CENTURION UNIVERSITY OF TECHNOLOGY AND MANAGEMENT ODISHA

CHOICE BEASED CREDIT SYSTEM

COURSE STRUCTURE & SYLLABUS

M.Sc (Core Courses)

[*With effect from 2021-22 Academic Session]*

2021

Course Structure
(Core Courses)

Sl.No	Code	Subject Name	Cerdit	Course Type (Th+Pr+Pj)
1	CUTM1525	Heat and Mass Transfer	4	2+1+1
2	CUTM1526	Numerical Methods for CFD	4	2+1+1
3	CUTM1527	Fluid Dynamics	4	3+1+0
4	CUTM1528	Geometry and Grid Generation	4	0+2+2
5	CUTM1529	Applications of CFD using Computational Tool-Simulia	4	0+2+2
6	CUTM1530	Advanced differential equations	4	2+1+1
7	CUTM1531	Graph Theory	4	3+1+0
8	CUTM1532	Optimization techniques	4	3+1+0
9	CUTM1533	Advanced Statistical Methods	4	2+1+1
10	CUTM1534	Applied Number Theory	4	3+1+0
11	CUTM1535	Advanced complex analysis	4	3+0+1
12	CUTM1536	Topology	4	3+0+1
13	CUTM1537	Differential Geometry and Tensor Calculus	4	3+0+1
14	CUTM1538	Advanced Algebra	4	3+0+1
15	CUTM1018	Data Analysis and Visualisation using Python	4	0+1+3
16	CUTM1019	Machine Learning using Python	4	1+2+1
		Total	64	

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Course outline

CUTM1525 HEAT AND MASS TRANSFER

Subject Name	Code	Type of course	T-P-Pj (Credit)	Prerequisite
HEAT AND MASS TRANSFER	CUTM1525	Theory+Practice+Project	2-1-1	Nil

Objective

- To understand the basic concepts and mechanisms of heat and mass transfer under steady state and transient conditions.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.	PO1(3), PO2(2), PO9(3)
CO2	• Explain basic laws for radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.	PO1(3), PO9(3)
CO3	• Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.	PO5(3)
CO5	• Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.	PO5(3), PO9(2)

<u>Course outline</u>

CUTM1525 Heat and Mass Transfer (2-1-1)

Module I (T-3 Hrs.+P-2Hrs.)

Introduction to heat transfer: Heat Transfer Mechanisms

Conduction:

Fourier's Law of Conduction, General Heat Conduction Equation in Different Coordinate Systems (No Derivation), One Dimensional Steady State Conduction in Plane Wall, Conduction with Internal Heat Generation.

Practice 1: To find the thermal conductivity of a material by the two slabs guarded hot plate method.

Assignment 1: Assignment on Conduction.

Module II (T-2 Hrs.+P-2Hrs.)

Fins and Transient Conduction:

Overall Heat Transfer Coefficients, Unsteady State Heat Conduction, Lumped Heat Capacity System and Lumped Capacitance Method.

Practice 2: To find the thermal resistance of the sample.

Assignment 2: Assignment on Fins and Transient Conduction.

Module III (T-4 Hrs.+P-4Hrs.)

Convection:

Thermal Boundary Layer, Principles and Governing Equations, Forced Convection: External Flow over a Flat Plate, Internal Flow Through Pipe, Natural Convection: Vertical&Horizontal Surfaces.

Practice 3: To determine the overall heat transfer coefficient at the surface of a given vertical metal cylinder by the natural convection method.

Practice 4: To verify Newton's Law of Cooling of different materials and different liquids.

Assignment 3: Assignment on Convection.

Module IV (T-2 Hrs.+P-2Hrs.)

Heat Transfer with Phase Change:

Film Wise and Drop Wise Condensation, Boiling Heat Transfer, Regimes of Boiling.

Module V (T-2 Hrs.+P-2Hrs.)

Heat Exchangers:

Types of Heat Exchangers, Heat Exchanger Analysis, LMTD, Overall Heat Transfer Coefficient, Heat Exchanger Effectiveness, NTU.

Practice 5: Determination of Effectiveness and Efficiency of Parallel Flow and Counter Flow Heat Exchanger.

Assignment 4: Assignment on Heat Exchangers.

Module VI (T-4 Hrs.+P-2Hrs.)

Radiation:

Black Body Emission, Emissive Power, Laws of Radiation, Nature of Black Bodies, Radiation Shape Factor, Radiation Heat Transfer Between Two Surfaces.

Practice 6: To find the emissivity of different material surface.

Assignment 5: Assignment on Radiation.

Module VII (T-3 Hrs.+P-2Hrs.)

Mass Transfer:

Introduction, Analogy between heat and mass transfer, Mass diffusion, Fick's law of diffusion, boundary conditions, Steady mass diffusion through a wall, Mass convection.

Assignment 6: Assignment on Mass Transfer.

Text Books:

1. Mahesh M. Rathore, Engineering Heat Transfer , Jones & Bartlett Learning, 2011
2. Yunus A. Cengel & Afshin J. Ghajar, "Heat and Mass Transfer-Fundamentals and Applications", McGraw Hill, 5th Edition 2015
3. Yunus Cengel, Heat And Mass Transfer: Fundamentals And Applications, McGraw-Hill Higher Education, 2014

Reference Books:

1. R.C Sachdeva, Fundamentals of Heat and Mass Transfer
2. R.K. Rajput, Heat Transfer, Laxmi Publication

Course outline

CUTM1526 NUMERICAL METHODS FOR CFD

Subject Name	Code	Type of course	T-P-Pj (Credit)	Prerequisite
NUMERICAL METHODS FOR CFD	CUTM1526	Theory + Practice + Project	2-1-1	Nil

Objective

- To learn fundamentals of computational methods like FDM and FVM for solving linear and non-linear partial differential equations related to fluid dynamics and heat transfer.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Assess the principles of numerical analysis and concepts of consistency, stability, and convergence.	PO1(3), PO2(2)
CO2	• Evaluate finite difference/volume schemes on model problems of computational fluid dynamics.	PO1(3), PO5(3), PO9(3)
CO5	• Construct program-code using Python to obtain numerical solutions of partial differential equations, relevant to Computational Fluid Dynamics.	PO5(3)

Course Outline

CUTM1526 Numerical Methods for CFD (2-1-1)

MODULE I

Introduction to CFD: Basics of computational fluid dynamics, Definition and overview of CFD- need, advantages, problem areas, Governing equations of fluid dynamics – Continuity, Momentum and Energy equations, Non-Dimensional form of these governing equations, Classifications of PDE: Elliptic, Parabolic and Hyperbolic equations.

MODULE II

Finite Difference Method (FDM): Derivation of Finite difference equations (FDE) of 1^{st} and 2^{nd} order derivatives using Taylor series expansion. Explicit method-FTCS Method, Implicit method-BTCS Method, Crank-Nicholson method, Error, Convergence and stability analysis of above numerical Scheme, Keller Box Method.

MODULE III

Solution of Simultaneous Equations: Direct and Iterative methods; Gauss-elimination, Gauss-Jordan, Gauss-Jacobi and Gauss-Seidel methods, Tri Diagonal Matrix Algorithm (TDMA) (Thomas)

Practice 1: Gauss-elimination method using Python
Practice 2: Gauss-Seidel method using Python
Practice 3: Tri Diagonal Matrix Algorithm using Python

Project 1: Solution of Simultaneous Equations using Gauss-Jordan method.
Project 2: Solution of Simultaneous Equations using Gauss-Jacobi method.

MODULE IV

Application of FDM: Solutions of
Elliptic PDE:One-and Two-dimensional steady heat conduction, Laplace's Equation, Poisson's equation
Parabolic PDE: Unsteady heat conduction, Stoke's 1^{st}& 2^{nd} Problems.
Hyperbolic PDE: One-dimensional wave equation

Practice 4: Solution of One-dimensional steady heat conduction using Python.
Practice 5: Solution of Laplace's equation using Python.
Practice 6: Solution of Unsteady heat conduction using Python.
Practice 7: Solution of One-dimensional wave equation using Python.
Practice 8: Solution of Stoke's Problem.

Project 3: Solution of Poisson's equation.

Project 4: Solution of Burger's equation.

MODULE V

Finite Volume Method (FVM):
Fundamentals of FVM, Integral Form of 1-D Conservation equation, Finite Volume

Method in 2-D

MODULE VI

Application of FVM: Solutions of1-D steady state Diffusion and Convection equations.

Project 5: Solutions of1-D steady state Diffusion equation.

MODULE VII

Application of FVM: Solutions of 2-D steady state Diffusion and Convection equations.

Project 6: Solutions of2-D steady state Convection equation.

Text Books:

1. Computational Fluid dynamics by John D.Anderson,Jr
2. Computational Fluid dynamics and Heat Transfer , by John C. Tannehill , Dale A.Anderson , Richard H. Pletcher

3.Introduction to finite elements in engineering, by Tirupathi R. Chadraupala, Ashok D. Belegundu, Chapter .3

4.An introduction to computational fluiddynamics, by HKVersteeg and W Malalasekera, Chapter 4,5

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Course outline

CUTM1527FLUID DYNAMICS

Subject Name	Code	Type of course	T-P-Pj (Credit)	Prerequisite
FLUID DYNAMICS	CUTM1527	Theory	3-0-1	Nil

Objective

- To introduce the foundations of fluid dynamics, various formulations of governing equations and their mathematical properties in order to establish a firm basis for other modules.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Distinguish and analyse the governing equations of fluid dynamics in various formulations for compressible and incompressible viscous and inviscid flows.	PO1(3), PO2(2)
CO2	• Estimate the impact of different physical phenomena based on dimensional analysis.	PO2(2), PO4(2)
CO3	• Examine mathematical properties of governing equations and be able to critically evaluate correct boundary/initial value problems for various flows.	PO5(2), PO9(2)

Course Outline

CUTM1527 Fluid Dynamics (3-0-1)

MODULE – I (4hr+0hr+2hr)

Kinematics of Fluids, Methods describing Fluid motion, Lagrangian and Eulerian Methods, Translation, Rotation and Rate of Deformation, Streamlines, Path lines and Streak lines.

PROJECT 1: A Report on Steady vs Unsteady Flow, Compressible vs incompressible Flow, Laminar vs Turbulent Flow, Newtonian vs Non-Newtonian Flow, Invisid vs Viscous Flow, Rotational vs Irrotational Flow. (Definition, Comparative Study & Examples)

MODULE – II (5hr+0hr+0hr)

Fundamental equations of the flow of viscous compressible fluids: Equations of continuity**,** motion and energy in Cartesian coordinate systems, The equation of state, Fundamental equations of continuity, motion and energy in Cylindrical & Spherical coordinate systems.

MODULE – III (4hr+0hr+2hr)

2-D and 3-D inviscid incompressible flow: Basic equations and concepts of flow, Circulation theorems, Velocity potential, Rotational and Irrotational flows, Bernoulli's Equation.

PROJECT 2: A study on Stokes Circulation Theorem

MODULE – IV (4hr+0hr+8hr)

Laminar Flow of Viscous Incompressible Fluids: Flow between parallel flat plates:Couette flow, Steady Flow in pipes: Hagen-Poiseuille flow, Unsteady motion of a flat Plate.

PROJECT 3: A study on plane Poiseuille flow.

PROJECT 4: A report on steady flow of viscous incompressible fluid between two porous parallel plates.

PROJECT 5: A study on laminar flow between two coaxial circular cylinders (i.e. an annulas).

PROJECT 6: A report on unsteady flow of a viscous incompressible fluid over an oscillating plate.

MODULE – V (5hr+0hr+0hr)

The Laminar boundary layer Flow: Properties of Navier-Stokes equations, Boundary layer equations in 2-D flow, Similarity of Flows, Reynold's Number, The boundary layer along a flat plate, Boundary layer on a surface with pressure gradient.

MODULE – VI (4hr+0hr+0hr)

Momentum Integral theorems for the boundary layer, Von karman-Pohlhausen method, Separation of boundary layer flow, Boundary layer control.

MODULE – VII (4hr+0hr+0hr)

The origin of Turbulence, Reynold's modification of the Navier-Stokes equations for Turbulent flow, Reynold's stresses, Prandtl's mixing length theory.

BOOK PRESCRIBED

1. S. W. Yuan, "Foundations of Fluid Mechanics", Prentice – Hall of India
   Chapters: 3 (3.1 to 3.4), 5 (5.1 to 5.6), 7 (7.1 to 7.5), 8(8.1, 8.3, 8.4, 8.8),9 (9.1 to 9.6, 9.8, 9.9), 10(10.1 to 10.3(a))

BOOK REFERENCE

1. J. L. Bansal , "Viscus Fluid Dynamics", IBH Publication, Joypur.
2. M. D. Raisinghania, "Fluid Dynamics with Complete Hydrodynamics", S. Chand & Company Ltd, New Delhi.

Link: https://nptel.ac.in/courses/112/105/112105171/

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Course outline

CUTM1528 GEOMETRY AND GRID GENERATION

Subject Name	Code	Type of course	T-P-P(Credit)	Prerequisite
GEOMETRY AND GRID GENERATION	**CUTM1528**	**Practice + Project**	**0-2-2**	**Nil**

Objective

- To introduce the concepts of grid generation required for Computational Fluid Dynamics applications providing hands-on experience using Simulia.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO2	• Evaluate the requirements of grid generation for Computational Fluid Dynamics applications.	PO1(3), PO2(2)
CO3	• Understand the construction techniques of structured and unstructured grids using Simulia.	PO5(2), PO9(2)
CO5	• Assess the control and efficiency of grid generation procedures.	PO5(2), PO9(2)

Course Outline

CUTM1528 Geometry and Grid Generation (0-2-2)

Detailed Structure of Practice:

1. Introduction to 2D & 3D Geometrical shapes used for CFD
   1.1 Geometrical shapes for Internal Flows
      1.1.1 2D Geometry shapes (Circle/Square/Rectangle/Triangle)
      1.1.2 3D Geometry shapes (Hollow Cylinder/Duct)
   1.2 Geometrical shapes for External Flows
      1.2.1 2D Geometry shapes (Circle/Square/Rectangle/Triangle/Aerofoil)
      1.2.2 3D Geometry shapes (Wedge/Sphere/Solid Cylinder/Cone)
   1.3 Importing Geometry, Geometry Clean up, Finding & Fixing Errors in Geometry

2. Grid Generation in CFD
   2.1 Structured Grid/Mesh Generation (2D-Quadrilateral/3D-Hexahedral)
      2.1.1 Mapped Meshing
      2.1.2 Sweeping Meshing
   2.2 Un-structured Grid/Mesh Generation(2D-Triangular/3D-Tetrahedral)
      2.2.1 Octree Meshing
      2.2.2 Delaunay Meshing
3. Creation of Density box, Prism mesh Generation, Mesh Quality checks, Mesh export

Practice:2Hrs.
Project:2Hrs. expect 8 and 9
Projects 8 & 9: 4 Hrs.

Practice 1. Generation of 2D mapped meshing for Rectangle.

Project 1. Grid generation for pipe at Re=500.

Practice 2. Generation of 2D mapped meshing for Aerofoil.

Project 2.3D coarse/ medium/ fine unstructured Octree Tetrahedron mesh for Aerofoil.

Practice 3. Generation of 2D Mapped meshing for Converging and Diverging Nozzle.

Project 3. Grid generation for compressible flow nozzle.

Practice 4. Generation of 3D mapped meshing for Cylinder.

Project 4. Grid generation for circular cylinder at $Re=10^7$.

Practice 5. Generation of 3D mapped meshing for Cuboid.

Project 5. Grid generation for rectangular Duct.

Practice 6. Generation of 3D Sweep mesh for U-Bend Pipe.

Project 6. Grid generation for cross flow heat exchanger.

Practice 7. Generation of 3D Mesh for Ahmed Body.

Practice 8. Generation of 3D mesh for 3D Cone.

Practice 9. Generation of 3D coarse/ medium/ fine sweep mesh for Pipe.

Practice 10. Generation of grid for Turbine Blade.

Practice 11. Generation of 3D mesh for Dimple Ball.

Practice 12. Generation of 2D Mapped meshing for a Wedge.

Project 7. Grid generation for flat plate at Re=1000000.

Project 8. Generation of grid for Narrowing pipe(4Hrs.)

Project 9. Grid generation for turbulent flow turbine blade(4Hrs.)

Project 10. Grid generation for cylinder with rectangular domain varying height and radius.

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Course outline

CUTM1529 APPLICATIONS OF CFD USING COMPUTATIONAL TOOL-SIMULIA

Subject Name	Code	Type of course	T-P-P(Credit)	Prerequisite
APPLICATIONS OF CFD USING COMPUTATIONAL TOOL-SIMULIA	**CUTM1529**	**Practice + Project**	**0-2-2**	**Nil**

Objective

- To produce a CFD simulation in order to generate an exact picture of a particular flow problem in various engineering fields.
- To apply for resolving different fluid flow related problems like flow velocity, density, temperature, and chemical concentrations for any area where flow is present.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO3	• To apply CFD simulation in various industries in order to achieve flawless product designs using computational tools.	PO5(2), PO9(2)
CO5	• To apply CFD simulation in various industries in order to achieve flawless product designs using computational tools.	PO5(2), PO9(2)

Course Outline

CUTM1529 Applications of CFD using Computational Tool-Simulia (0-2-2)

Practice: 2Hrs.
Project:4Hrs.

Practice 1. Getting Started with the 3DExperience Platform.

Practice 2.CFD analysis of steady state internal Laminar Pipe flow.

Project 1. Analysis of pipe flow at Re= 500.

Practice3.CFD analysis Steady-state external flow over an Airfoil.

Project 2. Estimation of Drag and lift coefficients in flat plate at Re=10,000.

Practice4. Grid Independence study for above cases (pipe / airfoil) using different solver schemes.

Project 3. Flow analysis over a circular cylinder at $Re=10^7$.

Practice5. Conjugate Heat Transfer (CHT) Analysis of an Electronics Module.

Project4. Temperature analysis through cross flow heat exchanger.

Practice 6. Aerodynamics analysis of DS Car.

Practice 7. Unsteady Flow across a Circular Cylinder.

Practice 8. Transonic Flow over an Airfoil.

Project 5. Varying radius and height of sphere inside the rectangular domain.

Practice9. Turbulent analysis for Ahmed body.

Practice10. Cavitating Flow through a Narrowing Pipe.

Project 6. Analysis of compressible flow of nozzle at nozzle exit.

Practice11. Flow Analysis in the Turbine Blade.

Practice12. Post processing results for above studies.

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Course outline

CUTM1530 ADVANCED DIFFERENTIAL EQUATIONS

Subject Name	Code	Type of course	T-P-Pj	Prerequisite
ADVANCED DIFFERENTIAL EQUATIONS	**CUTM1530**	**Theory+Practice+ Project**	**2-1-1**	

Objective

- Working with systems of ordinary differential equations and non-linear ordinary differential equations is also stressed.
- Developing and understanding and appreciation of the qualitative behaviour of the solution
- To introduce wave equations, Laplace equations, Heat equations, Diffusion equations.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Solve wave equation and understand significance of transverse waves.	PO1(3), PO2(2)
CO2	• Identify classes of non-linear ordinary differential equations.	PO2(2), PO4(2)
CO3	• Apply an appropriate method for the solution of non-linear ordinary differential equations.	PO9(3)
CO5	• Competence in solving applied problems which are linear and nonlinear form, Solve Laplace equation, Diffusion equation, heat equation.	PO2(2), PO1(3)

Course outline

Module I:
Introduction to Ordinary Differential Equations and Partial Differential Equations, First Order Non- linear Ordinary differential equations such as Equations solvable for x, Equations solvable for y, Equations solvable for p.

Practice- 1: Solve Ordinary Differential Equations in Python

Practice-2: Solve Partial differential Equations by python

Module II

Partial differential equation of second order with variable coefficients- Monge's method and its properties.

Project 1: Monge's Method of Solution of Non-linear Partial Differential Equations of Order Two

Module III

Classification of linear partial differential equation of second order, Cauchy's problem, Method of separation of variables.

Module IV

Solution of one- dimensional Laplace equation by method of separation of variables and Fourier series

Project 2 : Solution of Laplace's Equation for a Disk

Module V
Solution of one- dimensional Wave equation by method of separation of variables and Fourier series

Project 3: D' Alembert's solution of the wave equation

Practice 3: Solution of wave equation associated condition

$u(x,0)=\varphi(x), u_t (x,0)=\psi(x), u(0,t)=0, x\epsilon(0,\infty), t>0$

Practice 4: Solution of wave equation associated condition

$u(x,0)=\varphi(x), u(0,t)=a, x\epsilon(0,\infty), t\geq 0$

Module VI
Solution of one- dimensional Diffusion equation by method of separation of variables and Fourier series

Project 4: Solution of Diffusion equation in n-dimensional

Practice 5: Solution of one-dimensional diffusion equation by using boundary conditions
$u(x,0)=\varphi(x), u(0,t)=a, x\epsilon(0,\infty), t\geq 0$

Practice 6: Solution of one-dimensional diffusion equation

$u(x,0)=\varphi(x), u(0,t)=a, u(1,t)=b, 0<x0$

Module VII

Solution of one- dimensional Heat equation by method of separation of variables and Fourier series

Project 5: Two dimensional Heat equations- Polar form

Project 6: Temperature distribution in Rectangular plate

Text Books

1. Differential Equations and Their Applications, by Martin Braun, Springer, 4e, ISBN 9781111827052 (1993).
2. S. L. Ross: Differential Equations, Blaisdell Publishing Company, Londan, 1964.

Reference books:

1. S.J. Farlow: An Introduction to Ordinary Differential Equations, PHI
2. M.D. Raisinghania: Ordinary and Partial Differential Equations, S. Chand & Co.
3. V. Sundarapandian: Ordinary and Partial Differential Equations, McGraw-Hill

Developed by:(Faculty name), Saubhagyalaxmi Singh

Developed on (Month and Year): JUNE 2020

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Course outline

CUTM-1531 GRAPH THEORY

Subject Name	Code	Type of course	T-P-Pj (Credit)	Prerequisite
GRAPH THEORY	CUTM-1531	Theory & Practice	3-1-0	Nil

Objective:

- To introduce the students to graphs, their properties and their applications as models of networks.
- To represent almost any physical situation involving discrete objects and a relationship among them.
- To introduce the students to generating functions and their applications.

Course outcome:

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Know the basic definitions and concepts of graph theory and Write in a coherent and technically accurate manner.	PO1(3), PO2(2)
CO2	• Learn about how to develop graph theoretical algorithm and Know about many different coloring problems for graphs.	PO2(2), PO9(2)

Course Outline

Module-I

Introduction to Graphs and Definition of graphs;Basic terminologies and types of graphs;Degree of a vertex,Isolated and Pendent vertices;Sub graphs and graph Isomorphism.

Practice 1: Determine if two graphs are isomorphic and identify the isomorphism

Module-II

Directed Graphs and Types of Digraphs;Out-degree, In-degree, Connectivity and Orientation;Digraphs and Binary relations , Directed paths and contentedness;Euler Digraphs, De-Brujin sequences;Tournaments.

Practice 2: Ways to Represent Graphs using Python

Module-III

Basic concepts of Planar Graphs; Kuratowski's Two graphs ;Representation of Planar Graphs; Detection of planarity ;Euler's formula for planar graphs;

Practice 3: A look in to Planar Graphs and Euler's Relationship

Module-IV

Distance, cut-vertices, cut-edges, blocks;weighted graphs, connectivity;Dijkstra's shortest path algorithm;Floyd-War shall Shortest path algorithm;

Module-V

Proper Coloring of graphs;Chromatic numbers of a graph;Chromatic polynomial;Chromatic Partitioning;Four Colour theorem.

Practice 4: Finding **C**hromatic number using python-networks.

Module-VI

Definition and properties of trees;Rooted and Binary trees; Counting trees, Spanning trees;

Practice 5: Applications of graphs with Euler and Hamiltonian path and circuits(Chinese postman Problem)

Module-VII

Minimum spanning trees;Fundamental Circuit;Cut set and Separability;

Practice 6: Application of Minimum spanning tree in a Net work model

Text Book:

1. Deo, N., "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall India 2004

Chapters: 1(1.1,1.2,1.3,1.4,1.5) ,2 (2.1,2.2,2.4,2.4,2.6,2.9), 3 (3.1,3.2,3.5,3.7,3.8,3.9,3.10), 4 (4.1,4.4,4.5), 5(5.2,5.3,5.4,5.5), 7(7.1,7.2), 8 (8.1,8.2,8.3,8.6), 9 (9.1,9.2,9.3,9.4, 9.5)

Reference Books:

1. West, D. B., "Introduction to Graph Theory ", Prentice Hall India (2nd Edition 2009)

2. Aldous, J. M., Wilson, R. J. and Best S., “Graphs and Applications: An Introductory Approach”, Springer2003.
3. Deistel, R., “Graph Theory”, Springer (4th Edition) 2010.
4. Chartrand, G. and Zhang, P., "Introduction to Graph Theory", Tata McGraw Hill2007.
5. Bondy, J. A. and Murty, U. S. R., “Graph Theory”, Springer 2011

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Course Outline

CUTM1532 OPTIMIZATION TECHNIQUES

Subject Name	Code	Type of Course	T-P-Pj (Credit)	Prerequisite
OPTIMIZATION TECHNIQUES	CUTM1532	T + P	3-1-0	Nil

Course Objective

- To introduce a brief understanding about Non Linear Programming Problems.
- To cater the characteristics of Non Linear Programming Problems and its Applications.
- To demonstration of the utilization of Non Linear Programming Problems in industry and business.
- To apply the evolutionary optimization techniques in machine learning prediction model
- To solve the case study related to strategic management

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Formulate the necessary and sufficient optimality conditions for Non linear programming and demonstrate the geometrical interpretation of these conditions.	PO1(3), PO9(3)
CO3	• Use Evolutionary optimization techniques to optimize the forecasting models in machine learning.	PO4(3), PO2(2),
CO5	• Use the optimization techniques learned in this course to formulate new applications as optimal decision problems and seek appropriate solutions algorithms.	PO5(2), PO9(2)

Course Outline

CUTM1532 Optimization Techniques (3-1-0)

Module-I (5 Hours)

Non Linear Constrained Optimization Problem: Constrained optimization using Lagrange Method, Lagrange Multiplier Equality Constraints, Constrained optimization using Kuhn Tucker Method, Kuhn Tucker inequality Constraints.

Practice-1: **(2 Hours)**

Solving minimization constrained optimization problem using python

Practice-2: **(2 Hours)**

Solving maximization constrained optimization problem using python

Module-II (5 Hours)

Direct Search Method for Unconstrained Optimization Problem: Univariate Search Method, Golden Section Search Method and Application of Golden Section Search Method.

Practice-3: **(2 Hours)**

Solving nonlinear system of equations using Python

Module-III (4 Hours)

Gradient Method for Unconstrained Optimization Problem: Gradient Descent Method, Algorithm for Gradient Descent Method, Steepest Descent Gradient Method.

Practice-4: **(2 Hours)**

Implementing Gradient Descent algorithm in Python

Practice-5: **(2 Hours)**

Linear Regression using Gradient Descent in Python

Module-IV (4 Hours)

Sequencing Models: Problems with n' Jobs through Two Machines, Problems with 'n' Jobs through Three Machines, Problems with Two Jobs through 'm' Machines.

Module-V (4 Hours)

Particle Swarm Optimization: Particle Swarm Optimization Theory, Particle Swarm Optimization Algorithm, Application of Particle Swarm Optimization,

Practice-6 & 7: **(2+2 Hours)**

Implementing the Particle Swarm Optimization (PSO) Algorithm in Python

Module-VI (4 Hours)

Game with Pure Strategy: Game and Strategy, Maximin-Minimax principle, Two person zero-sum game with Saddle Point, Solving matching coin problem using game theory.

Module-VII (4 Hours)

Game with Mixed Strategy: Mixed Strategy Game, Game without Saddle Point, Graphical Method to Solve Mixed Strategy Game, Dominance Principle to Solve Mixed Strategy Game.

Text Books:

Kanti Swarup, P.K. Gupta and Man Mohan-Operations Research, S. Chand and Co. Pvt.Ltd.

Engineering Optimization Theory and Practice by Singiresu S. Rao, JOHN WILEY & SONS, INC., Fourth Edition

Reference Book:

Mathematical Programming by N. S. Kambo, East West Press.

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Course Outline

CUTM1533 ADVANCED STATISTICAL METHODS

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1533	**ADVANCED STATISTICAL METHODS**	**2-1-1**	**NIL**

Objective

- Ability to summarize and present data numerically and visually.
- Knowledge of which statistical methods to use in which situations
- Ability to think critically about data-based claims and quantitative arguments.
- Ability to learn new statistical analysis techniques on your own.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Apply statistical methods and hypothesis testing to business problems	PO1(3), PO9(2)
CO2	• Learn the details and complexities of Analysis of Variance (ANOVA)	PO4(3), PO2(2),
CO4	• Understand Chi Squared Tests and Understand different type of data.	PO3(2)
CO5	• Learn some of the details and complexities of multiple regression (MR).	PO5(2), PO9(2)

Course Content

Module I: (2 hrs+0 hrs+2hr)

Statistics: Population, Sample, Sampling, Estimators and Estimates, Maximum Likelihood , Confidence Intervals

Project-1

Application of Confidence intervals as a tool in decision making

Module II: (3 hrs+0hr+2hr)

Hypothesis Testing: Null and the alternative hypothesis, Rejection region and significance level, Chi-Square Test

Project-2

Hypothesis Testing in Quality Management

Module III: (4 hrs+4 hrs+0hr)

Regression: Multiple Regression and Logistic Regression

Practice-1

Multiple Regression Analysis in Python

Practice-2

Logistic Regression using Python

Module IV: (3 hrs+4 hrs+2hr)

Analysis of Variance (ANOVA): F- Distribution, One way ANOVA, Two Way ANOVA

Practice-3

One way ANOVA using Python

Practice-4

Two way ANOVA using Python

Project-3

The utility of multivariate statistical techniques in hydro geochemical studies

Module V: (3 hrs+2 hrs+2hr)

Covariance: (ANCOVA): Analysis of Covariance (ANCOVA), Bivariate Pearson Correlation, Alternative Correlation Coefficients

Practice-5

Python Analysis of covariance (ANCOVA)

Project-4

Application of Analysis of covariance (ANCOVA) in psychological research

Module VI: (3 hrs+0hr+2hr)

Multivariate analysis of variance (MANOVA): One-way MANOVA, Two-way MANOVA

Project-5

Comparison of MANOVA to ANOVA Using an Example

Module VII: (3 hrs+2 hrs+2hr)

Time Series Analysis: Introducing Time Series Analysis, Components of Time Series Analysis, Multivariate Time Series Analysis

Practice-6

Time Series Analysis using Python

Project-6

A Report on Applications of Time Series Analysis in Census Analysis

Text Books:

1. Statistical Methods By S.P. Gupta (31st Edition) ; Publisher: Sultan Chand & Sons
2. Mathematical Statistics by S.C. Gupta & V.K. Kapur (10th Edition); Publisher: Sultan Chand & Sons.

Reference Books:

Understanding And Using Advanced Statistics by Jeremy Foster Emma Barkus Christian Yavorsky, SAGE Publications

Course outline Prepared by: Dr.Banitamani Mallik **Date**: 18-06-2020

Centurion University

Course outline

CUTM1534 APPLIED NUMBER THEORY

Subject Name	Code	Type of course	T-P-Pj (Credit)	Prerequisite
APPLIED NUMBER THEORY	CUTM1534	Theory	3-1-0	Nil

Objective

- To analyze, evaluate, or solve problems with in given a set of circumstances or data.
- To understand and utilize mathematical functions and empirical principles and processes.
- Enhance and reinforce the student's understanding of concepts through the use of technology when appropriate

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Demonstrate knowledge and understanding of topics including applications.	PO1(3), PO2(2)
CO3	• Learn methods and techniques used in number theory.	PO2(2)
CO5	• Use mathematical induction and other types of proof writing techniques and programming to compute number theoretic problems.	PO4(2), PO9(2)

Course Outline

CUTM 1534 APPLIED NUMBER THEORY (3-1-0)

MODULE – I (4hr+2hr+0hr)

Divisibility, Representations of Integers,Computer Operations with Integers,Prime Numbers

Practice-1: Write a program to decide whether an integer is prime using trial division of the integer by all primes not exceeding its square root.

MODULE – II (6hr+4hr+0hr)

Greatest common divisor,EuclideanAlgorithm,Modified Euclidean Algorithm, Prime factorization,Factorization of Integers

Practice-2: Write a program to find the greatest common divisor of two integers using the Euclidean algorithm.

Practice-3:Find the prime factorization of a positive integer.

MODULE – III (5hr+2hr+0hr)

Congruence’s, Properties of Congruence’s,System linear Congruence’s

Chinese Remainder Theorem.

Practice -4: Write a program to solves systems of linear congruence

MODULE – IV (5hr+0hr+0hr)

Wilson's Theorem,Fermat's Little Theorem,Pseudo prime, Carmichael number

MODULE – V (4hr+2hr+0hr)

Euler's Theorem, Euler Phi-function, Perfect Numbers, Mersenne Primes

Practice -5: Write programs to find values of the Euler phi-function

MODULE – VI (3hr+2hr+0hr)

Character Ciphers, Block Ciphers, Exponentiation ciphers, Public-Key Cryptography (RSA Cryptosystem).

Practice-6: Write a program for RSA crypto system/Algorithm

MODULE – VII (3hr+0hr+0hr)

Knapsack ciphers, Some applications to computer science.

BOOK PRESCRIBED

1. Elementary Number Theory and lts Applications by Kenneth H. Rosen, ADDISON-WESLEY PUBLISHING COMPANY ISBN 0-201-06561c chapter- 1(1.2-1.5),

2(2.1-2.4), 3,5,6(6.1-6.3),7

BOOKS FOR REFERENCE

1. Elementary Number Theory by David M. Burton, fifth edition, McGraw-Hill Publication, ISBN- 0-07-232569-0
2. A Course in Number Theoretic Cryptography by Neal Koblitz, Springer Verlag, GTM

Centurion UNIVERSITY

Course outline

CUTM1535 ADVANCED COMPLEX ANALYSIS

Subject Name	Code	Type of course	T-P-Pj (Credit)	Prerequisite
ADVANCED COMPLEX ANALYSIS	CUTM1535	Theory	3-0-1	Nil

Objective

- To understand the applications of Residue for evaluation of definite and improper integrals occurring in Real analysis and Applied mathematics.
- To know about special functions like Riemann zeta function which plays a pivotal role in analytic number theory and has applications in physics, probability theory, and applied statistics.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Get a deep understanding of the fundamental concepts of Residues, Laurent series, Harmonic and Periodic functions.	PO1(3), PO2(2), PO9(3)
CO2	• Evaluatedefinite and improper real integrals applying the Cauchy's Residue Theorem.	PO1(3),

Course Outline

CUTM1535 Advanced Complex Analysis (3-0-1)

MODULE – I (3hr+0hr+0hr)

Index of a point with respect to a closed curve, Simply connected region, General statement of Cauchy's theorem.

MODULE – II (4hr+0hr+2hr)

Residue, process for finding out the residues, Residue theorem,the Argument Principle.

PROJECT 1: Study on Residues and their applications.

MODULE – III (5hr+0hr+2hr)

Definite Integrals: Evaluation of definite integrals (Types -1, 2, 3, 4, 5).

PROJECT 2: Evaluation of different types of real definite integrals using Residue theorem.

MODULE – IV (4hr+0hr+2hr)

Harmonic functions, conjugate differential, The Mean-Value Property, Poisson's formula.

PROJECT 3: A study on Harmonic functions.

MODULE – V (6hr+0hr+2hr)

Taylor Series, Taylor's theorem, Laurent series, Laurent's theorem, infinite products, theorems on infinite products.

PROJECT 4: A study on Laurent series expansion of different types of meromerphic functions.

MODULE – VI (3hr+0hr+2hr)

Entire functions: Jensen's formula, Riemann Zeta function, theorem on Riemann Zeta function.

PROJECT 5: A study on Riemann Zeta function and it's properties.

MODULE – VII (6hr+0hr+2hr)

Simply periodic function, Module, Discrete module, Unimodular transformation, Canonical basis, theorem on Canonical basis.

PROJECT 6: A study on discrete modules.

BOOK PRESCRIBED

1 L. V. Ahlfors, “Complex Analysis”, McGraw-Hill, Inc.

Chapters: 4 (2.1, 4.2 to 4.5, 5.1 to 5.3, 6.1 to 6.3), 5 (1.2, 1.3, 2.2, 3.1, 4.1), 7 (1.1, 2.1, 2.2,2.3)

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Course outline

CUTM1536 TOPOLOGY

Subject Name	Code	Type of course	T-P-P	Prerequisite
TOPOLOGY	**CUTM1536**	**Theory & Project**	**3-0-1**	**NIL**

Objective

• To introduce the student to elementary properties of topological spaces and structures defined on them • To introduce the student to maps between topological spaces • To develop the student's ability to handle abstract ideas of Mathematics and Mathematical proofs

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Understanding elementary properties of topological spaces and structures defined on them	PO1(3), PO9(2)
CO2	• Construct maps between topological spaces • ability to handle abstract ideas of Mathematics and Mathematical proofs	PO4(3), PO2(2),
CO4	• Demonstrate an understanding of the concepts of metric spaces and topological spaces, and their role in mathematics. • Demonstrate familiarity with a range of examples of these structures.	PO3(2)
CO5	• Prove basic results about completeness, compactness, connectedness and convergence within these structures.	PO5(2), PO9(2)

Course outline

Module I

Introduction of topological space, Open sets and limit points, Closed sets and closure, Bases and relative topologies

Project 1: Applications of Topology to the Analysis of 1-Dimensional Objects

Project 2: Topologies sequentially equivalent to Kuratowski Painlev´e convergence

Module II

Connected sets and components,compact and Countable compact spaces **,** continuous functions, Homeomorphisoms

Project 3: Sober topological space

Module III

To-and T_1-spaces and sequence, Separation axioms

Module IV

Axioms of count ability, Regular and normal spaces, Completely regular spaces

Project 4: Upper Topology

Module V

Urysohn's metrization theorem **,** Urysohn's Lemma, Metrization**,** Tietze extension theorem

Project 5: Scott topology

Project 6: Scott continuity

Module VI

Finite products, product invariant properties, product topology

Module VII

Metric topology, Metric products, Dense set

Text Books

1. W.J. Pervin, Foundations of General Topology, Academic Press. Chapters: 3 (3.1, 3.2 and 3.4), 4(4.1 to 4.4), 5 (5.1 to 5.3, 5.5 and 5.6), 8 (8.1 to 8.4), 10 (10.1only).
2. J. R. Munkres; Topology – A First Course, Prentice Hall of India, 1996.

Reference Book

1. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983.
2. http://mat.uab.cat/ret/sites/default/files/material/otras_contribuciones/ProceedingsWI

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Developed by:(Faculty name), Saubhagyalaxmi Singh

Developed on (Month and Year): JUNE 2020

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Course outline

CUTM 1537 DIFFERENTIAL GEOMETRY

Subject Name	Code	Type of course	T-P-Pj	Prerequisite
DIFFERENTIAL GEOMETRY AND TENSORS CALCULUS	**CUTM 1537**	**Theory & Project**	**3-0-1**	**NIL**

Objective

- This course unit aims to introduce the basic ideas and techniques of Differential Geometry for use in many other courses.
- To study about different geometrical skills for figure and their representation in mathematical equations
- To study about notations and operations of Tensor.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Write equation of normal , binormal and tangent to a curve.	PO1(3), PO2(2), PO9(3)
CO2	• Able to understand tonsorial expressions.	PO1(3),

Course outline

Module-I

Introduction to Differential Geometry,Osculating plane and Rectifying Plane
Project 1:.finding the direction of tangent , normal and binormal at any point of curve

Module-II

Curvatures of a curve at a point,Torsion of a curve at a point, Expression of Curvature and Torsion in terms of arc length parameter, Expression of Curvature and Torsion in terms of arbitrary parameter

Project 2: Compute the Curvature of an ellipse.

Module-III

Spherical Indicatrix, Evolutes , Involutes
Project 3: Determine the evolutes of the given curve.

Module-IV

Betrand Curve,Osculating Spheres , Osculating circles.
Project-4 : Show that the tangent to the locus of osculating sphere passes through the centre of the Oscilating Circle.

Module-V

Surface: Tangent planes and Normals,The two fundamental forms
Project 5: Find the normal to a given surface

Module-VI

Tensor : Definitions and explanations,Vector Space,Free systems, Basis and Dimension, Suffix Conventions,Transformation law for change of Basis Vectors and Components ,Dual Spaces

Module-VII

Transformation law for change of Basis in dual Space, Isomorphism, Tensor Product of Vector Spaces, Real Valued Bilinear Functions, Special Tensors
Project-6: Show that the velocity of a fluid at any point is component of a contravariant vector

BOOK PRESCRIBED

1. A text book of vector calculus-Shanti Narayana and J.N.Kapoor
   Chapters: II and III

2. An Introduction to Differential Geometry by T.G. Willmore-Oxford University Press (1983) Chapters: V

BOOK FOR REFERENCE

1. Differential Geometry-P.P.Gupta,G.S.Malik, S.K.Pundir
2. Tensor Analysis- Edward Nelson(Princeton University Press & University of Tokyo Press),1967
3. Introduction to Tensor Analysis and the Calculus of Moving Surfaces-Pavel Grinfeld, Springer

Developed by:(Faculty name) : Dr T.N.Samantara

Developed on (Month and Year): May 2020:

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Course outline

CUTM1538 ADVANCED ALGEBRA

Subject Name	Code	Type of course	T-P-P(Credit)	Prerequisite
ADVANCED ALGEBRA	**CUTM1538**	**Theory**	**3-0-1**	**Nil**

Objective

- A major objective is to introduce students to the language and precision of modern algebra. This means that the course will be proof-based, in the sense that students will be expected to understand, construct, and write proofs.
- A challenge for all students of mathematics is to balance the understanding with the communication. There is a tendency to think you are finished once you see why a mathematical statement is true or false.
- In fact you are just half-way there because constructing a legitimate proof involves different skills and expertise than the discovery part of the process. In this course both angles of problem-solving will be stressed.

Course outcome

COs	Course outcomes	Mapping Cos with POs (High-3, Medium-2, Low-1)
CO1	• Effectively write abstract mathematical proofs in a clear and logical manner.	PO1(3), PO2(2)
CO2	• Locate and use theorems to solve problems in number theory and theory of polynomials over a field.	PO2(2), PO4(2)
CO3	• Demonstrate ability to think critically by interpreting theorems and relating results to problems in other mathematical disciplines. • Demonstrate ability to think critically by recognizing patterns and principles of algebra and relating them to the number system.	PO9(3)
CO5	• Work effectively with others to discuss homework problems put on the board.	PO2(2), PO1(3)

Course Outline

CUTM1538 Advanced Algebra (3-0-1)

MODULE – I (6hr+0hr+2hr)

Group Theory:

Another Counting Principle, Sylow's Theorems.

Project 1 : A Notes on the Proof of the Sylow Theorem

MODULE – II (6hr+0hr+2hr)

Ring Theory:

Introduction to Ring, Some special classes of ring, Ring homomorphisms.

Project 2: A study on ring theory and it's property

MODULE – III (3hr+0hr+2hr)

More Ideals and Quotient Rings, The Field of Quotients of an Integral Domain.

Project 3: The Quotient Field of an Intersection of Integral Domains

MODULE – IV (4hr+0hr+2hr)

Euclidean Rings, A Particular Euclidean Ring, Polynomial Rings.

Project 4: On the Existence of a Euclidean Algorithm in Number Rings with Infinitely Many Units

MODULE – V (4hr+0hr+0hr)

Polynomial Rings over the Rational Field, Polynomial Rings over Commutative Rings.

MODULE – VI (3hr+0hr+2hr)

Fields:

Extension Fields, Roots of polynomials

Project 5: A study on Structure of a Finite Field

MODULE – VII (4hr+0hr+2hr)

Vector Spaces:

Elementary Basic Concepts of Vector Space, Linear Independence and Basis, Dual Spaces, Inner Product Spaces

Project 6: Notes on dual spaces

BOOK PRESCRIBED

Topics in Algebra – I. N. Herstein (John Wiley and Sons or Vikas Publication), 2nd Edition

Chapters: 2 (2.11 to 2.12), 3 (3.1 to 3.11), 4 (4.1 to 4.4), 5(5.1 and 5.3)

BOOKS FOR REFERENCE

1. S.Singh and Q. Zameeruddin, Modern Algebra, Vikas Publishing House, 1990
2. P.B. Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra, Cambridge University Press, 1995.