Joint entropy and conditional entropy, Relative entropy and mutual information, Chain rules for entropy, Conditional relative entropy and conditional mutual information, A measure of mutual information.

UNIT – II: Information Inequality and Coding Theory (15 hours)

Interpretation of Shannon's fundamental inequalities, Redundancy, Efficiency and channel capacity, Jensen's inequality and its characterizations, The log sum inequality and its applications. Introduction to error detecting and correcting codes, Maximum likelihood decoding, Hamming distance, Nearest neighbour/minimum distance decoding, Distance of a code, Main coding theory problems, Equivalence of codes, Sphere-packing bound, Perfect codes, Balanced block designs, Finite fields, The ISBN code.

UNIT – III: Linear Codes (15 hours)

Introduction to vector space over finite fields, Linear codes, Bases for linear codes, Encoding and decoding with a linear code, Dual code, Generator and parity check matrices, Nearest neighbour decoding for linear codes, Syndrome decoding. Binary Hamming codes, q-ary Hamming codes.

Essential Readings

1. Cover, Thomas M. and Thomas, Joy A. (2006). Elements of Information Theory (2nd ed.). Wiley India. Indian Reprint 2017.
2. Hill, Raymond. (1996). A First Course in Coding Theory. Oxford University Press.
3. Reza, Fazlollah M. (1961). An Introduction to Information Theory. Dover Publications Inc, New York. Reprint July 2022.

Suggestive Readings

- Bose, R. (2016). Information Theory, Coding and Cryptography (3rd ed.). McGraw-Hill.
- Hamming, R. W. (1980). Coding and Information Theory, Prentice Hall, Englewood.
- Ling, S. and Xing, C. (2004). Coding Theory: A First Course. Cambridge University Press.
- Pless, V. (1998). Introduction to the Theory of Error-Correcting Codes. John-Wiley.
- Sloane, N. J. A. and MacWilliams, F. J. (2007). Theory of Error Correcting Codes. North-Holland Mathematical Library 16, North-Holland.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 5(v): OPTIMIZATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Optimization	4	3	1	0	Class XII pass with Mathematics	Multivariate Calculus

Learning Objectives: The main objective of this course is to introduce:

- Nonlinear optimization problems.
- Convex and generalized convex functions and their properties.
- Optimality and duality in nonlinear optimization.
- Methods to solve unconstrained optimization problems, quadratic and fractional programming problems with linear constraints.

Learning Outcomes: This course will enable the students to:

- Learn about the optimal solutions of nonlinear optimization problems.
- Understand and apply Karush-Kuhn-Tucker (KKT) necessary and sufficient optimality conditions for nonlinear optimization problems.
- Demonstrate and apply Lagrangian duality results, and techniques to solve certain classes of nonlinear optimization problems.

SYLLABUS OF DSE-5(v)

UNIT – I: Nonlinear Optimization and Convex Functions (15 hours)

Problem statement of a nonlinear optimization problem, Example of production inventory, Location facilities, Stochastic resource allocation, Convex sets, Convex functions, Epigraph and hypograph of a function, Differentiable convex function, Twice differentiable convex function, Minima of convex function, Quasiconvex functions, Psuedoconvex functions.

UNIT – II: Optimality and Duality Theory in Nonlinear Optimization (15 hours)

Unconstrained problems: Necessary optimality conditions, Sufficient optimality conditions; Problems having inequality constraints: Fritz John optimality conditions, Karush-Kuhn-Tucker (KKT) necessary optimality conditions; Fritz John conditions, KKT necessary and sufficient optimality conditions for problems with inequality and equality constraints; Lagrangian dual problem, Weak duality theorem, Duality gap, Strong duality theorem.

UNIT – III: Numerical Methods to Solve Nonlinear Optimization Problems (15 hours)

Descent property, Order of convergence, Global convergence, Steepest descent method, Newton's method, Wolfe's method for quadratic programming problem; Linear fractional programming problem and simplex algorithm.

Essential Readings

1. Bazaraa, Mokhtar S., Sherali, Hanif D. & Shetty, C. M. (2006). Nonlinear Programming: Theory and Algorithms (3rd ed.). John Wiley & Sons. Wiley India (2017).
2. Chandra, Suresh, Jayadeva and Mehra, Aparna (2009). Numerical Optimization with Applications. Narosa Publishing House Pvt. Ltd. Delhi. Second Reprint 2016.

Suggestive Readings

- Durea, Marius and Strugariu, Radu. (2014). An Introduction to Nonlinear Optimization Theory. de Gruyter Open.
- Eiselt, H. A. and Sandblom, Carl-Louis. (2019). Nonlinear Optimization: Methods and Applications. Springer Nature Switzerland.
- Luenberger, David, G. and Ye, Yinyu. (2021). Linear and Nonlinear Programming (5th ed.). Springer Nature Switzerland.