PREFACE OF THE COURSE FILE
DEPARTMENT OF MECHANICAL ENGINEERING
TEZPUR UNIVERSITY

Academic Year	:	**2019–2020**
Session	:	**Spring Semester 2020**
Department for which the Course is offered	:	**Mechanical Engineering**
Name of the Programme	:	**M.Tech. in Mechanical Engineering (Specialization: Machine Design)**
Students' Batch	:	**2019–2021**
Semester	:	**Second**
Title of the Course	:	**Evolutionary Algorithms for Optimum Design**
Course Code	:	**ME 540**
L-T-P Structure of the Course	:	**3-0-0**
Category of the Course	:	**Open Elective III**
Class Timetable of the Course	:	$\frac{\textbf{Mon}}{\textbf{3.30–4.30 pm}}$, $\frac{\textbf{Tue}}{\textbf{12.30–1.30 pm}}$, $\frac{\textbf{Thurs}}{\textbf{10.30–11.30 am}}$
Course Coordinator/Instructor	:	**Prof. Dilip Datta**
Other Table of the Course Instructor	:	**ME 530 ::** $\frac{\textbf{Mon}}{\textbf{11.30 am–12.30 pm}}$, $\frac{\textbf{Wed}}{\textbf{11.30 am–12.30 pm}}$, $\frac{\textbf{Thurs (Practical)}}{\textbf{2.30–4.30 pm}}$, $\frac{\textbf{Fri}}{\textbf{3.30–4.30 pm}}$

Instructor **HOD**

1 Objectives

(1) To introduce students with evolutionary algorithms (EAs) for solving such problems for which classical optimization methods are not adequate.

(2) To introduce EAs covering both single-objective and multi-objective optimization in both continuous and discrete regions, constraint handling, elite preservation, as well as performance metrics and statistical methods for evaluating performances of multi-objective optimizers.

2 Lesson Plan

SN	Unit	Indented Learning Outcomes (ILOs)	L-T/P	Completion Date		Remarks
				Proposed	Actual	
1	Introduction	1. Brief review of classical optimization methods (optimality conditions for unconstrained problems, Kuhn-Tucker conditions for constrained problems, gradient-based numerical methods, discrete optimization, and limitations of classical methods). 2. Definition and importance of nontraditional techniques (mainly evolutionary algorithms).	3+0			
2	Evolutionary Algorithms (EAs)	1. Solution representations for different types of variables (binary-coded, real-coded, integer-coded and permutation representations). 2. Population initialization and evolution (solution encoding and decoding, fitness evaluation, constraint handling, solution comparison, elite preservation, termination criteria). 3. Different EAs, and their similarities and dissimilarities.	7+4			
3	Genetic Algorithm (GA)	1. GA operators (selection, crossover and mutation operators). 2. Significance and influence of crossover and mutation probabilities.	4+1			
4	Differential Evolution (DE)	1. DE operators (mutation, crossover and selection operators). 2. Significance and influence of perturbance factor and crossover probability.	4+1			
5	Particle Swarm Optimization (PSO)	1. Personal-best of a particle, and local-best and global-best of the swarm. 2. Velocity and position of a particle. 3. Significance and influence of inertia constant, and cognitive and social behavioral factors.	4+1			
6.	Multi-objective optimization	1. Solving multi-objective problems as single-objective problems. 1. Concept of dominance and non-dominated sorting. 2. Diversity of solutions. 3. Pareto front and its visualization.	6+2			
7	Performance measurement of multi-objective optimizers	1. Concept of dominance relation among Pareto fronts. 2. Performance metrics and their properties. 3. Statistical methods for comparing performances of optimizers.	3+0			
		Total contact hours	**31+9**			

Instructor **HOD**

3 Course Outcomes (COs)

SN	Course Outcome (CO)	Units
1	Understand the need of evolutionary algorithms (EAs) over classical optimization methods	1
2	Learn the general working procedure of evolutionary algorithms	2
3	Learn some well-established EAs in detail	3, 4, 5
4	Learn how multi-objective EAs work	6
5	Evaluate performances of multi-objective EAs	7

4 Textbooks

1. Sivanandom, S.N. and Deepa, S.N. *Introduction to Genetic Algorithms.* Springer, 2010.
2. Price, K.V., Storn, R.M., and Lampinen, J.A. *Differential Evolution: A Practical Approach to Global Optimization.* Natural Computing Series, Springer, 2005.
3. Olsson, A.E. *Particle Swarm Optimization: Theory, Techniques and Applications.* Nova Science Pub, 2011.
4. Deb, K. *Multi-Objective Optimization using Evolutionary Algorithms.* John Wiley & Sons, 2001.

5 References

1. Coello Coello, C.A., Lamont G.B., and van Veldhuizen, D.A. *Evolutionary Algorithms for Solving Multi-Objective Problems.* Springer, 2007.
2. Tan, K.C., Khor, E.F., and Lee, T.H. *Multiobjective Evolutionary Algorithms and Applications.* Springer, 2005.
3. Chakraborty, U.K. *Advances in Differential Evolution.* Springer, 2008.
4. Clerc, M. *Particle Swarm Optimization.* John Wiley & Sons, 2010.
5. Mann, P.S. *Introductory Statistics.* John Wiley & Sons, 2004.

Instructor **HOD**