B.Sc.(Hons)Mathematics,Semester-III,DSE-Courses

DISCIPLINESPECIFICELECTIVECOURSE-1(i):GRAPHTHEORY

CREDIT DISTRIBUTION,ELIGIBILITY ANDPRE-REQUISITESOFTHE COURSE

Course title &Code	Credits	Creditdistributionofthe course			Eligibility criteria	Pre-requisite ofthecourse (if any)
		Lecture	Tutorial	Practical/ Practice		
Graph Theory	4	3	1	0	Class XII pass with Mathematics	Nil

Learning Objectives

Theprimaryobjectiveofthiscourseisto introduce:

- Problem-solvingtechniquesusingvariousconceptsofgraphtheory.
- Variouspropertieslikeplanarityandchromaticityof graphs.
- Severalapplicationsoftheseconceptsinsolvingpracticalproblems.

Learning Outcomes

Thiscoursewillenablethestudents to:

- Learnmodellingofreal-worldproblemsbygraphs.
- Knowcharacteristicsofdifferent classesofgraphs.
- Learnrepresentationofgraphsintermsof matrices.
- Learnalgorithmstooptimizea solution.
- Understandsomepropertiesofgraphsandtheirapplicationsindifferentpractical situations.

SYLLABUSOFDSE-1(i)

Unit–1 **(12 hours)**

Graphs,PathsandCircuits

Definition, Examples and basic properties of graphs, Subgraphs, Pseudographs, Complete graphs, Bipartite graphs, Isomorphism of graphs, Paths and circuits, Connected graphs, Euleriancircuits,Hamiltoniancycles,Adjacencymatrix,Weightedgraph,Travellingsalesman problem, Shortest path, Dijkstra's algorithm.

Unit–2 **(15 hours)**

ApplicationsofPathsandCircuits,Trees

Applications of Path and Circuits: The Chinese Postman Problem, Digraphs, Bellman-Ford Algorithm, Tournaments, Scheduling Problem, Trees, Properties of Trees, Spanning Trees, Minimum Spanning Tree Algorithms.

Unit–3 **(18 hours)**

ConnectivityandGraphColoring,PlanarGraphs

Cut-vertices, Blocks and their Characterization, Connectivity and edge-connectivity, Planar graphs, Euler's formula, Kuratowski theorem, Graph coloring and applications, Matchings, Hall's theorem, Independent sets and covers.

Essential Readings

1. Goodaire, Edgar G., & Parmenter, Michael M. (2006). DiscreteMathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint.
2. Chartrand,Gary,&Zhang,Ping(2012).AFirstCourseinGraphTheory.Dover Publications.

SuggestiveReadings

- Bondy, J. A., and Murty, U.S.R. (2008). Graph Theory. Graduate Texts in Mathematics, Springer.
- Diestel,Reinhard(2017).GraphTheory(5thed.).GraduateTextsinMathematics,Springer.
- West, Douglas B. (2001).Introduction to Graph Theory(2nd ed.). Prentice Hall. Indian Reprint.

Note:Examinationschemeandmodeshallbeasprescribedbytheexamination Branch, University of Delhi, from time to time.

DISCIPLINESPECIFICELECTIVECOURSE–1(ii): MATHEMATICAL PYTHON

CREDIT DISTRIBUTION,ELIGIBILITY ANDPRE-REQUISITESOFTHE COURSE

Coursetitle & Code	Credits	Creditdistributionofthe course			Eligibility criteria	Pre-requisite ofthecourse (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematical Python	4	3	0	1	Class XII pass with Mathematics	Basic knowledge of Python

Learning Objectives

TheLearningObjectivesofthiscourseareasfollows:

- TobeabletomodelandsolvemathematicalproblemsusingPython Programs.
- To experience utility of open-source resources for numerical and symbolic mathematical software systems.

Learning Outcomes

ThiscoursewillenablethestudentstousePython:

- Fornumericalandsymboliccomputationinmathematicalproblemsfromcalculus,algebra, and geometry.
- Totabulateandplotdiversegraphsoffunctionsandunderstandtracingofshapes,geometries, and fractals.
- TopreparesmartdocumentswithLaTeX interface.

SYLLABUSOFDSE-1(ii)

Theory

Unit–1 **(15 hours)**

DrawingShapes,GraphingandVisualization

Drawing diverse shapes using code and Turtle; Using matplotlib and NumPy for data organization, Structuring and plotting lines, bars, markers, contours and fields, managing subplots and axes; Pyplot and subplots, Animations of decay, Bayes update, Random walk.

Unit–2 **(18 hours)**

NumericalandSymbolicSolutionsofMathematical Problems

NumPyforscalarsandlinearalgebraon*n*-dimensionalarrays;Computingeigenspace,Solving dynamical systems on coupled ordinary differential equations, Functional programming fundamentals using NumPy; Symbolic computation and SymPy: Differentiation and integration of functions, Limits, Solution of ordinary differential equations, Computation of eigenvalues, Solution of expressions at multiple points (lambdify), Simplification of expressions, Factorization, Collecting and canceling terms, Partial fraction decomposition, Trigonometric simplification, Exponential and logarithms, Series expansion and finite differences, Solvers, Recursive equations.

Unit–3 **(12 hours)**

DocumentGenerationwithPythonandLaTeX

Pretty printing using SymPy; Pandas API for IO tools: interfacing Python with text/csv, HTML,LaTeX,XML,MSExcel,OpenDocument,andothersuchformats;Pylatexandwriting document files from Python with auto-computed values, Plots and visualizations.

Practical(30hours): Softwarelabsusing IDEsuchasSpyderandPythonLibraries.

- Installation,update,andmaintenanceofcode, troubleshooting.
- Implementationofallmethodslearnedin theory.
- ExploreandexplainAPIlevelintegrationandworkingoftwoproblemswithstandard Python code.

Essential Readings

1. Farrell,Peter(2019).MathAdventureswithPython.NoStarchPress.ISBNNumber:978- 1-59327-867-0.
2. Farrell,Peterandetal.(2020).TheStatisticsandCalculuswithPythonWorkshop.Packet Publishing Ltd.ISBN: 978-1-80020-976-3.
3. Saha,Amit(2015).DoingMathwithPython.NoStarchPress.ISBN:978-1-59327-640-9

SuggestedReadings

- Morley,Sam(2022).ApplyingMathwithPython(2nded.).PacketPublishingLtd.ISBN: 978-1-80461-837-0
- Onlineresourcesanddocumentationonthelibraries,suchas:
  - https://matplotlib.org
  - https://sympy.org
  - https://pandas.pydata.org
  - https://numpy.org
  - https://pypi.org
  - https://patrickwalls.github.io/mathematicalpython/

Note:Examinationschemeandmodeshallbeasprescribedbytheexamination Branch, University of Delhi, from time to time.

DISCIPLINESPECIFICELECTIVECOURSE-1(iii):NUMBERTHEORY

CREDITDISTRIBUTION,ELIGIBILITYANDPRE-REQUISITESOFTHECOURSE

Course title &Code	Credits	Creditdistributionofthe course			Eligibility criteria	Pre-requisite ofthecourse (if any)
		Lecture	Tutorial	Practical/ Practice		
Number Theory	4	3	1	0	Class XII pass with Mathematics	Algebra

Learning Objectives

Theprimaryobjectiveofthiscourseisto introduce:

- Thenumbertheoretictechniquesofcomputationswiththeflavourof abstraction.
- TheEuclidean algorithm,linearDiophantineequations,congruence equations, arithmeticfunctionsandtheirapplications,Fermat'slittle,Euler'sandWilson's theorems.
- Primitiveroots,quadraticresiduesandnonresidues,theLegendresymbolandthelawof Quadratic Reciprocity.
- Introductiontocryptography,public-keycryptosystemsand applications.

Learning Outcomes

Thiscoursewillenablethestudents to:

- Usemodulararithmeticin solvinglinearandsystem oflinearcongruenceequations.
- Workwiththenumbertheoreticfunctions,theirpropertiesandtheiruse.
- Learntheformsofpositiveintegersthatpossessprimitiverootsandthe Quadratic Reciprocity Law which deals with the solvability of quadratic congruences.
- Understandthepublic-keycryptosystems,inparticular,RSA.

SYLLABUSOFDSE-1(iii)

Unit–1 **(12 hours)**

LinearDiophantineequationandTheoryof Congruences

The Euclidean Algorithm and linear Diophantine equation; Least non-negative residues and complete set of residues modulo *n*; Linear congruences, The Chinese remainder theorem and system of linear congruences in two variables; Fermat's little theorem, Wilson's theorem and its converse, Application to solve quadratic congruence equation modulo odd prime *p*.

Unit–2 **(21 hours)**

Number-TheoreticFunctionsandPrimitiveRoots

Number-theoretic functions for the sum and number of divisors, Multiplicative function, Möbius inversion formula and its properties; Greatest integer function with an application to the calendar; Euler's Phi-function, Euler's theorem and some properties of the Phi-function; Theorderofan integer modulo *n* and primitiveroots forprimes, Primitiveroots ofcomposite numbers *n*: when *n* is of the form 2^k, and when *n* is a product of two coprime numbers.

Unit–3 **(12 hours)**

QuadraticReciprocityLawandPublicKey Cryptosystems

The quadratic residue and nonresidue of an odd prime and Euler's criterion, The Legendre symbol and its properties, Quadratic Reciprocity law and its application; Introduction to cryptography, Hill's cipher, Public-key cryptography and RSA.

EssentialReading

1. Burton,DavidM.(2011).Elementary NumberTheory(7th ed.).McGraw-HillEducation Pvt. Ltd. Indian Reprint 2017.

SuggestiveReadings

- Andrews,GeorgeE.(1994).NumberTheory.Doverpublications,Inc.New York.
- Robbins, Neville (2007). Beginning Number Theory (2nd ed.). Narosa Publishing House Pvt. Ltd. Delhi.
- Rosen, Kenneth H. (2011). Elementary Number Theory and its Applications (6th ed.).Pearson Education. Indian Reprint 2015.

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