Tulsiramji Gaikwad-Patil College of Engineering and Technology
Wardha Road, Nagpur-441 108
NAAC Accredited (A+ Grade)

B. Tech. VI Sem Aeronautical Engineering Honor

BAE33625: Aerospace structural health monitoring

Teaching Scheme			Examination Scheme	
Lectures	3hr/week		CIE	40 Marks
Tutorials	-		ESE	60 Marks
Practical	-		Total	100 Marks
Total Credits	3		Duration of Exam: 3 Hours	

The Objectives of this course are:

1	To explore the development and integration of novel smart sensors.
2	To introduce various damage detection techniques
3	To understand the design and fabrication of sensors using smart materials
4	To develop skills in the experimental analysis and performance assessment
5	To distinguish between theoretical sensor design concepts and real-world engineering applications

Course Contents

Unit I	**AIRCRAFT STRUCTURAL HEALTH AND USAGE MONITORING** Introduction - aircraft structural damage - ageing aircraft problem - lifecycle cost of aerospace structures - aircraft structural design - damage monitoring systems in aircraft - non-destructive testing - structural health monitoring - emerging monitoring techniques and sensor technologies
Unit II	**OPERATIONAL LOAD MONITORING USING OPTICAL FIBRE SENSORS** Introduction - Fibre Optics - Sensor Target Specifications - Reliability of Fibre Bragg Grating Sensors - Fibre Coating Technology - Example of Surface Mounted Operational Load Monitoring Sensor System - Optical Fibre Strain Rosette - Example of Embedded Optical Impact Detection System
Unit III	**DAMAGE DETECTION USING STRESS AND ULTRASONIC WAVES** Acoustic Emission – Ultrasonics - Acousto-ultrasonics - Guided Wave Ultrasonics - Piezoelectric Transducers - Passive Damage Detection Examples - Active Damage Detection Examples
Unit IV	**SIGNAL PROCESSING FOR DAMAGE DETECTION** Introduction - Data Pre-processing - Signal Features for Damage Identification - Time–Domain Analysis - Spectral Analysis - Instantaneous Phase and Frequency - Time–Frequency Analysis - Wavelet Analysis - Dimensionality Reduction Using Linear and Nonlinear Transformation - Data Compression Using Wavelets Wavelet-based Denoising - Pattern Recognition for Damage Identification - Artificial Neural Networks
Unit V	**STRUCTURAL HEALTH MONITORING EVALUATION TESTS:** Introduction - Large-scale Metallic Evaluator - Large-scale Composite Evaluator- Flight Tests - Summary

Text Books

1	Staszewski, W., Boller, C., & Tomlinson, G. R. (Eds.). (2004). Health monitoring of aerospace structures: smart sensor technologies and signal processing. John Wiley & Sons.
2	S. S. Rao (2011), Mechanical Vibrations, 5th editions, Prentice Hall of India, New Delhi.

Reference Books

1	Structural Health Monitoring for Space Systems (Aerospace Series) Andrei Zagrai (Editor), Brandon Arritt (Editor), Derek Doyle (Editor) Wiley-Blackwell ISBN-10: 1118729641
2	Donaldson B. K (2008), Analysis of Aircraft Structures an introduction to Aeronautical Structures Analysis, 2nd edition, Cambridge University Press, USA.
3	

Useful Links

1	https://onlinecourses.nptel.ac.in/noc18_oe05/preview
2	http://www.cism.it/courses/A1102/
3	http://courses.ce.metu.edu.tr/ce5802/2015/02/11/hello-world/

BAE32425	Course Outcomes	CL	Class Sessions
CO1	**Explain** the concepts of aircraft structural damage, ageing problems, and lifecycle costs	3	9
CO2	**Evaluate** reliability and coating technologies of Fibre Bragg Grating sensors,	3	9
CO3	**Apply** piezoelectric transducers for passive and active damage detection	3	9
CO4	**Evaluate** pattern recognition methods such as artificial neural networks for structural damage identification.	2	9
CO5	**Explain** evaluation procedures for large-scale metallic and composite structures	2	9

Head
Aeronautical Engineering
TGPCET, Nagpur

Dean Academics
Tulsiramji Gaikwad-Patil
College Of Engineering
and Technology, Nagpur

	NAAC Accredited (A+ Grade)	

B. Tech. IV Sem Aeronautical Engineering Minor

BAE33621: Design of Fixed Wing Unmanned Aerial Vehicles

Teaching Scheme			**Examination Scheme**	
Lectures	**3 Hr /Week**		**ESE**	**60 Marks**
Tutorial	**-**		**CIE**	**40 Marks**
Practical	**-**		**Total**	**100 Marks**
Theory Credits : 3			**Duration of Exam :3 Hours**	

Course Objectives

The Objectives of this course are:

1.	**Understand** the fundamental principles, design parameters, mission requirements, and design methodology of fixed-wing UAVs.
2.	**Develop** the ability to select suitable aircraft configurations, airfoils, and wing planform geometries based on mission specifications.
3.	**Analyze** weight estimation, centre of gravity, aerodynamic characteristics, flight performance, and stability parameters of fixed-wing UAVs.
4.	**Apply** analytical methods, CAD modelling, and simulation tools for detailed sizing and design validation of fixed-wing UAVs
5.	**Acquire** practical skills in prototype fabrication, wind tunnel testing, and experimental evaluation of fixed-wing UAV aerodynamic performance.

Course Contents

Unit-I	**Introduction and Preliminary Design of Fixed-Wing UAVs** Introduction to fixed-wing unmanned aerial vehicles, classification and applications of fixed-wing UAVs, fundamentals of UAV design, design objectives and constraints, basic design parameters, mission requirements and specifications, design algorithm and methodology, case studies of fixed-wing UAV design, identification of feasible design parameters, and preliminary sizing based on mission requirements.
Unit-II	**Configuration Layout and Geometric Design** Configuration layout and selection of aircraft configuration, airfoil selection criteria, airfoil aerodynamic characteristics, selection of wing planform geometry, wing aspect ratio, taper ratio, wing loading, tail configuration and sizing fundamentals, fuselage layout, control surface selection, geometric constraints, and preliminary three-view drawing of a fixed-wing UAV.
Unit-III	**Weight Estimation, Aerodynamic Analysis and Performance** Weight estimation and weight breakdown, centre of gravity (CG) estimation and balancing, analytical estimation of design parameters, estimation of lift and drag characteristics, aerodynamic performance analysis, thrust and power requirements, stall speed, take-off and landing performance, climb performance, endurance and range estimation, static stability and control considerations, and preliminary stability and performance assessment of fixed-wing UAVs.
Unit-IV	**Simulation, Detailed Sizing and Inertial Property Estimation** Introduction to UAV design and simulation tools, aerodynamic and performance simulation, simulation-based design verification, parametric analysis and design optimization, detailed sizing of wing, fuselage and empennage, propulsion system selection, payload integration, estimation of mass distribution and inertial properties, three-dimensional CAD modelling, determination of moments of inertia, and refinement of the design based on simulation results.

Unit-V	**Prototype Fabrication and Experimental Testing** Materials and manufacturing methods for fixed-wing UAVs, prototype fabrication and assembly, installation of propulsion and control systems, integration of avionics and payload, pre-test inspection and safety considerations, fundamentals of wind tunnel testing, experimental aerodynamic characterization, measurement of lift and drag, determination of aerodynamic coefficients, comparison of experimental results with analytical and simulation predictions, design validation, and preparation of a technical design report.

Text Books	
1	Unmanned Aircraft Design A review of fundamentals by Mohammad H. Sadraey
2	Aircraft Design : A Conceptual Approach by Daniel P. Raymer
3	Unmanned Aircraft Systems : UAVs Design Development and Deployment by Reg Austin
4	Small Unmanned Fixed-wing Aircraft Design: A Practical Approach by Andrew J. Keane and James P. Scanlan
Reference Books	
1	G. Introduction to Flight by John D. Anderson
2	Performance, Stability, Dynamics, and Control of Airplanes by Bandu N. Pamadi
3	Aircraft performance and design by John D. Anderson
Useful Links	
1	https://nptel.ac.in/courses/101/104/101104010/
2	https://nptel.ac.in/courses/101/106/101106038/
3.	https://nptel.ac.in/courses/101/105/101105084/

BAE33621	**Course Outcomes**	**CL**	**Class Sessions**
CO1	Explain the fundamental design principles, mission requirements, and preliminary sizing procedures of fixed-wing UAVs.	**2**	**9**
CO2	Select suitable aircraft configurations, airfoils, and planform geometries based on design requirements.	**2**	**9**
CO3	Estimate UAV weight, centre of gravity, aerodynamic characteristics, flight performance, and stability parameters.	**3**	**9**
CO4	Develop and simulate a fixed-wing UAV design using suitable analytical and CAD-based tools.	**3**	**9**
CO5	Fabricate a fixed-wing UAV prototype and evaluate its aerodynamic characteristics through experimental testing.	**4**	**9**

Head
Aeronautical Engineering
TGPCET, Nagpur

Dean Academics
Tulsiramji Gaikwad-Patil
College Of Engineering
and Technology, Nagpur