COMPUTATIONAL APPROACHES TO AEROSPACE VEHICLE DESIGN

(CORE COURSE- VI)

II Semester: AEROSPACE ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B27608	CC	3	-	-	3	30	70	100
Contact Classes: 60	Tutorial Classes:	Practical Classes:				Total Classes: 60		

UNIT-I	PRINCIPLES OF AEROSPACE DESIGN	Classes: 12

Historical Perspective on aerospace design, Traditional manual approaches to design and design iteration, Design teams, Advances in modeling techniques, Tradeoffs in aerospace system design, Design automation, evolution and innovation, Design search and optimization, Take-up of computational methods, Design oriented Analysis: Geometry modeling and design parameterization, Computational mesh generalization, Analysis and design of coupled systems

UNIT-II	ELEMENTS OF NUMERICAL OPTIMIZATION-I:	Classes: 12

Single variable optimizers- line search, Multi variable optimizers: Population versus single point methods, Gradient based methods, Noisy/Approximate function values, Non-gradient based algorithms, Termination and convergence aspects, Constrained optimization, Problem transformations, Lagrange multipliers, Feasible directions method, Penalty function methods, Combined Lagrangian and penalty function methods, Sequential quadratic programming, Chromosome repair

UNIT-III	ELEMENTS OF NUMERICAL OPTIMIZATION-II:	Classes: 12

Meta models and Response surface methods: Global versus local meta models, Meta modeling tools, Simple RSM examples, Combined approaches-Hybrid searches and meta heuristics, Multi-objective optimization, Multi-objective weight assignment techniques, Methods for combining goal functions, fuzzy logic and physical programming, Pareto set algorithms

SENSITIVITY ANALYSIS:

Finite-difference methods, Complex variable approach, Direct methods, Adjoint methods, Semi-analytical methods, Automatic differentiation

UNIT-IV	APPROXIMATION CONCEPTS:	Classes: 12

Local approximations, Multipoint approximations, Black-box modeling, Generalized linear models, Sparse approximations techniques, Gaussian process interpolation and regression, Data parallel modeling, Design of experiments, Surrogate modeling using variable fidelity models, Reduced basis methods

Design Space Exploration-Surrogate Models:

Managing surrogate models in optimization: Trust regions, Space mapping approach, Surrogate assisted optimization using global models, Managing surrogate models in evolutionary algorithms

UNIT-V	DESIGN IN THE PRESNCE OF UNCERTAINTY:	Classes: 12

Uncertainty modeling and representation, Uncertainty propagation, Taguchi methods, Welch-Sacks method, Design for six sigma, decision theoretic formulations, Reliability-based optimization, Robust design using information-gap theory, Evolutionary algorithms for robust design

MULTI-DISCIPLINARY OPTIMIZATION:

Multi-disciplinary analysis, Fully integrated optimization, System decomposition and optimization, Simultaneous analysis and design, Distributed analysis optimization formulation, Collaborative optimization, Concurrent subspace optimization, Co-evolutionary architectures

Text Books:

Computational Approaches for Aerospace Design-The Pursuit of Excellence, *Andy J. Keane, Prasanth B. Nair, John Wiley & Sons, 2005*, ISBN 10:0-470-85540-1