	National Service Scheme (NSS)	NCMC	NSS Coordinator	0	0	2	**-**	**100**	**-**	**100**	**0**
	BPE610	Physical Education (PE)(Sports and Athletics)		Physical Education Director								
	BYO610	Yoga		Yoga Teacher								
	BMU610	Music		Music Teacher								
									700	**300**	**1000**	**20**

ASC: Applied Science Course, PCC: Professional Core Course, IPCC: Integrated Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, NCMC: Non Credit Mandatory Course, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Professional Elective Course – II

Course Code	Course Name	Course Code	Course Name
BAE623A	Heat and Mass Transfer	BAE623C	Guidance, Navigation and Control
BAE623B	Helicopter Dynamics	BAE623D	Theory of Aeroelasticity

Professional Elective Course – III

Course Code	Course Name	Course Code	Course Name
BAE624A	Wind Tunnel Techniques	BAE624C	Space Mechanics & Launch Vehicles
BAE624B	Introduction to Experiments in Flight	BAE624D	Industrial & Experimental Aerodynamics

Open Elective Course – I

Course Code	Course Name	Course Code	Course Name
BAE645A	Introduction to Aeronautics	BAE645C	Introduction to UAV
BAE645B	Fundamentals of Helicopters	BAE645D	Air Transportation System

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L: T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2024-25 may please be referred.

National Service Scheme(NSS) /Physical Education (PE)(Sports and Athletics)/Yoga/Music: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education(PE)(Sports and Athletics), Yoga and Music with the concerned coordinator / teacher of the course during the first week of 3rd semester. Activities shall be carried out between 3rd Semester to the 6th semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Music activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of student's strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I: Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work

Semester: VI					
Aircraft Performance and Stability					
Course Code	**:**	BAE601	**Credits**	**:**	4
Hours/Week (L:T:P)	**:**	3:2:0	**CIE**	**:**	50 Marks
Total Hours	**:**	50L	**SEE**	**:**	50 Marks
Course Type	**:**	PCC	**SEE Duration**	**:**	3 Hours

Pre requisites:

Courses	• Mechanics of Material • Aerodynamics • Aircraft Structures-I
Knowledge on Fundamental Concepts	• Newton's laws and equations of motion • Basic fluid mechanics and aerodynamic forces (lift, drag) • Aircraft flight phases and coordinate systems • Static and dynamic stability concepts
Knowledge on Connected Tools (If any)	--

Course Learning Objectives: This course will enable the students

CLO1	Understand steady-level flight performance and apply it to climb and glide.
CLO2	Acquire knowledge on cruise performance, range, and endurance for different engines
CLO3	Solve takeoff and landing performance.
CLO4	Explain static stability and control in longitudinal flight.
CLO5	Discuss static stability and control in directional flight.

Module-1	**08 Hrs**

The Equations of Motion Steady Unaccelerated Flight: Introduction, four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

Steady Performance – Level Flight, Climb & Glide Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach, climb performance graph (hodograph diagram); maximum climbing.

Text Book: 1, Ch4:4.1 to 4.3,Ch:5.1 to 5.3 & 5.5 to 5.12

Module-2	**08 Hrs**

Fundamental Airplane Performance Parameters The fundamental Parameters: Thrust – to – weight ratio, Wing loading, Drag polar, and lift-to – drag ratio. Minimum velocity. Aerodynamic relations associated with lift-to-drag ratio.

Range and Endurance: Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance.

Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind.

Text Book: 1, Ch5: 5.4, 5.13 & 5.14

Module-3	**08 Hrs**
Aircraft Performance in Accelerated Flight Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length **Landing Performance and Accelerated Climb:** Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb. Maneuvers Performance **Turning performance:** Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over. **Text Book: 1, Ch6: 6.1 to 6.8**	
Module-4	**08 Hrs**
Static Longitudinal Stability and Control-Stick Fixed: Historical perspective, Aerodynamic Nomenclature, Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane Introduction, Trim condition. Static margin. Stick fixed neutral points. Longitudinal control, Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range. **Text Book: 2, Ch5: 5.1 to 5.7, 5.9 to 5.14** **Text Book: 3, Ch1: 1.6, 1.7 Ch2: 2.1 to 2.4**	
Module-5	**08 Hrs**
Static Longitudinal Stability: Introduction, Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G. **Static Directional Stability and Control-Stick free:** Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition. Weather cocking effect. **Text Book: 2, Ch-6, 6.1 - 6.9 & 8.1 - 8.4**	
Course Outcomes: At the end of the course, the student will be able to	
CO1	Understand the performance characteristics in Un-accelerated steady level flight, apply the concept of Level flight to climb and glide to the steady performance of an aircraft
CO2	Describe the performance parameter & cruise performance of an airplane in relation to range and endurance with different types of engine
CO3	Estimate accelerated flight performance parameters for takeoff and landing scenarios
CO4	Summarize the concept of static stability and control of the aircraft in longitudinal condition with stick fixed
CO5	Discuss the concept of statics stability and control of an aircraft in direction condition with stick free
Text Books	
1. Aircraft Performance and Design, John D. Anderson, Jr., McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 1999 2. Airplane Performance stability and Control, Perkins, C.D., and Hage, R.E., John Wiley Son	

Inc, New York, 1988
3. Flight Stability and Automatic Control, Nelson, R.C., McGraw-Hill Book Co., 2007.
4. Introduction to flight, John D. Anderson, Jr., McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 2000.

Reference Books

1. Aerodynamics, Aeronautics and Flight Mechanics, Barnes W. McCormick, John Wiley& Sons, Inc. 1995.
2. Performance, Stability, Dynamics and Control of Airplanes, Bandu N. Pamadi,, AIAA 2nd Edition Series, 2004.
3. The Principles of the Control and Stability of Aircraft, W.J. Duncan, Cambridge University Press, 2016.

Web links and Video Lectures (e-Resources)

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

CO -PO MAPPING

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

Semester: VI					
Aircraft Structures – II					
Course Code	:	BAE602	**Credits**	:	4
Hours/Week (L:T:P)	:	3:0:2	**CIE**	:	50 Marks
Total Hours	:	40L+12P	**SEE**	:	50 Marks
Course Type	:	IPCC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	• Mechanics of Materials • Composite Materials & Structures-I
Knowledge on Fundamental Concepts	• Bending stresses in beams • Joining and fitting
Knowledge on Connected Tools (If any)	--

Course Learning Objectives: This course will enable the students

CLO1	Acquire the knowledge of types of loads on aerospace vehicles.
CLO2	Realize the bending stresses in unsymmetrical sections using different methods.
CLO3	Compute the buckling of plates, joints and fittings
CLO4	Understand the stress in wings and fuselage frames.

Module-1	**08 Hrs**

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

Bending of open and closed Thin walled Beams: Symmetrical bending, & unsymmetrical bending, direct stress distribution due to bending, position of the neutral axis, load intensity, shear force, and bending moment relationships, deflection due to bending, calculation of section properties, approximation for thin-walled sections

Text Book:1 Ch16:16.1 to 16.4

Module-2	**08 Hrs**

Shear of Open and Closed Thin Walled Beams: General stress, strain, and displacement relationship for open and single-cell closed section thin-walled beams, shear of open section beams, shear Centre, shear of closed section beams.

Torsion of Open and Closed Thin Walled Beams: Torsion of close section beam and displacement associated with the Bredt-Batho shear flow. Torsion of open section beam. Combined bending, shear, torsion.

Text Book:.1 Ch17:17.1 to 17.3 Ch18: 18.1 to 18.2 Ch19:19.1 to 19.3

Module-3	**08 Hrs**

Buckling of Plates: Buckling of Isotropic flat plates in compression, ultimate compressive strength of Isotropic flat sheet, plastic buckling of flat sheet, columns subjected to local crippling failure, Needham & Gerard method for determining crippling stress, curved sheets in compression, elastic buckling of curved rectangular plates. Pure tension field beams, angle of diagonal tension in web.

Joints and Fitting: bolted or riveted joints, accuracy of fitting analysis eccentrically loaded connections, welded joints, and concept of effective width.

Text Book:1 Ch9: 9.1 to 9.7
Text Book:2 Ch14

Module-4	**08 Hrs**

Structural Idealization: Structural idealization Principle, Idealization of a panel, effect of idealization on the analysis of open and closed section beams. Bending of open and closed section idealized beams, shear of open section and closed section idealized beams Deflection of open and closed section idealized beams.

Design Criteria: Design Criteria, Safety Factor, Design life criteria, Analysis method, Life Assessment procedures, Design Principle, Two bay crack criteria, Widespread Fatigue damage. **Text Book:1 Ch20: 20.1 to 20.4**
Text Book:3 Ch19

Module-5	**08 Hrs**

Stress Analysis in Wing Spars and Box beams: Tapered wing spar, open and closed section beams and beams having variable stringer areas, three- boom shell, torsion and shear, tapered wings, cut-outs in wings.

Stress Analysis in Fuselage Frames: Bending, shear, torsion, cut-outs in fuselages, principles of stiffeners construction, fuselage frames, and shear flow distribution.

Text Book: 1 Ch21:21.1 to 21.3, Ch22: 22.1 to 22.4, Ch23: 23.1 to 23.8, Ch.24.1 to 24.3.

Practical Component of IPCC

Sl. No.	**List of Experiments**
1.	Deflection of a Simply Supported Beam
2.	Verification of Maxwell's Reciprocal Theorem
3.	Verification of Superposition Theorem
4.	Poisson Ratio Determination
5.	Determination of Young's Modulus using strain gages
6.	Bending Modulus of sandwich Beam
7.	Shear Failure of Bolted and Riveted Joints
8.	Buckling load of slender Eccentric Columns and Construction of South well Plot
9.	Determination of shear flow for Closed section - Symmetrical bending and Open section - Unsymmetrical bending.
10.	Determining of Shear centre through shear flow measurement for Closed section – Symmetrical bending and Open section – Unsymmetrical bending

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

CO1	Implement the Symmetrical and unsymmetrical bending of structures to study the load intensity and bending moment relationships.
CO2	Calculate shear and torsion stress in open and closed thin walled beams.
CO3	Utilize principal of Idealization to analysis of beams.
CO4	Determine the Buckling of isotropic plates, joints and fittings.
CO5	Analyze the stress in wings and fuselage frames.

Text Books

1. Introduction to Aircraft Structural for Engineering Students, H.G Megson, Butterworth-Heinemann Publications, 2017, ISBN 13: 978-93-82291-05-3.
2. Aircraft Structures, Peery D J & Azar J JMcGraw Hill N.Y, 2nd edition, 1993.
3. Basic aerodynamics, fundamentals of flight, Lalith Gupta and Dr.OP Sharma, volume 2 sponsored by Aeronautics research and development board, Himalayan books New Delhi. Print in 2015.

Reference Books

1. Introduction to Aircraft Structural Analys, Megson, T. H. G, Elsevier 2nd Edition, 2014.
2. Analysis of Aircraft Structures, Bruce K Donaldson, Cambridge Aero space Series1992.

Web links and Video Lectures (e-Resources)

1. https://onlinecourses.nptel.ac.in/noc20_ae08/preview/
2. https://onlinecourses.nptel.ac.in/noc24_ae11/preview/

CO -PO MAPPING

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

Semester: VI					
Heat and Mass Transfer					
Course Code	**:**	BAE623A	**Credits**	**:**	3
Hours/Week (L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40L	**SEE**	**:**	50 Marks
Course Type	**:**	PEC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	• Mathematics-III for ME Stream • Aero Engineering Thermodynamics • Fluid Mechanics
Knowledge on Fundamental Concepts	• Basic principles of energy, heat and work Properties of fluids and thermal systems • Laws of thermodynamics and continuity equations
Knowledge on Connected Tools (If any)	----

Course Learning Objectives: This course will enable the students

CLO1	Understand the modes of heat transfer and basic conduction principles in aerospace components.
CLO2	Study the principles of transient conduction, radiation and fin performance in aeronautical systems.
CLO3	Gain the knowledge of convection, heat exchanger and mass transfer concepts to aircraft thermal management.

Module-1	**08 Hrs**

Introductory Concepts and definition: Review of basics of Modes of Heat Transfer Conduction-Basic Equations: General form of one-dimensional heat conduction equation. Boundary conditions of first, second and third kinds.

One dimensional Steady state conduction without heat generation: Steady state conduction in slab, cylinder and sphere with engineering applications. Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance, its applications in Aeronautical engineering.

Text Book 1: Ch1: 1.2-1.4 Ch2: 2.2 to 2.7.

Module-2	**08 Hrs**

Extended surfaces: Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip, fin efficiency & effectiveness, Discussion on engineering applications.

One dimensional Transient conduction: Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; concept of semi-infinite solids, Discussion on engineering applications.

Text Book 1: Ch4: 4.1 to 4.10 Ch5:5.1 to 5.4.

Module-3	**08 Hrs**
Radiation Heat transfer: Introduction to physical mechanism - Radiation properties - Radiation shape factors - Heat exchange between non-black bodies - Radiation shields, Numerical problems. **Concepts and Basic Relations in Boundary layers:** Flow over a flat plate -Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient. **Text Book 1:Ch11:11.1 to 11.9,Ch12:12.1 to 12.11**	
Module-4	**08 Hrs**
Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct, Numerical problems. **Free or Natural Convection**: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder, Numerical problems. **Text Book 1: Ch7:7.3 to 7.5, Ch8: 8.1 to 8.6**	
Module-5	**08 Hrs**
Heat Exchangers: Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers, Numerical problems. **Mass Transfer:** Introduction, Fick's law, Species conservation equation, Introduction to convective and diffusive mass transfer, Numerical problems. **Text Book 1:Ch10:10.1-10.7,Ch13:13.1 to 13.11**	
Course Outcomes: At the end of the course, the student will be able to	
CO1	Understand and apply steady-state conduction concepts in slabs, cylinders, spheres, and composite media.
CO2	Analyze heat transfer in fins and apply transient conduction methods using charts and lumped analysis.
CO3	Explain radiation mechanisms and compute heat transfer using radiation and boundary layer theory.
CO4	Apply correlations for forced and natural convection in various geometries.
CO5	Evaluate heat exchanger performance and mass transfer principles.
Text Books	
1. Heat and Mass Transfer, R.K. Rajput and S. Chand in SI Units.	
Reference Books	
1. Heat Transfer, Ozisik,-A basic approach, Tata McGraw Hill 2002. 2. Heat Transfer, P.K. Nag, "Tata McGraw Hill 2002. 3. Heat Transfer, Yunus A- Cengel, "", a practical approach, Tata McGraw Hill, 3rd edition, 2007.	
Hand Books of Tables/ Charts/ Data Sheets	
1. Heat and Mass Transfer, Kothandaraman C.P, Data Book New Age Publishers Pvt Ltd.	

Web links and Video Lectures (e-Resources)
1. https://nptel.ac.in/courses/112101097/

CO -PO MAPPING													
	PO 1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	1	-	1	3	2
CO2	3	3	2	2	-	-	-	-	1	-	1	3	2
CO3	3	2	2	1	-	-	-	-	1	-	1	3	2
CO4	3	3	2	2	-	-	-	-	1	-	1	3	2
CO5	3	3	3	2	-	-	-	-	1	-	1	3	3

Semester: VI					
Helicopter Dynamics					
Course Code	**:**	BAE623B	**Credits**	**:**	3
Hours/Week (L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	50L	**SEE**	**:**	50 Marks
Course Type	**:**	PEC	**SEE Duration**	**:**	3 Hours
Prerequisites:					
Courses	• Mechanics of Materials • Aerodynamics				
Knowledge on Fundamental Concepts	• Rotary Wing Aerodynamics, • Kinematics and Dynamics of Rotating Systems				
Knowledge on Connected Tools (If any)	---				

Course Learning Objectives: This course will enable the students

CLO1	Understand the fundamental principles and aerodynamics of helicopter flight, including rotor aerodynamics and blade element theory
CLO2	Analyze helicopter performance, control, and stability using methods and mathematical models
CLO3	Evaluate helicopter dynamic stability and control, and understand standards, specifications, and conceptual design considerations

Module-1	**08 Hrs**

Introduction: History of helicopter flight. Fundamentals of Rotor Aerodynamics; Momentum theory analysis in hovering flight. Disk loading, power loading, thrust and power coefficients. Figure of merit, rotor solidity and blade loading coefficient. Power required in flight. Axial climb, descent, and autorotation.

Blade Element Analysis: Blade element analysis in hovering and forward flight.

Rotating blade motion: Types of rotors. Concept of blade flapping, lagging and coning angle. Equilibrium about the flapping hinge, lead/lag hinge, and drag hinge.

Text Book: 1 Ch2:2.1 to 2.3, 2.5, 2.8, 2.11 & 2.13,Ch3: 3.1 & 3.2 Ch4: 4.1 to 4.4

Text Book: 2 Ch6:6.2

Module-2	**08 Hrs**

Basic Helicopter Performance: Forces acting on helicopters in forward flight. Methods of achieving translatory flight. Controlling cyclic pitch: Swash-plate system. Lateral tilt with and without conning. Lateral and longitudinal asymmetry of lift in forward flight. Forward flight performance- total power required, effects of gross weight, effect of density altitude. Speed for minimum power, and speed for maximum range. Factors affecting forward speed, and ground effects.

Text Book: 1 Ch4:4.5 to 4.9, Ch5:5.1 to 5.5 & 5.8

Module-3	**08 Hrs**
Rotor Airfoil Aerodynamics: Rotor airfoil requirements, effects of Reynolds number and Mach number. Airfoil shape definition, Airfoil pressure distribution. Pitching moment. Maximum lift and stall characteristics, high angle of attack range. **Rotor Wakes and Blade Tip Vortices:** Flow visualization techniques, Characteristics of rotor wake in hover, and forward flight. Other characteristics of rotor wake. **Text Book: 1 Ch7: 7.1 to 7.5, 7.7, 7.9 & 7.11 Ch10: 10.1 to 10.5.**	
Module-4	**08 Hrs**
Helicopter Stability and Control. Introductory concepts of stability. Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. **Static stability of helicopters:** longitudinal, lateral-directional and directional. Dynamic stability aspects. Main rotor and tail rotor control. Flight and Ground Handling Qualities-General requirements and definitions. Control characteristics, Levels of handling qualities. **Flight Testing -** General handing flight test requirements and, basis of limitations. **Text Book:2 Ch5:5.1-5.6**	
Module-5	**08 Hrs**
Standards and Specifications: Scope of requirements. General and operational requirements. Military derivatives of civil rotorcraft. Structural strength and design for operation on specified surfaces. Rotorcraft vibration classification. **Conceptual Design of Helicopters:** Overall design requirements. Design of main rotors-rotor diameter, tip speed, rotor solidity, blade twist and aerofoil selection, Fuselage design, Empennage design, Design of tail rotors, High speed rotorcraft. **Text Book: 1 Ch6:6.1 to 6.4, 6.6, 6.7, 6.9 & 6.11**	
Course Outcomes: At the end of the course, the student will be able to	
CO1	Apply fundamental principles of helicopter aerodynamics and dynamics to analyze the forces, moments, and stability of helicopter flight.
CO2	Compute performance parameters of helicopters in various flight regimes, including hover, climb, descent, and forward flight
CO3	Assess helicopter dynamic stability and control characteristics, and perform basic conceptual design of helicopter components
CO4	Design rotorcraft systems and components by applying aerodynamic, stability and structural considerations using appropriate tools and standards.
Text Books	
1. Principles of Helicopter Aerodynamics, J. Gordon Leishman, “”, Cambridge University Press, 2002. 2. Dynamics of Helicopter Flight, George H. Saunders, “”, John Wiley & Sons, Inc, NY,1975.	
Reference Books	

1. Rotary Wing Aerodynamics, W Z Stepniewski and C N Keys, Dover Publications, Inc, New York, 1984.
2. Helicopter Dynamics, ARS Bramwell, George Done, and David Balmford, 2nd Edition, Butterworth-Heinemann Publication, 2001.
3. Basic Helicopter Aerodynamics, John, M. Seddon and Simon Newman, Wiley, 2011.
4. Helicopter Flight Dynamics, Gareth D. Padfield, 2nd Edition, Wiley, 2011.
5. Helicopter Theory, Wayne Johnson, Dover Publications INC., New York, 1980

Web links and Video Lectures (e-Resources)

1. https://nptel.ac.in/courses/101104017/

CO -PO MAPPING

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

Semester: VI					
Guidance, Navigation and Control					
Course Code	**:**	BAE623C	**Credits**	**:**	3
Hours/Week (L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40L	**SEE**	**:**	50 Marks
Course Type	**:**	PEC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	• Fundamentals of Aircrafts • Aircraft Systems and Instrumentation.
Knowledge on Fundamental Concepts	• Basic Aircraft Systems and Instrumentation.
Knowledge on Connected Tools (If any)	• Drone Pilot Training • Flight Simulator

Course Learning Objectives: This course will enable the students	
CLO1	Understand the basic principles of Guidance Navigation and Control.
CLO2	Comprehend the concepts of RADAR Technology.
CLO3	Contrast the different principles of Missile Guidance System.

Module-1	**08 Hrs**
Concepts of Navigation, Guidance and Control: Introduction to basic principles, Introduction to Navigation. Basic Navigation Definitions. Basic DR Navigation Systems. Gyros and Accelerometers, Sensors used in navigation systems, Air Data Information, Air Data Measurement, Air Data Quantities and their Importance. **Text Book 1: Ch6:6.1 Ch7: 7.1 & 7.2.**	
Module-2	**08 Hrs**
Inertial Navigation System: Introduction, Basic principles of Schuler Tuning, Attitude Heading Reference System, Azimuth Monitoring using a Magnetic Heading Reference, GPS – Global Positioning System, GPS System Description, Basic Principles of GPS System, Integration of GPS and INS, GPS and GNSS, Global Navigation Satellite System, Fundamentals of Satellite Navigation. **Text Book 1: Ch6: 6.2, 6.4 & 6.5.**	
Module-3	**08 Hrs**
Gyros and Accelerometers: Micro Electro Mechanical System Technology, Optical Gyroscopes, Accelerometers, Skewed Axes Sensor Configuration. Inertial Guidance and Laser based guidance, Imaging Infrared guidance, Introduction to Radar. Principle of working, Radar Equation. Classification of Radar, Applications of RADAR, Pulse Doppler Radar. **Text Book 1: Ch5: 5.1 & 5.2.** **Text Book 2: Ch1: 1.1 to 1.5.**	
Module-4	**08 Hrs**
Tracking Radar: Introduction, Tracking Radar, Mono pulse tracking, Conical Scan and Sequential Lobbing Tracking Radar, Moving Target Detector, MTI (Moving Target Indication), Limitation of MTI performance, Automatic Tracking with Surveillance Radar (ADT), Principles of ATC Radar Surveillance System Operation. **Text Book 2: Ch3:3.1, 3.6 & 3.7. Ch4:4.1 to 4.3, 4.9.**	

Module-5	**08 Hrs**
Guidance Systems: Introduction, Guided Missile Concept, Proportional Navigation Guidance, Command Guidance, Comparison of Guidance System Performance, Bank to turn missile guidance, Roll Stabilization, Control of Aerodynamic Missile, Missile Parameters for Dynamic Analysis, Missile Autopilot Schematics. **Text Book 3: Ch7: 7.1 to 7.6. Ch8:8.1 to 8.5. Ch9: 9.1 to 9.4.**	

Course Outcomes: At the end of the course, the student will be able to	
CO1	Understand the Basic principles of Navigation Systems.
CO2	Apply the Principles of Satellite Navigation, Inertial Navigation.
CO3	Contrast the various Advanced Navigation System.
CO4	Comprehend the concepts of RADAR Technology.
CO5	Summarize the Principles of Missile Guidance System.

Text Books

1. Introduction to Avionics Systems, R.P.G. Collinson, Springer Science, Third Edition.2011.
2. Introduction to Radar Systems, Merrill I. Skolnik, McGraw-Hill Education. Second Edition.
3. Automatic Control of Aircraft & Missiles, John H Blakelock, Wile - Inter Science Publication, 2nd edition, May 1990.

Reference Books

1. Global Navigation Satellite Systems, Inertial Navigation, and Integration, Grewal, M. S., Andrews, A. P., Bartone, C. G, John Wiley and Sons Inc, 2013.
2. Principles of GNSS, Inertial and Multisensory Integrated Navigation systems, Groves, P. D, Artech House.

Web links and Video Lectures (e-Resources)

1. https://nptel.ac.in/courses/101101079/
2. https://ocw.mit.edu/courses/16-885j-aircraft-systems-engineering-fall-2005/resources/lecture-16/
3. https://www.srecwarangal.ac.in/ece-downloads/IV_II%20satellite_communications_by_dennis_roddy4thedition.pdf

CO -PO MAPPING

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

Semester: VI					
Theory of Aero Elasticity					
Course Code	:	BAE623D	**Credits**	:	3
Hours/Week (L:T:P)	:	3:0:0	**CIE**	:	50 Marks
Total Hours	:	40L	**SEE**	:	50 Marks
Course Type	:	PEC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	• Fluid Mechanics • Aerodynamics • Mechanics of Materials • Theory of Vibrations
Knowledge on Fundamental Concepts	• Bending, torsion, shear • Single and multi-degree of freedom systems
Knowledge on Connected Tools (If any)	----

Course Learning Objectives: This course will enable the students

CLO1	Introduce the fundamental concepts and real-world implications of aeroelastic phenomena in aerospace structures.
CLO2	Understand the static and dynamic interactions between aerodynamic forces and structural deformation.
CLO3	Describe aeroelastic instabilities and associated countermeasures using analytical, computational and experimental techniques.

Module-1	**08 Hrs**

Introduction Aero elasticity: definition and problems. Influence of aeroelastic phenomenon on design - flutter, buffeting, dynamic loads problems, load distribution, divergence, control effectiveness & reversal. Critical flutter speeds versus wing sweep back. Effect of speed on control effectiveness.

Deformation of airplane structures under static loads: Deformation due to several forces. Influence coefficients. Properties of influence coefficients. Deformation under distributed forces. Influence functions. Properties of influence functions. Simplified elastic airplane. Deformation of airplane wing. Force and torque applied to wing. Integration by weighting matrices. Bending, torsional and shear stiffness curves

Text Book 1:Ch1, Ch2, Ch3, Ch4 & Ch5

Text Book 2:Ch1, Ch2, Ch3, Ch4 & Ch6

Module-2	**08 Hrs**

Static Aero elastic Phenomena: Load distribution and divergence-wing torsional divergence (two dimensional case, & finite wing case). Swept wing divergence. Prevention of aeroelastic instabilities.

Control effectiveness and reversal: Aileron effectiveness and reversal -2 dimensional case, and finite wing case. Strip theory. Aileron effectiveness in terms of wing -tip helix angle. Critical aileron reversal speed. Rate of change of local pitching moment coefficient with aileron angle.

Text Book 1:Ch2, Ch4 & Ch7

Text Book 2:Ch3, Ch4 & Ch5

Module-3	**08 Hrs**

Deformation of airplane structures under dynamic loads: Differential and Integral forms of equations of motions of vibrations. Natural modes and frequencies of complex airplane structures - introduction. Dynamic response phenomenon -equations of disturbed motion of an elastic airplane.

Dynamic problems of aero elasticity: Flutter. Single-degree-of- freedom system. Determination of critical flutter speed. Aeroelastic modes. Wing bending and torsion flutter. Coupling of bending and torsion oscillations and destabilizing effects of geometric incidences. Stall flutter, Supersonic panel flutter, Buffeting and, Aileron buzz. Flutter prevention and control.

Text Book 1:Ch3, Ch6 & Ch8

Text Book 2:Ch6, Ch7, Ch8, Ch9 & Ch10

Module-4	**08 Hrs**

Test model similarities: Dimensional concepts. Vibration model similarity laws. Dimensionless form of equation of motion. Mode shapes and natural frequencies in dimensionless forms. Model scale factors. Flutter model similarity law. Scale factors.

Structural simulation:-shape, mass and stiffness.

Text Book 1:Ch9

Text Book 2:Ch11

Module-5	**08 Hrs**

Testing Techniques: Measurement of structural flexibility. Measurements of natural frequencies and mode shapes. Polar plot of the damped response. Identification and measurement of normal modes. Steady state aeroelastic model testing. Dynamic aeroelastic model testing. Flights flutter testing.

Text Book 1:Ch10

Text Book 2:Ch12

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

CO1	Describe aero elasticity and identify various aeroelastic problems such as flutter, buffeting, and control reversal.
CO2	Analyze deformation characteristics of airplane structures under both static and dynamic loading using influence coefficients and simplified elastic models
CO3	Evaluate for control effectiveness and reversal using strip theory, and determine critical reversal speeds for flight control surfaces.
CO4	Solve dynamic aeroelastic problems including flutter and coupled bending-torsion oscillations using single-degree and multi-degree-of-freedom systems.
CO5	Apply similarity laws, dimensional analysis, and experimental testing techniques for identifying natural frequencies, mode shapes, and verifying aeroelastic behavior in scale models.

Text Books

1. A Modern Course in Aero elasticity, Dowell, E. H., Crawley, E. F., Curtiss Jr., H. C., Peters, D. A., Scanlan, R. H., and Sisto, F., Kluwer Academic Publishers, 3rdEdition, 1995. (TL574.A37.M62)
2. Aero elasticity, Bisplinghoff R, Ashley H and Halfman R L, Dover, 1955. (TL570.B622)

Reference Books
1. An Introduction to the Theory of Aero elasticity, Fung, Y. C., 1955 (Dover, 1969).
2. Aircraft structures for Engineering students, Megson THG, Edward Arnold.

Web links and Video Lectures (e-Resources)
1. https://nptel.ac.in/courses/101106047
2. https://ocw.mit.edu/courses/16-20-structural-mechanics-spring-2003/

CO -PO MAPPING

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

Semester: VI					
Wind Tunnel Techniques					
Course Code	:	BAE624A	**Credits**	:	3
Hours/Week (L:T:P)	:	3:0:0	**CIE**	:	50 Marks
Total Hours	:	40L	**SEE**	:	50 Marks
Course Type	:	PEC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	• Fluid Mechanics • Aerodynamics
Knowledge on Fundamental Concepts	• Reynolds number, Mach number • Pitot-static principle, Pressure coefficient • Lift/drag measurement
Knowledge on Connected Tools (If any)	• Aerodynamics lab

Course Learning Objectives: This course will enable the students

CLO1	Comprehend the basic of wind tunnel testing.
CLO2	Understand the types and functions of wind tunnel.
CLO3	Acquire the knowledge on conventional measurement techniques and special wind tunnel.

Module-1	**08 Hrs**

Introduction to Wind Tunnels: Need of experiments, Classification of wind tunnels, Applications of wind tunnels, Model making, non-dimensional parameters, Low speed wind tunnel - Irregularities of flow in low speed tunnels, Reduction of turbulence, Effect of screens on turbulence, Honey combs, Wind tunnel contractions, The diffuser, Losses in wind tunnel circuit, Power requirements – power economy, Power economy by pressurization, Power economy by choice of working fluid, Power economy by reduction in stagnation temperature.

Text Book 1: Ch1: 1.1 & 1.2, Ch3: 3.1 to 3.3

Module-2	**08 Hrs**

High Speed Wind Tunnels : Types of high speed tunnels, Supersonic wind tunnels - Test section flow parameters, Dynamic pressure, Mass flow rate, Test section velocity, Maximum velocity, Free stream reynolds number, Components of supersonic wind tunnels - Air storage tanks, Settling chamber /wide angle diffusers, Convergent-divergent (c-d) nozzle, Diffuser, Power required for the operation of supersonic wind tunnels, Closed circuit supersonic wind tunnel, Actual flow in the supersonic wind tunnel - Starting the wind tunnel with the model in the test section, Sizing the wind tunnel model, Two problems in the operation of the supersonic wind tunnel (i) Condensation (ii) Liquefaction.

Text Book 1: Ch3: 3.4 to 3.5

Module-3	**08 Hrs**

Measurement of Pressure: Units of pressure, Pressure measuring devices - Liquid column manometers, Inclined manometer, Mercury barometer, Micro manometer, Mechanical manometers - Bourdon tube, Elastic diaphrams, a) Corrugated diaphragms b) Capsules, bellows, Pressure transducers - Diaphragm type pressure transducers, Piezo-electric pressure transducers, Pressure sensitive

paints (psp) - Measurement of high pressures, Electrical resistance gauges – principle of operation, Ranges of different manometers, Measurement of pressure in flows - Measurement of static pressure, Static pressure probes for subsonic flow, Static pressure probes for supersonic flow, Measurement of stagnation or total pressure - In subsonic flows, In supersonic flows, Lag in manometric systems.

Text Book 1: Ch7: 7.1 to 7.7, 7.9 to 7.11

Module-4	**08 Hrs**

Velocity measurements: Pneumometric methods, Measurement in compressible flows, Measurement of supersonic velocity/Mach number, Hot wire anemometer (HWA), Two modes of HWA - Constant current anemometer, Constant temperature anemometer, Elementary physics of laser action, Characteristics of laser light Laser doppler anemometry or laser velocimetry - Doppler shift: simplistic physical explanation, Classical approach to doppler shift equation, Intensity of the scattered light, Forward and backward scattering modes of IDA, Basic IDA arrangement, Single beam laser anemometer, Dual beam laser anemometer, Fringe model of IDA.

Text Book :1 Ch8:8.1 to 8.7

Module-5	**08 Hrs**

High Speed Flow Visualization Techniques: Introduction, Flow visualization by direct injection (Tracer methods), Index of refraction methods - Theoretical background, Deflection of light ray in a medium of constant density gradient, The schlieren method, Colourschlieren, Shadowgraph method, Interferometer method, Glow discharge visualization for low density flows.

Text Book 1:Ch4:4.2 & 4.3

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

CO1	Explain wind tunnel components and analyze flow improvement techniques.
CO2	Describe supersonic tunnels and evaluate operational challenges.
CO3	Compare pressure measurement techniques and demonstrate application in various flow regimes.
CO4	Analyze velocity measurement methods in compressible and supersonic flows.
CO5	Illustrate high-speed flow visualization techniques.

Text Books

1. Instrumentation, Measurements, and Experiments in Fluids, E. Radha krishnan, CRC Press, 2007.
2. Low Speed Wind Tunnel Testing, Rae W.H. and Pope. A, John Wiley Publication, 3rd edition, 2010, ISBN-13: 978-8126525683.

Reference Books

1. Experimental Fluid Mechanics, Bradsaw, Pergamon Press, 2nd revised edition, 1970, ISBN-13: 978-0080069814.

Web links and Video Lectures (e-Resources)

1. https://nptel.ac.in/courses/101106040/

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

Semester: VI					
Introduction to Experiments in Flight					
Course Code	:	BAE624B	**Credits**	:	3
Hours/Week (L:T:P)	:	3:0:0	**CIE**	:	50 Marks
Total Hours	:	50L	**SEE**	:	50 Marks
Course Type	:	PEC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	• Fundamentals of Aerodynamics • Aircraft Performance • Aircraft Propulsion
Knowledge on Fundamental Concepts	• Basic flight mechanics (Lift, Drag, Thrust, Weight, Stability) • Aircraft coordinate systems and forces • Instrumentation and measurement principles • Fundamentals of control systems
Knowledge on Connected Tools (If any)	• Simulation tools • Microsoft Excel

Course Learning Objectives: This course will enable the students	
CLO1	Understand the fundamentals and historical evolution of flight test engineering and instrumentation systems.
CLO2	Gain knowledge of pre-flight planning, including test objectives, types of tests, and test plan preparation.
CLO3	Learn the calibration of air data systems, flight envelope testing, and data acquisition techniques

Module-1	**08 Hrs**
Introduction to Flight test Engineering: Introduction, Historical Perspective, One Hundred Years of Flight Testing, Background Considerations, Establishing the test team, logistics support considerations. **Flight Test Instrumentation:** Introduction, The Instrumentation Specification, Introduction to Instrumentation Systems, Instrumentation Systems Management, Design Considerations, Operational Considerations. **Text Book: 1 Ch1:1.1,Ch6:6.1 to 6.5**	
Module-2	**08 Hrs**
Preparation of the Flight Test Plan: Introduction, Objectives of the Test Plan, Contents of the Test Plan, Testing of Civil Aircraft. **Pre-Flight Tests:** Introduction, Wind Tunnel Tests, Simulation Tests, Propulsion Tests, Weight and Balance Tests, Ground Vibration Tests, Structural Loads Tests, Gain Margin Tests, Verification and Calibration Tests, Taxi Tests. **Text Book: 1, Ch8:8.0, Ch9:9.1 to 9.9**	
Module-3	**08 Hrs**
Air data Measurement and Calibration: Introduction, Test Objectives, Measurement and Calibration of Air data Quantities, Parameters Required for Air data Calibration, Typical Calibration Techniques, Data Processing and Analysis. **Flight Envelope:** Introduction, Airworthiness Requirements, Limitations, Design Loads, The Flight Envelope, Test Objectives, Typical Measurands, Sampling Rates, and Frequency	

Requirements Typical Test Maneuvers, Data Analysis Considerations.

Text Book:1, Ch10, Ch12.1 to 12.8

Module-4	**08 Hrs**

Human Factors: Introduction, Test Objectives, Test Techniques, Test Preparations, Ground Test Program, Flight Test Program, Data Analysis, Test Results, New Developments

Avionics: Introduction, General Considerations, Autopilot System, Navigation and Communication Systems, Offensive Sensor Systems, Defensive Systems, System Integration

Text Book: 1, Ch20:20.1 to 21.6

Module-5	**08 Hrs**

Post Flight Operations: Introduction, Post Flight Debrief (PFD), Reports, Data Reduction, Data Analysis, Planning the Next Flight.

Post-Test Operations: Introduction, Post-Test Briefings, Preparation for Reporting, Reporting, Future Trends

Text Book: 1, Ch28, Ch30:30.1to30.3

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

CO1	Explain the basic principles and historical background of flight testing and instrumentation.
CO2	Prepare a comprehensive flight test plan and outline pre-flight test procedures.
CO3	Perform air data calibration and analyze flight envelope data.
CO4	Evaluate the influence of human factors and avionics systems on flight testing.
CO5	Interpret post-flight data analysis and reporting processes.

Text Books

1. Introduction to Flight Test Engineering, North Atlantic Treaty Organisation, Flight Test Techniques Series – Volume 14.

Reference Books

1. Introduction to experiments in Flight, Prof. A.K. Ghosh, IIT Kanpur

Web links and Video Lectures (e-Resources)

1. https://drive.google.com/file/d/1fiSWZxSSIX3q-9IhTI1mDu4BbdTXtT02/view
2. https://apps.dtic.mil/sti/pdfs/ADA444990.pdf

CO -PO MAPPING

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

Semester: VI					
Space Mechanics & Launch Vehicles					
Course Code	**:**	BAE624C	**Credits**	**:**	3
Hours/Week (L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40L	**SEE**	**:**	50 Marks
Course Type	**:**	PEC	**SEE Duration**	**:**	3 Hours
Prerequisites:					
Courses	• Mathematics-III for ME Stream • Mechanics of Materials • Aero Engineering Thermodynamics • Fluid Mechanics • Mechanism & Machine Theory				
Knowledge on Fundamental Concepts	• Kinematics and Dynamics • Newtonian and Rotational Mechanics • Differential Equations				
Knowledge on Connected Tools (If any)	----				
Course Learning Objectives: This course will enable the students					
CLO1	Introduce the fundamental concepts of orbital mechanics and satellite dynamics using inertial and rotating reference frames.				
CLO2	Explain the functioning and classification of launch vehicles and rocket propulsion systems				
CLO3	Explore spacecraft design elements, including power systems, life support, and material selection for space applications.				
Module-1					**08 Hrs**
Introduction to space mechanics: Space vehicles/ platforms. Inertial and Earth fixed coordinate reference frames. Representation of vector (position, velocity and acceleration) in fixed and moving reference frames, Coordinate transformations, Euler transformations. **Central force motion**: Two body problem and one body problem. Kepler's laws of motion. **Text Book 1:Ch1 & Ch2.** **Text Book 2:Ch1 & Ch2.**					
Module-2					**08 Hrs**
Orbital mechanics: Establishment of orbits, single impulse and two impulse orbital transfers, ballistic trajectory, orbital perturbations – general and special perturbation methods, Sun synchronous and Geo-synchronous orbits. **Satellite dynamics**: Geosynchronous and geostationary satellites life time - satellite perturbations - Hohmann orbits - calculation of orbit parameters - Determination of satellite rectangular coordinates from orbital elements. **Text Book 1:Ch3 & Ch5** **Text Book 2:Ch4 & Ch5**					

Module-3	**08 Hrs**
Introduction to launch vehicles: Introduction to launch vehicles.. Introduction to Solid, Liquid and Cryogenic rocket engines. Performance parameters. Comparison of liquid propellant, solid Propellant and hybrid rockets. **Text Book 1: Ch7** **Text Book 3: Ch2, Ch3, Ch5 & Ch10**	
Module-4	**08 Hrs**
Principles of operation and types of rocket engines: One dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields. Description of vertical, inclined and gravity turn trajectories. Simple approximations to burnout velocity. **Rocket performance and staging**: Launch vehicle trajectories, two body problem and orbital elements. Staging of rockets. **Text Book 1: Ch4 & Ch6** **Text Book 2 Ch3 & Ch6**	
Module-5	**08 Hrs**
Spacecraft: Preliminary concepts of space, spacecraft. Introduction to manned and unmanned space missions. Spacecraft power generation. Life support system for manned space missions. Materials for spacecraft. Selections of materials for spacecraft - special requirements of materials to perform under adverse conditions - ablative materials. . Life time estimation for a satellite. **Text Book 1:Ch8 & Ch9** **Text Book 3:Ch13 & Ch14**	
Course Outcomes: At the end of the course, the student will be able to	
CO1	Apply reference frame transformations and Kepler's laws to solve two-body orbital problems.
CO2	Analyze orbital mechanics problems involving transfer orbits, perturbations and satellite trajectories using impulse maneuvers.
CO3	Evaluate solid, liquid, and hybrid rocket engines based on performance parameters and applications.
CO4	Design launch vehicle trajectories including multi-stage rockets, burnout velocity and gravity turn profiles.
CO5	Describe spacecraft systems and mission lifetimes considering materials, power generation and space environment effects.
Text Books	
1. Modern Spacecraft Dynamics and Control, M. H. Kaplan, John Wiley and Sons, 1976. 2. Introduction to Space Dynamics, W. T. Thomson, Dover Publications", 1986. 3. Rocket Propulsion Elements, G P Sutton, John Wiley and Sons, 1993.	
Reference Books	
1. Space Mechanics. **H. S. Siefert (Ed.)**, John Wiley & Sons, 1969	
Web links and Video Lectures (e-Resources)	
1. https://nptel.ac.in/courses/101106072 2. https://ocw.mit.edu/courses/16-346-astrodynamics-fall-2008/	

CO -PO MAPPING													
	PO 1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PSO 1**	**PSO2**
CO1	3	3	2	2	-	-	-	-	1	-	1	3	2
CO2	3	3	3	3	-	-	-	-	1	-	1	3	2
CO3	3	2	2	2	-	-	-	-	1	-	1	3	2
CO4	3	3	3	3	-	-	-	-	1	-	1	3	2
CO5	3	2	2	2	-	-	-	-	1	-	1	3	3

Semester: VI					
Industrial & Experimental Aerodynamics					
Course Code	**:**	BAE624D	**Credits**	**:**	3
Hours/Week (L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40 L	**SEE**	**:**	50 Marks
Course Type	**:**	PEC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	• Aerodynamics • Fluid Mechanics • Aero Engineering Thermodynamics
Knowledge on Fundamental Concepts	• Laws of thermodynamics relevant to wind energy and power extraction • Bernoulli's principle • Basic energy conversion concepts • Rigid body motion and equilibrium • Basics of mechanical measurements
Knowledge on Connected Tools (If any)	• Sub Sonic Wind tunnel.

Course Learning Objectives: This course will enable the students	
CLO1	Learn the working principles, configurations, and performance characteristics of wind energy collectors.
CLO2	Understand the aerodynamic performance of ground vehicles including trains and hovercrafts.
CLO3	Study aerodynamic behavior and environmental wind effects on low-rise and tall buildings, and flow-induced vibrations.

Module-1	**08 Hrs**
Wind Energy Collectors: Horizontal axis and vertical axis machines. Power coefficient. Betz coefficient by momentum theory. **Vehicle Aerodynamics:** Power requirements and drag coefficients of automobiles. Effects of cut back angle. Aerodynamics of Trains and Hovercraft. **Text book 1: Ch8: 8.3, Ch14:14.1 & 14.4** **Text book2: Ch1:1.1, Ch2: 2.1, 2.2 &2.4**	

Module-2	**08 Hrs**
Building Aerodynamics: Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, building ventilation and architectural aerodynamics. **Flow Induced Vibrations:** Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall. **Text Book 1: Ch3: 3.1, 3.2 & 3.8, Ch5: 5.3, 5.8, 5.5, 5.6**	

Module-3	**08 Hrs**
Model Measurements: Balances: - design, installation and, calibration. Internal balances. Mounting of models, rigidity. Measurement of interference. Lift and drag measurements through various techniques. Testing procedures. **Testing**: 3-D wings, controls, complete model, power effects, aero elasticity, dynamic stability.	

Testing with ground plane, testing wind mill generator. Testing for local loads. Testing of rotor. Testing engines, Jettison tests. Data reduction. Data correction.
Text Book 1: Ch6: 6.1 to 6.4, 6.7 & 6.8.

Module-4	**08 Hrs**

Aerodynamics of Slender and Blunt Bodies: Aerodynamics of slender and blunt bodies, wing-body interference effects, Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles, determination of aero elastic effects.
Text Book 1: Ch8: 8.1, 8.2, 8.4 & 8.6.

Module-5	**08 Hrs**

Wind Tunnel Boundary Corrections and Scale Effects: Effects of lateral boundaries. Method of images. Wall corrections. Effects of Buoyancy, Solid Blocking, Wake Blocking. General downwash correction. Lift interference correction. Corrections for reflection plane models. Scale effects on aerodynamic characteristics and stability derivatives.
Text Book 1: Ch9: 9.1, 9.2, 9.4 & 9.6.

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

CO1	Understand the performance of wind energy collectors and aerodynamic Characteristics of ground vehicles.
CO2	Evaluate wind forces on buildings and assess flow-induced vibrations using aerodynamic principles for bluff bodies and tall structures.
CO3	Interpret wind tunnel model testing techniques, including balance calibration and lift- drag.
CO4	Apply aerodynamic effects in slender and blunt bodies and examine unsteady flows and aero elastic phenomena relevant to launch vehicles.
CO5	Analyze correction techniques for wind tunnel boundary and scale effects and assess the impact on aerodynamic stability derivatives.

Text Books

1. Low speed Wind Tunnel Testing, Jewel B. Barlow, William H RAE, Jr. and Alan Pope, John Wiley & Sons, 3rd edition, 2010, ISBN-13: 978-8126525683.
2. Introduction to Wind Turbine Aerodynamics, Alois P. Schaffarczyk, McGraw-Hill Book Co
3. Wind Loading of Structures, John D. Holmes & Seifu Bekele,4th Ed, Tata McGraw Hill Education Private Limited, New Delhi.

Reference Books

1. Modern compressible flows, Anderson Jr., D., McGraw-Hill Book Co., New York 1999.
2. Winds forces in engineering, P. Sachs, Pergamon Press, 2nd edition, 2013.
3. Flow induced vibrations, D. Blevins, Van Nostrand, 1990.

Web links and Video Lectures (e-Resources)

1. https://archive.nptel.ac.in/courses/101/105/101105088/
2. http://acl.digimat.in/nptel/courses/video/101105088/L01.html
3. https://onlinecourses.nptel.ac.in/noc24_ae04/preview

CO -PO MAPPING													
	PO 1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	1	-	-	-	-	-	3	1
CO2	3	3	1	-	-	-	-	-	-	-	-	3	1
CO3	3	3	3	2	-	-	-	-	-	1	-	3	2
CO4	3	2	2	2	-	-	-	-	-	-	-	3	2
CO5	3	3	2	3	-	-	-	-	-	-	-	3	2

Semester: VI					
Introduction to Aeronautics					
Course Code	:	BAE645A	**Credits**	:	3
Hours/Week (L:T:P)	:	3:0:0	**CIE**	:	50 Marks
Total Hours	:	40L	**SEE**	:	50 Marks
Course Type	:	OEC	**SEE Duration**	:	3 Hours
Prerequisites:					
Courses	• Applied Physics • Fundamentals of Electrical Engineering				
Knowledge on Fundamental Concepts	• Bernoulli's principle • Newton's Law • Types of fluid flow				
Knowledge on Connected Tools (If any)	• Wind Tunnel				

Course Learning Objectives: This course will enable the students

CLO1	Understand basic principles of aviation and the history of aircrafts.
CLO2	Acquire the basic knowledge of aircraft structures, aerodynamics, propulsion.
CLO3	Explore the Challenges in the field of Aeronautical Engineering.

Module-1	**08 Hrs**

Introduction to Aircrafts: History of aviation; Classification of aircrafts; Basic components of an aircraft; aircraft axis system; aircraft motions; Aircraft control surfaces, Conventional design configurations, Basic Helicopter parts and functions.

Aircraft Structures and Materials: Introduction; structural members; types of fuselage construction; semi-monologue structures; typical wing structure; Use of Aluminum alloy, titanium, stainless steel and composite materials for aircraft application.

Text Book 1: Ch1:1.1 to 1.9, Ch2:2.6

Module-2	**08 Hrs**

Basic principles of flight: International standard atmosphere; significance of speed of sound; airspeed and groundspeed; Bernoulli's theorem and its application for generation of lift and measurement of airspeed; Forces on an aircraft in flight; forces over wing section, airfoil nomenclature, Lift and drag components, types of drag, center of pressure and its significance; aerodynamic center, aspect ratio, Mach number.

Text Book 1: Ch3:3.1 to 3.6, Ch4:4.9 & 4.11, Ch5:5.2

Module-3	**08 Hrs**

Aircraft Propulsion: Classification based on power plant and location. Turboprop, Turbojet and Turbofan engines; Ramjets and Scramjets, Brayton cycle; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation, Propulsion Technologies for Future Aircraft Generations.

Text Book 2: Ch7:7.1 to 7.7

Module-4	**08 Hrs**

Stability and Control: Concepts of static and dynamic stability and control - yaw and sideslip; Straight and level flight, Conditions for minimum drag and minimum power; Gliding, cruise and climbing flight, Range and endurance; Takeoff and landing; V-n diagram, aircraft maneuvers, Aerobatics.

Text Book 3:Ch5:5.2, 5.3, 5.6, 5.10, 5.13& 5.14, Ch6:6.5, 6.7 & 6.8

Module-5	**08 Hrs**

Aircraft systems: (Mechanical) – Hydraulic and Pneumatic systems and their applications; Environmental control system; fuel system, oxygen system. Cockpit instrumentation; communication systems; navigation systems; Auxiliary power Module, Ram air turbine.

Challenges in Aeronautical Engineering: Future challenges –safety, light, high-speed, fuel-efficient vehicles and autonomous operations, Global perspectives of aerospace industry - vision and mission, Indian aerospace activities.

Text Book 4: Ch1: 1.7, 1.10 & 1.12, Ch2: 2.8, Ch3: 3.2 & 3.3, Ch4, Ch5:5.3, 5.4 & 5.10, Ch6:6.3, Ch7:7.2 & 7.4

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

CO1	Interpret the historical development, basics, structures and materials of aircrafts.
CO2	Examine the effect of aerodynamic principles on various Aircrafts.
CO3	Compare the working principles and performance characteristics of different aircraft power plants.
CO4	Describe the basics of stability & performance of an aircraft for different maneuvers
CO5	Understand the fundamentals of Aircraft systems, Challenges & trends in the field of Aeronautical Engineering

Text Books

1. Introduction to Flight, John D. Anderson, McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673.
2. Gas Turbines, V. GANESAN, Tata McGraw Hill Education Private Limited, 2010, ISBN 1283188872, 9781283188876
3. Jr. “Aircraft Performanceand Design, John D. Anderson, McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 1999.
4. Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Ian Moir, Allan Seabridge, “”, JohnWiley & Sons, 2011, ISBN: 978111965006.

Reference Books

1. Flight without formulae, A.C. Kermode, Pearson Education India, 1989. ISBN: 9788131713891.
2. The Jet Engine, Rolls Royce, 6th Edition
3. Mechanics and Thermodynamics of Propulsion, Philip Hill, Carl Peterson, Pearson published Second edition, 1991, ISBN-13: 9780201146592

Web links and Video Lectures (e-Resources)

1. https://nptel.ac.in/courses/101/101/101101083/
2. https://nptel.ac.in/courses/101104069/
   https://online-learning.tudelft.nl/courses/
3. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-00-introduction-to-aerospace-engineering-and-design-spring-2003/
4. https://www.iata.org/contentassets/086e8361b2f4423e88166845afdd2f03/iata-future-airline-industry.pdf
5. https://itpo-tokyo.unido.org/files/01_India_SIATI_rev2.pdf/

CO -PO MAPPING													
	PO 1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PSO 1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	3	3	2	2	2
CO2	3	2	-	-	-	2	2	-	3	3	2	2	2
CO3	3	2	-	2	-	1	2	2	3	3	2	2	2
CO4	3	2	-	-	-	1	2	-	3	3	2	2	2
CO5	3	2	-	2	-	2	2	2	3	3	2	2	2

Semester: VI					
Fundamentals of Helicopters					
Course Code	:	BAE645B	**Credits**	:	3
Hours/Week (L:T:P)	:	3:0:0	**CIE**	:	50 Marks
Total Hours	:	50L	**SEE**	:	50 Marks
Course Type	:	OEC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	• Applied Physics • Mathematics-I & II
Knowledge on Fundamental Concepts	• Principles of flight and Newtonian mechanics. • Bernoulli's theorem, continuity equation and conservation of momentum.
Knowledge on Connected Tools (If any)	-

Course Learning Objectives: This course will enable the students	
CLO1	Understand the evolution, classification, and working principles of helicopters and their components.
CLO2	Gain foundational knowledge of helicopter aerodynamics and flight mechanics including climb, descent, and autorotation.
CLO3	Apply theoretical principles to analyze helicopter flight control, performance, and center of gravity calculations.

Module-1	**08 Hrs**
Introduction to Helicopters: Overview of helicopters, history, types, and applications. Fundamental principles of helicopter flight. Comparison of helicopters with fixed-wing aircraft, Turbine age, uses, rotor system, controlling flight, flight conditions. **Text Book: 1, Ch1: 1.1 to 1.6**	
Module-2	**08 Hrs**
Helicopter Aerodynamics: Aerodynamics of flight: introduction, forces acting on an air, airfoil, airflow and reaction in the rotor disc, powered flight, hovering flight, vertical and forward flight, sideward, rearward and turning flight and auto rotation **Text Book: 1, Ch2: 2.1 to 2.2**	
Module-3	**08 Hrs**
Helicopter Flight controls: Introduction, collective pitch control, throttle control, governor/ correlator, cyclic pitch control, anti torque pedals. **Helicopter Components and Sections:** Introduction, airframe, fuselage, main rotor system, anti-torque system, engines and transmission system. **Text Book: 1, Ch3: 3.1 to 4.10**	
Module-4	**08 Hrs**

Climbing and Descending: Climbing, The Horsepower Available Curve (The HPA), Factors Affecting the Horsepower Available Curve, Density Altitude, Collective Setting, Rate of Climb, Angle of Climb, Effect of Lowering Horsepower Available Curve, Effect of the Wind, Climb Performance, Descending, Angle of Descent, Effect of the Wind on Descents, Descent Performance.

Text Book: 2, Ch14:14.1 to 14.11

Module-5	**08 Hrs**

Weight and Balance: Weight, Balance, Beyond the Center of Gravity Limits, Excessive Forward Center of Gravity, Excessive Aft Center of Gravity, Calculating the Center of Gravity Position, To Calculate the Longitudinal Center of Gravity Position, To Calculate the Lateral Takeoff Center of Gravity Position, Effect of External Loads on Center of Gravity Position.

Text Book: 2, Ch26:26.1 to 26.6

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

CO1	Discuss the fundamental concepts, history, and classifications of helicopters and their comparison with fixed-wing aircraft.
CO2	Examine the aerodynamic behavior of helicopters during different flight modes such as hovering, forward, vertical, and autorotation.
CO3	Illustrate the role and functioning of various flight control systems and major structural components in helicopters.
CO4	Evaluate climb and descent performance using horsepower and environmental conditions.
CO5	Compute weight and balance calculations and assess the effect of CG positions on helicopter stability and performance.

Text Books

1. Helicopter Flying Handbook, FAA, FAA-H-8083-21B, U.S. Department of Transportation, Federal Aviation Administration, Flight Standards Service, 2019.
2. Principles of Helicopter Flight, Aviation Supplies & Academics, Walter J. Wagtendonk, Inc. 7005 132nd Place, SE Newcastle, Washington 98059-3153 U.S.A., 1992

Reference Books

1. Helicopter Performance, Stability, and Control, Prouty, R.W., Krieger Publishing Company, 1725 Krieger Drive, Malabar, Florida 32950, U.S.A., 2005.
2. Helicopter Theory, Johnson, W., Dover Publications, Inc., 31 East 2nd Street, Mineola, New York 11501, U.S.A., 1994.
3. Dynamics of Flight: Stability and Control, Gaonkar, G.H., American Institute of Aeronautics and Astronautics (AIAA), 12700 Sunrise Valley Drive, Reston, Virginia 20191, U.S.A., 2000.

Web links and Video Lectures (e-Resources)

1. https://archive.nptel.ac.in/courses/101/104/101104017/

CO -PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2

CO1	3	2	-	-	-	-	-	-	-	1	-	3	-
CO2	3	3	-	2	-	-	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	-	-	-	-	-	3	-
CO4	3	3	-	2	1	-	-	-	-	-	-	3	2
CO5	3	3	-	-	-	-	-	-	-	1	-	3	1

Semester: VI					
Introduction to UAV					
Course Code	:	BAE645C	**Credits**	:	3
Hours/Week (L:T:P)	:	3:0:0	**CIE**	:	50 Marks
Total Hours	:	40L	**SEE**	:	50 Marks
Course Type	:	OEC	**SEE Duration**	:	3 Hours
Prerequisites:					
Courses	• Applied Physics • Mathematics-I & II				
Knowledge on Fundamental Concepts	• Principles of flight and Newtonian mechanics. • Bernoulli's theorem, continuity equation and conservation of momentum.				
Knowledge on connected Tools (If any)	--				

Course Learning Objectives: This course will enable the students

CLO1	Learn the basic evolution of Drones and UAV systems.
CLO2	Acquire the knowledge of basic aerodynamics, performance, stability and control for UAV systems.
CLO3	Understand the regulatory and certification aspects, and select appropriate propulsion systems and structural materials for UAVs

Module-1	**08 Hrs**
Basics: Introduction, History, UV types: UGV, UAV, USV, UUWV, Drones in India, Future scope. Introduction to nano drones and Swarm Drones Principles, Newton's Laws, Degrees of Freedom, Stick Movements, Flight Modes, Basic Manoeuvres, Take-off, Pitch, Roll, Yaw, Landing. Swarm drones, AI-powered UAVs, Drone delivery systems. **Text book 1: Ch 1 – 1.1, 1.2, 1.3**	
Module-2	**08 Hrs**
Components and Systems: Basic components, Micro controllers, microprocessors, Sensors, Pre-Flight Checks, Flight Planning, Transmitter, Receiver. Introduction to Arduino Sensors, Program Structures, Flight Controllers, Telemetry, Mission Planning, Camera, Binding, etc. **Text book 1: Ch 2**	
Module-3	**08 Hrs**
Air Worthiness: DGCA Rules and Regulations and Global UAV Regulations (FAA, EASA, etc.), Pilot Licensing requirements, NPNT Compliance. Certifications, Certification, No-fly Zones, Geo-fencing, UAV Maintenance, Troubleshooting & Safety Protocols, Cyber security in UAV systems, Ethics and Privacy Issues, Future Trends: Urban Air Mobility (UAM), Drone taxis (e.g., Volocopter, E Hang). **Reference book 1: Ch2 – 2.1, Ch4 – 4.1, 4.2, 4.3, 4.4, 4.5**	

Module-4	**08 Hrs**
Basics of Structures: Configurations, Payload Configurations, Design Considerations. **Basics of Propulsion:** Batteries Technologies (Li-Po, Li-ion), Hybrid Propulsions, IC Engines, Mini Turbines, Solar. Electric motors, ESC (Electronic Speed Controllers), Propellers, Power Distribution Boards, Redundancy Systems, Basics of Flight Control Systems (FCS), Stability and Control: GPS, IMU, Altimeters,	

Barometers, Solar-powered UAVs, Hydrogen fuel cell drones **Text Book 1: Ch3**	
Module-5	**08 Hrs**
UAV Frame Materials: Carbon fiber, composites, lightweight alloys, Frame Geometry and Aerodynamics, Design Considerations: Weight, Payload capacity, Structural integrity, Bio-inspired frames (e.g., dragonfly drones), Tuning, Testing, Manufacturing Constraints, Simulator Training, Applications. **Case Studies: Construction and testing of a basic drone.** **Text book 1: Ch7**	
Course Outcomes: At the end of the course, the student will be able to	
CO1	Understand the fundamentals of UAV types, flight principles, maneuvers and AI- Powered drones in modern applications.
CO2	Explain UAV subsystems including microcontrollers, sensors and communication systems.
CO3	Apply DGCA and global UAV regulations, licensing requirements, safety protocols, cyber security and ethics in UAV applications.
CO4	Interpret the structural configurations, propulsion systems, and flight control systems required for UAV performance and stability.
CO5	Analyze UAV frame materials and geometries, design considerations, and testing and manufacturing constraints to basic drone construction.

Text Books

1. Thomas James Gleason, Paul Gerin Fahlstrom, Introduction To UAV Systems, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd.
2. Unmanned Aerial Vehicle, Landen Rosen, Publisher: Alpha Editions, ISBN 13:9789385505034.

Reference Books

1. An Introduction to Aircraft Certification and Operations Airworthiness, Filippo De Florio, 2016.
2. Design and Airworthiness Requirements for Service Aircraft, Ministry of Defense, Defense Standard 00-970 Part 11, Issue 1 Publication Date 27 January 2006.
3. Unmanned Aerial Vehicles, DOD's Acquisition Efforts, Publisher: Alpha Editions, ISBN13: 9781297017544.
4. Unmanned Aerial Vehicles, Valavanis, Kimon P, Springer, 2011.

Web links and Video Lectures (e-Resources)

1. https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle/
2. https://www.edx.org/course/uavs-and-drones-an-introduction-to-uav-technology/

CO -PO MAPPING													
	PO1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PSO 1**	**PSO2**
CO1	3	2	-	-	-	1	-	-	-	-	-	3	1
CO2	3	3	2	2	-	-	-	-	-	1	-	3	2
CO3	2	2	2	1	-	3	2	3	-	-	-	2	1
CO4	3	2	2	2	-	1	1	-	-	-	1	3	2
CO5	3	3	3	3	-	1	-	-	-	-	2	3	2

Semester: VI					
Aircraft Transportation Systems					
Course Code	**:**	BAE645D	**Credits**	**:**	3
Hours/Week (L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40L	**SEE**	**:**	50 Marks
Course Type	**:**	OEC	**SEE Duration**	**:**	3 Hours
Prerequisites:					
Courses	--				
Knowledge on Fundamental Concepts	--				
Knowledge on Connected Tools (If any)	--				

Course Learning Objectives: This course will enable the students

CLO1	Understand the air transport systems
CLO2	Acquire the knowledge of aircraft characteristics, airlines and airport.
CLO3	Explore environmental, technological and automation trends in the aviation industry.

Module-1	**08 Hrs**

Overview of Aircraft Transportation Systems: Components of the air transport system: Aircraft, airports, airspace, airlines, passengers, Stakeholders: ICAO, IATA, FAA, DGCA, EASA, Euro control, Hub-and-spoke v/s point-to-point models, Historical evolution and global growth trends Impact of COVID-19 and recovery strategies.

Text Book 1: Ch1:1.2 to 1.4, Ch3: 3.2 & 3.4, Ch6: 6.2, Ch15:15.1

Module-2	**08 Hrs**

Airport Infrastructure and Operations : Airport classification, layout, and terminal design, Airside v/s Landside operations, Runway and taxiway systems, Passenger and cargo handling systems, Airport capacity planning and slot management

Text Book 1: Ch4:4.2 to 4.6, Ch5: 5.4 & 5.5,Ch9: 9.3, Ch10: 10.1 & 10.2

Module-3	**08 Hrs**

Air Traffic Management and Airline Operations: Air traffic control (ATC), flight information regions (FIR), and navigation systems, Airline scheduling, fleet planning, and crew management, Load planning and aircraft turnaround, Network optimization and route profitability, Role of A-CDM (Airport Collaborative Decision Making)

Text Book 1: Ch7: 7.2, 7.4 to 7.6,Ch8: 8.1, 8.4 & 8.5

Module-4	**08 Hrs**
Safety, Regulation, and Economics: Aviation safety systems and safety management system (SMS),ICAO Annexes, DGCA rules, and global air law frameworks, Accident and incident investigation processes, Cost structures of airlines: Direct v/s Indirect, Airline business models: LCC, FSC, Hybrid. **Text Book: 2 Ch11: 11.2, 11.4 to 11.6, Ch14: 14.2 to 14.4, Ch15: 15.3 & 15.4**	
Module-5	**08 Hrs**
Modern Trends in Air Transportation: Green aviation: Sustainable aviation fuels (SAF), electric aircraft, Digitalization: AI in air traffic, predictive maintenance, IoT in airport operations, Automation in ATC and airport operations, Urban Air Mobility (UAM) and drones in logistics, Case studies: Smart airports, autonomous towers, and climate impact mitigation. **Text Book:1, Ch16: 16.2, 16.4 to 16.6,Ch18:18.3, 18.4 &18.6**	

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

CO1	Describe the fundamental structure and stakeholders of the aircraft transportation system.
CO2	Illustrate airport and airline operations including scheduling, air traffic flow, and ground handling.
CO3	Understand the regulatory frameworks and international aviation standards.
CO4	Evaluate modern technologies such as automation, sustainability, and digitalization in air transport.
CO5	Apply system thinking to optimize aircraft transportation operations in real-world scenarios.

Text Books

1. Air Transportation: A Management Perspective, John G. Wensveen**,** Routledge, 9th Edition.
2. Air Transport System, Dieter Shmitt, and Valker Gollnick, Springer, 2016.

Reference Books

1. Airport Planning and Management, Alexander T. Wells & Seth B. Young, McGraw-Hill Education.
2. The Global Airline Industry, Peter Belobaba, Amedeo Odoni, Cynthia Barnhart, Wiley.

Web links and Video Lectures (e-Resources)

1. https://www.icao.int/
2. https://www.faa.gov/
3. https://www.flightradar24.com/
4. https://nptel.ac.in/courses/101104064/
5. https://www.youtube.com/playlist?list=PLUl4u3cNGP61zK5sL7q2Vg-91xQD8ob8e/

CO -PO MAPPING

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 1	PSO 1	PSO2
CO1	3	2	2	-	-	-	-	3	-	-	3	3	2
CO2	3	3	2	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	-	-	-	2	-	-	-	-	3	2
CO4	3	3	2	-	-	2	-	-	-	-	-	3	2
CO5	3	3	2	-	-	-	-	-	-	-	-	3	2

Semester: VI					
Flight Simulation Lab					
Course Code	**:**	BAEL607	**Credits**	**:**	1
Hours/Week (L:T:P)	**:**	0:0:2	**CIE**	**:**	50 Marks
Total Hours	**:**	20L	**SEE**	**:**	50 Marks
Course Type	**:**	PCCL	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	• Computational Tool for Aircraft Performance Analysis. • Theory of Vibrations.
Knowledge on Fundamental Concepts	• Transfer Function, Root Locus and Bode Plot. • Analyzing the Dynamic System. • A Graphical, Interactive Environment for Modeling.
Knowledge on Connected Tools (If any)	• MATLAB and Simulink Tool.

Course Learning Objectives: This course will enable the students	
CLO1	Understand the Root Locus and Bode Plot.
CLO2	Relate the Graphical representation of Spring Mass Damper System and the Servo Mechanism System with feedback in Simulink.
CLO3	Acquire the knowledge to use computational tools to model aeronautical vehicle dynamics.

List of Experiments

Sl. No	**Experiments**
1	Draw Pole-Zero map of dynamic system model with plot customization option.
2	Plot root locus with variables in transfer function & dynamic system through MATLAB.
3	Draw Bode plot from a transfer function in MATLAB and explain the gain and phase margins.
4	Simulate a spring- mass- damper system with and without a forcing function though SIMULINK.
5	Simulate a simple servo-mechanism motion with feedback- in the time domain, and in `s` domain.
6	Simulate a bomb drop from an aircraft on a moving tank in pure pursuit motion.
7	Simulate aircraft Take-off and Landing with trajectory tracing.
8	Simulate stall of aircraft and show the effect of variation in static margin on stalling characteristics.
9	Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a pulse input in pitch that is intended to bleed the airspeed.
10	Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a doublet input in pitch.

11	Given a Quadratic characteristic equation, determine two quadratics that shall result in poles of short period oscillations and poles of Phugoid. Vary the coefficients of polynomial to study the movement of poles.
12	Given a Quadratic characteristics equitation, determine Poles and Time constants for Roll mode, Spiral motion, and Dutch roll. Vary the coefficients of polynomial to study the movement of poles.

Course Outcomes: At the end of the course, the student will be able to	
CO1	Sketch the Root Locus and Bode Plot.
CO2	Calculate the dynamics response of aircraft.
CO3	Use Computational Tools to model aircraft trajectory.
CO4	Analyze the Stalling Characteristics of the aircraft.
CO5	Solve the Quadratic Characteristic Equation to trace the Poles and Time Constants.

CO- PO MAPPING

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

Semester: VI					
Competency Enhancement Course-4 Stream: ME/AE/AS					
Course Code	**:**	**BCE608**	**Credits**	**:**	0
Hours/Week (L:T:P)	**:**	2:0:0	**CIE**	**:**	**100 Marks**
Total Hours	**:**	40	**SEE**	**:**	-
Course Type	**:**	NCMC	**SEE Duration**	**:**	-
Prerequisites:					
Courses	FEM, Solid Edge, Auto cad				
Knowledge on Fundamental Concepts	--				
Knowledge on Connected Tools (If any)	--				

Course Learning Objectives: This course will enable the students

CLO1	Understand the fundamentals of Finite Element Analysis (FEA)
CLO2	Familiarize with ANSYS software environment
CLO3	Apply the general FEA analysis procedure in ANSYS
CLO4	Perform different types of engineering analyses in ANSYS
CLO5	Develop simulation-based solutions through projects and case studies

Module-1	**03 Hrs**

Fundamentals of Finite Element Analysis (FEA)

Introduction to FEA: Concept, applications and limitations, Historical development and role of FEA in engineering.

Mathematical foundation: governing equations, boundary conditions and discretization, Types of problems solved by FEA (structural, thermal, fluid, coupled field)

Steps in FEA: Pre-processing, solution, post-processing, Common terminology in FEA

(nodes, elements, DOFs, meshing, shape functions)

Text book1: Ch1& Ch2

Text book2: Ch1& Ch2

Module-2	**03 Hrs**

Introduction to ANSYS Environment: Overview of ANSYS software and its capabilities, ANSYS workbench vs. classical interface, ANSYS GUI and menus: Project schematic, toolbox, engineering data, geometry, mesh, solution, results, File management and units system in ANSYS, Understanding ANSYS element library, Importing and creating geometry (Design Modeler/Space Claim basics)

Text book1 : Ch.3, Text book3 – Ch1,Ch2 & Ch3 Text book 4

<table>
<tr><th>Module-3</th><th>06 Hrs</th></tr>
<tr><td colspan="2">General FEA Analysis Procedure in ANSYS
Pre-processing in ANSYS: geometry creation, material properties, meshing, Types of meshing and mesh quality parameters, Defining loads, boundary conditions and constraints, Solver settings and run procedure.
Post-processing: interpreting results (stress, strain, deformation, temperature) Error checking, convergence studies and result verification.
Text book1:Ch4, Ch5 & Ch6, Text book 4</td></tr>
<tr><th>Module-4</th><th>08 Hrs</th></tr>
<tr><td colspan="2">Analysis Types in ANSYS
Structural Analysis: Linear static analysis of beams, trusses and frames, Contact analysis and nonlinear material behavior, Buckling analysis.
Thermal Analysis: Steady-state and transient heat transfer problems, Conduction, convection and radiation in ANSYS
Modal Analysis: Natural frequencies and mode shapes, Harmonic and transient vibration analysis, Damping effects and interpretation of modal results.
Text book1: Ch7, Ch8 & Ch9, Text book 3, Ch6, Ch7 & Ch8</td></tr>
<tr><th>Module-5</th><th>20 Hrs</th></tr>
<tr><td colspan="2">Case Studies & Project Work:
Hands-on tutorials for each analysis type (structural, thermal, modal), Real-world problem simulation (e.g., mechanical component under load, heat dissipation in electronics), Optimization studies and parametric analysis, Documentation and report preparation for FEA projects
Mini-projects: Problem definition, modeling, simulation, validation and presentation
Text book 3: Ch9 & Ch10, Text book 4</td></tr>
<tr><td colspan="2">Course Outcomes: At the end of the course, the student will be able to</td></tr>
<tr><td>CO1</td><td>Describe the fundamental concepts, mathematical foundations and applications of Finite Element Analysis (FEA) in engineering</td></tr>
<tr><td>CO2</td><td>Demonstrate proficiency in navigating and utilizing the ANSYS Workbench environment for different engineering simulations</td></tr>
<tr><td>CO3</td><td>Apply the general FEA procedure (pre-processing, solution and post-processing) to model, analyze and interpret engineering problems</td></tr>
<tr><td>CO4</td><td>Perform structural, thermal and modal analyses in ANSYS, including interpretation of results for decision-making</td></tr>
<tr><td>CO5</td><td>Design and execute simulation-based projects, perform optimization studies, validate results and prepare professional technical reports.</td></tr>
<tr><td colspan="2">Text Books</td></tr>
</table>

1. Finite Element Analysis: Theory and Application with ANSYS, Saeed Moaveni, 4th Edition, Pearson Education, 2014. ISBN: 978-0133840803
2. Fundamentals of Finite Element Analysis, David Hutton, McGraw Hill Education, 2017. ISBN: 978-0072922363
3. Practical Finite Element Analysis for Mechanical Engineers with ANSYS Applications. Kishore Kumar G., Venkatesh K, I.K. International Publishing House, 2021. ISBN: 978-9386768830
4. ANSYS, Inc. – ANSYS Workbench User's Guide (Latest Release Documentation, available via ANSYS Help)

Web links and Video Lectures (e-Resources)

1. https://www.ansys.com/learning
2. https://forum.ansys.com/
3. https://www.engineeringtoolbox.com/
4. https://confluence.cornell.edu/display/SIMULATION/ANSYS+Tutorials/
5. https://caeai.com/resources/

CO -PO MAPPING

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

Semester: VI					
Indian Knowledge Systems Stream: CSE/ECE/ME/CV					
Course Code	:	BIK609	**Credits**	:	0
Hours/Week (L:T:P)	:	1:0:0	**CIE**	:	100Marks
Total Hours	:	15	**SEE**	:	-
Course Type	:	NCMC	**SEE Duration**	:	-
Prerequisites:					
Courses	Environmental Studies, Indian Philosophy or Ethics				
Knowledge on Fundamental Concepts	Basic understanding of ancient Indian civilization, literature				
Knowledge on Connected Tools (If any)	--				

Course Learning Objectives: This course will enable the students

CLO1	Understand the foundational concepts of Indian Knowledge Systems(IKS)
CLO2	Explore the contributions of traditional Indian knowledge to various fields in the humanities and sciences
CLO3	Recognize the relevance and applications of traditional knowledge in professional domains
CLO4	Develop an appreciation for the interdisciplinary nature of IKS
CLO5	Analyze the integration of IKS with contemporary academic and professional practices

Module-1	**05 Hrs**
Introduction to Indian Knowledge Systems (IKS) Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge. **Text book 1: Ch1, Ch2 & Ch3, Text book-2: Ch 2& Ch3**	
Module-2	**05 Hrs**
Traditional Knowledge in Humanities and Sciences Linguistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology. **Text book 1, Ch4,Ch5, Ch6 & Ch7, Text book 2: Ch3 & C4**	
Module-3	**06 Hrs**
Traditional Knowledge in Professional domain Town planning and architecture Construction, Health, wellness and Psychology Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals. **Text book 1:Ch.8 , Ch9, Ch10, Ch11& Ch12, Text book-2: Ch5,Ch6& Ch7**	

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

CO1	Elucidate the scope, significance and philosophical foundations of Indian Knowledge Systems (IKS).
CO2	Compare traditional knowledge systems with indigenous and western knowledge frameworks.

CO3	Identify the applications of traditional Indian knowledge in humanities and scientific domains.
CO4	Demonstrate an understanding of traditional Indian contributions to professional domains.
CO5	Relate traditional knowledge systems to contemporary global frameworks such as Sustainable Development Goals (SDGs).

Text Books

1. Introduction to Indian Knowledge System- concepts and applications, B Mahadevan, Vinayak Rajat Bhat, Nag Private Ltd, ISBN-978-93-91818-21-0
2. Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230

Reference Book

1. Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh, Vol.1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334

Web links and Video Lectures (e-Resources)

1. https://www.youtube.com/watch?v=LZP1StpYEPM
   http://nptel.ac.in/courses/121106003/
2. https://www.wipo.int/pressroom/en/briefs/tk_ip.html
3. https://unctad.org/system/files/official-document/ditcted10_en.pdf/
4. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf/

CO -PO MAPPING

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

Semester: VI					
National Service Scheme (NSS) Stream: CSE/ECE/CV/ME					
Course Code	**:**	**BNS610**	**Credits**	**:**	0
Hours/Week (L:T:P)	**:**	0:0:2	**CIE**	**:**	**100Marks**
Total Hours	**:**	24	**SEE**	**:**	-
Course Type	**:**	NCMC	**SEE Duration**	**:**	-

Course Learning Objectives: This course will enable the students

CLO1	Understand the community in general in which they work
CLO2	Identify the needs and problems of the community and involve them in problem – solving
CLO3	Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions
CLO4	Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
CLO5	Appraise the importance of ethical issues and team working abilities pertaining to the social services.

Activity– 1	**08 Hrs**
Plantation and adoption of plants. Know your plants	
Activity– 2	**08 Hrs**
Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).	
Activity– 3	**08 Hrs**
Govt. school Rejuvenation and helping them to achieve good infrastructure.	

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.	**Topic**	**Group Size**	**Location**	**Activity Execution**	**Reporting**	**Evaluation of the Topic**
1.	Plantation and adoption of plants. Know your plants.	May be individual or team	Villages/ City Areas / Grama panchayat / public associations/Government Schemes officers/ campus etc.	Place 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.	Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).	May be individual or team	Villages/ CityAreas / Grama panchayat/ public associations/Government Schemes officers/ campus etc.	Place 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.	Govt. school Rejuvenati On and helping them to achieve good infrastructur e.	Maybe individual or team	Villages/City Areas/Gram a panchayat / public associations / Government Schemes officers/cam pus etc.	Place selection/pr op er consultation/ Continuous monitoring / Information board	Repor t shoul d 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 5th 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 10minutes by each student At the end of semester with Report.

- In the 6th 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 6th semester, consolidated report of all activities compiled report should be submitted as per the instructions.

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

CO1	Exploit the importance of his / her responsibilities towards society.
CO2	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.
CO4	Implement government or self-driven projects effectively in the field of societal problems.
CO5	Appraise the importance of ethical issues and team working abilities pertaining to the social services

Assessment Details for CIE (100 Marks)

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

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	-	-	-	-	3	1	1
CO2	-	-	-	-	-	3	-	-	-	-	3	1	1
CO3	-	-	-	-	-	3	-	-	-	-	3	1	1
CO4	-	-	-	-	-	3	-	-	-	-	3	1	1
CO5	-	-	-	-	-	2	3	3	-	-	3	1	1

Semester: VI					
Physical Education (PE) (Sports & Athletics) Stream: CSE/ECE/CV/ME					
Course Code	**:**	BPE610	**Credits**	**:**	0
Hours/Week (L:T:P)	**:**	0:0:1	**CIE**	**:**	**100Marks**
Total Hours	**:**	24	**SEE**	**:**	-
Course Type	**:**	NCMC	**SEE Duration**	**:**	-

Course Learning Objectives: This course will enable the students	
CLO1	Develop awareness about common postural deformities and equip students with techniques for stress management to enhance physical and mental well-being
CLO2	Enable students to acquire the basic rules, techniques, and motor skills of selected games such as Throw Ball, Table Tennis, or Athletics, and to encourage regular participation in physical activities
CLO3	Improve cardiovascular fitness, flexibility, and coordination through structured aerobic exercises.

Module-1	**04 Hrs**
Orientation A. Postural deformities. B. Stress management	
Module-2	**16 Hrs**
Specific games (Any one to be selected by the student) A. Throw ball B. Table Tennis C. Athletics (Field Events- Jumps) – Any event as per availability of Ground.	
Module-3	**04 Hrs**
A. **Aerobics**	

Course Outcomes: At the end of the course, the student will be able to	
CO1	Identify common postural deformities and suggest corrective measures
CO2	Apply basic stress management techniques to enhance physical and mental well- being
CO3	Demonstrate fundamental skills, rules and techniques of a selected game (Throw Ball / Table Tennis / Athletics – Field Events)
CO4	Exhibit improved coordination, flexibility, endurance and cardiovascular fitness through aerobic exercises
CO5	Integrate principles of physical fitness, posture correction and stress management into daily routines for holistic health

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													
	PO 1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PSO 1**	**PSO2**
CO1	2	-	-	-	-	2	3	-	2	-	-		
CO2	2	-	-	-	-	3	3	2	2	-	-		
CO3	2	1	-	-	-	2	-	-	3	-	-		
CO4	3	-		-	-	2	-	-	2	-	-		
CO5	3	2	-	-	-	3	3	2	3	-	-		

Semester: VI					
Yoga Stream: CSE/ECE/CV/ME					
Course Code	**:**	**BYO610**	**Credits**	**:**	00
Hours/Week (L:T:P)	**:**	0:0:2	**CIE**	**:**	100Marks
Total Hours	**:**	15T+20S	**SEE**	**:**	00Marks
Course Type	**:**	NCMC	**SEE Duration**	**:**	0Hours

Course Learning Objectives: This course will enable the students	
CLO1	Adopt healthy lifestyle practices and maintain mental hygiene to promote physical and mental well-being
CLO2	Develop emotional intelligence and foster emotional stability through self awareness and mindfulness practices
CLO3	Impart moral values and enhance self-awareness to facilitate personal growth and attain higher levels of consciousness

Module-1	**03 Hrs**
Higher Ashtanga Yoga: Ashtanga Yoga – last three limbs: Dharana (Concentration), Dhyana (Meditation), Samadhi (Absorption), Importance in spiritual and mental wellbeing	
Module-2	**03 Hrs**
Sitting & StandingAsanas: Sitting Asanas: Bakasana, Hanumanasana, Ekapada Rajakapotasana, Yogamudra in Vajrasana, Standing Asanas: Vatayanasana, Garudasana, Technique, precautions & benefits	
Module-3	**03 Hrs**
Balancing & Supine Asanas: Balancing Asanas: Veerabhadrasana, Sheershasana, Supine Asanas: Sarvangasana, Setubandha Sarvangasana, Shavasana (Relaxation), Asana meaning, method, safety tips & benefits	
Module-4	**03 Hrs**
Pranayama & Kapalabhati: Pranayama: Bhastrika, Bhramari, Kapalabhati revision – 80 strokes/min, 3 rounds, Technique, precautions & benefits	
Module-5	**03 Hrs**
Shatkriyas: Meaning, need & types of Shatkriyas, Techniques, safety & benefits of: Jalaneti & Sutraneti, Nouli (only for men), Sheetkarma Kapalabhati	

Course Outcomes: At the end of the course, the student will be able to	
CO1	Describe the origin, history, objectives, and fundamental concepts of Yoga and its various schools.
CO2	Demonstrate Suryanamaskara and various types of Asanas with correct techniques, precautions, and benefits
CO3	Differentiate between yogic and non-yogic practices
CO4	Apply yogic principles to promote physical and mental well-being.

Text Books

1. Light on Yoga by BKS Iyengar, Thorsons Publishers, ISBN-10 : 8172235011
2. Teaching Methods for Yogic practices by Dr. M L Gharote & Dr. S K Ganguly, 4th Edition, Kaivalyadhama Publishers, ISBN-10 : 9788189485245
3. Yoga Instructor Course hand book published by SVYASA University, Bengaluru

Reference Books

1. Yogapravesha in Kannada by Ajitkumar
2. Yoga for Children –step by step – by Yamini Muthanna

Web links and Video Lectures (e – Resources)

1. https://www.youtube.com/watch?v=KB-TYlgd1wE
2. https://www.youtube.com/watch?v=aa-TG0Wg1Ls

Semester: VI					
Music Stream: CSE/ECE/CV/ME					
Course Code	**:**	BMU610	**Credits**	**:**	0
Hours/Week (L:T:P)	**:**	0:0:2	**CIE**	**:**	100 Marks
Total Hours	**:**	26	**SEE**	**:**	-
Course Type	**:**	NCMC	**SEE Duration**	**:**	-

Course Learning Objectives: This course will enable the students

CLO1	Understand the foundational concepts of Indian classical music, including the evolution and structure of Shruthi, Nada, Swara, Laya, Raga, Tala and Mela systems.
CLO2	Recognize and describe various types of Carnatic compositions such as Geethe, Jathi, Swara, Swarajathi, Varna, Krithi and Thillana, along with the basics of the notation system.
CLO3	Appreciate the contributions of key composers like Purandaradasa, Thyagaraja and Mysore Vasudevacharya to Indian music and understand their musical legacy.
CLO4	Identify and explain the classification and basic construction of traditional Indian musical instruments, including string, wind, percussion and idiophones, with appropriate examples.

Module-1	**03 Hrs**
Preamble: Contents of the curriculum intended to promote music as language to develop an analytical, creative and intuitive understanding. For this the student must experience music through study and direct participation in improvisation and composition. **Origin of the Indian Music:** Evolution of the Indian music system, understanding of Shruthi, Nada, Swara, Laya, Raga, Tala, Mela **Text book 1: V-1 Ch:1-4**	
Module-2	**03 Hrs**
Compositions: Introduction to the types of composition in Carnatic Music – Geethe, Jathi, Swara, Swarajathi, Varna, Krithi and Thillana, Notation System. **Text book 2: Ch: 4-7**	
Module-3	**03 Hrs**
Composers: Biography and contributions of Purandaradasa, Thyagaraja, Mysoroasudevacharya, Kanakadasa **Text book 3: Ch:2-5**	
Module-4	**03 Hrs**
Music Instruments: Classification and construction of string instruments, wind instruments, percussion Instruments, Idiophones (Ghana Vaadya), Examples of each class of instruments. **Text book1:V-4 – Ch:2-6**	
Module-5	**14 Hrs**
Abhyasa Gana: Singing the swara exercises (SaraleVarase Only), Botatio writing for saralevarase and sulafisapta tala (Only in mayamalavagowla raga), singing 4 geethe in malahari and one jathiswara, oekrithi in a mela raga **Text book1, V:1&2**	

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

CO1	Outline the evolution of Indian music and key concepts like Shruthi, Swara, Raga and Tala.

CO2	Identify and interpret basic Carnatic compositions using standard notation.
CO3	Summarize the contributions of composers.
CO4	Classify Indian musical instruments and describe their construction and use.

CO5	Demonstrate basic Carnatic vocal skills through selected exercises and compositions.

Text Books

1. South Indian Music – Vol. I to VI, Prof. P. Sambamoorthy, The Indian Music Publishing House, Chennai.
2. A Textbook of Carnatic Music, Dr. S. Bhagyalekshmy, CBH Publications
3. Karnataka Sangeetha Charitre, Dr. V. S. Sampathkumaracharya, Kannada University, Hampi.

Reference Books

3. Music of India, B. Chaitanya Deva, Munshiram Manoharlal Publishers
4. Essentials of Musicology in South Indian Music, Prof. S. R. Janakiraman, Asian Educational Services

CO -PO MAPPING

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