University of Kelaniya
Sri Lanka

Bachelor of Science (General) External Degree Programme

Syllabus

Centre for Distance and Continuing Education
University of Kelaniya
Kelaniya

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Centre for Distance and Continuing Education
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Inquiries :-

Senior Assistant Registrar,
Centre for Distance and Continuing Education,
No. 56/6,
Koongahawatte Road,
Kandy Road,
Kiribathgoda.

Telephone :-

011 2987000
011 2987001
011 2987002
011 2987005

Web :-

www.kln.ac.lk / cdce

Contents

1. Introduction

The Faculty of Science at University of Kelaniya is one of the prominent faculty in Sri Lanka produces high quality science based graduates and it is envisaged to propose new subject combinations for External Degree Programme in order to launch an innovative science based external degree programme.

2. Proposed subject combinations for the External Degree Programme

With the introduction of the subjects Statistics, Computer Science and Mathematics, the Department of Statistics & Computer Science and the Department of Mathematics would like to propose the following subject combinations for the B.Sc. (External) programme:

Combination 1: Pure Mathematics, Applied Mathematics, Statistics

Combination 2: Pure Mathematics, Applied Mathematics, Computer Science

Combination 3: Pure Mathematics, Computer Science, Statistics

3. Graduate Profile

Graduate profile with Intended Learning Outcomes (ILOs) of Bachelor of Science Degree (External) Program in Physical Science.

Faculty of Science, University of Kelaniya.

Graduate Profile: Bachelor of Science (External) Degree

Bachelor of Science (BSc) degree holder of the Faculty of Science of the University of Kelaniya will be an enthusiastic, honest, responsible, emotionally mature, assertive, and motivated life-long learner with;

- comprehensive knowledge on the principles, concepts and practices of the area of physical science;
- ability to apply knowledge obtained efficiently and effectively to identify, analyze and find appropriate solutions to real-world problems;
- identify, access, organize, process, evaluate and synthesize quantitative and qualitative information;
- proficiency to use computing appropriately to industrial problems;
- ability to communicate information effectively and convincingly to diverse audiences;
- intercultural perspective and respect for human rights;
- ability to adapt, work independently and in collaboration with others;
- ethical conduct, professional integrity, punctuality and managerial skills.

Intended Learning Outcomes of the Bachelor of Science (External) Degree Programme

- demonstrate the comprehensive knowledge and understanding of concepts, principles and practices in physical sciences
- represent the real-world problems in scientific framework using the concepts and principles in physical sciences
- collect qualitative and quantitative data; analyze and interpret in logically and accurately
- develop arguments and make sound judgment in accordance with basic theories and concepts of physical sciences
- apply knowledge and understanding of the principles, concepts and practices of physical sciences towards solving the problems
- use computing to solve real-world problems effectively and efficiently
- adopt emerging technologies leading to better and efficient solution
- communicate effectively convincingly to diverse ordinances
- work effectively with team member and stakeholders, displaying the skills of listening, negotiating and leadership
- integrate and work in different cultures and sub cultures, and respect their values
- adapt, work independently and in collaboration with others
- identify the ethics and exercise them
- maintain professional integrity, punctuality and practice effective managerial skills

4. Revised Curriculum

4.1 Applied Mathematics

Subject: Applied Mathematics (AMAT)						
Year	Semester	Code	Title	Type	Pre-requisite	Co-requisite
1	I	AMAT 16513	Vector Analysis	C	A/L Combined Mathematics	
		AMAT 16522	Mechanics I	C	A/L Combined Mathematics	
	II	AMAT 17532	Vector Methods in Geometry	C	AMAT 16513	
		AMAT 17543	Numerical Methods I	C	AMAT 16513	
2	I	AMAT 26553	Scientific Computing using Appropriate Software I	C	AMAT 17543	
		AMAT 26562	Mechanics II	C	AMAT 16522	
	II	AMAT 27572	Numerical Methods II	C	AMAT 17543	
		AMAT 27582	Scientific Computing using Appropriate Software II	C	AMAT 26553	AMAT 27572
3	I	AMAT 36593	Computational Mathematics	C	AMAT 27582	
		AMAT 36603	Mathematics for Finance I	C	PMAT 16522	
	II	AMAT 37613	Mathematical Modeling	C	PMAT 27572	
		AMAT 37623	Introduction to Fluid Dynamics	C	PMAT 36593	

4.2 Computer Science

Subject: Computer Science (COSC)					
Year	**Semester**	**Code**	**Title**	**Type**	**Pre-requisite**
1	I	COSC 16012	Computer Systems	C	G.C.E. A/L
		COSC 16023	Introduction to Programming	C	G.C.E. A/L
	II	COSC 17032	Software Engineering	C	COSC 16012
		COSC 17043	Object Oriented Programming	C	COSC 16023
2	I	COSC 26052	Computer Architecture and Operating Systems	C	COSC 16012, COSC 16023
		COSC 26063	Data Structures and Algorithms	C	COSC 17043
	II	COSC 27072	Computer Networks	C	COSC 16012
		COSC 27083	Database Management Systems	C	COSC 16023
3	I	COSC 36092	Information Security	C	COSC 27072
		COSC 36103	Web Technologies	C	COSC 17043, COSC 27072, COSC 27083
	II	COSC 37113	Principles of Data Science	C	COSC 26063
		COSC 37122	Software Quality Assurance	C	COSC 17032, COSC 36103

4.3 Career Based Work Training (CBWT)

Subject: Career Based Work Training (CBWT)					
Year	**Semester**	**Code**	**Title**	**Type**	**Pre-requisite**
3	I / II	CBWT 38013	Career Based Work Training	O	All compulsory course units of years 1 & 2

4.4 Pure Mathematics

Subject: Pure Mathematics (PMAT)					
Year	**Semester**	**Code**	**Title**	**Type**	**Pre-requisite**
1	I	PMAT 16513	Discrete Mathematics I	C	A/L Combined Mathematics
		PMAT 16522	Matrix Algebra	C	A/L Combined Mathematics
	II	PMAT 17532	Discrete Mathematics II	C	PMAT 16513
		PMAT 17543	Theory of Calculus	C	PMAT 16513
2	I	PMAT 26553	Linear Algebra	C	PMAT 16522
		PMAT 26562	Infinite Series	C	PMAT 17543
	II	PMAT 27573	Ordinary Differential Equations	C	PMAT 17543
		PMAT 27583	Functions of Several Variables	C	PMAT 26553
3	I	PMAT 36593	Complex Variables	C	PMAT 27583
		PMAT 36602	Abstract Algebra	C	PMAT 26553
	II	PMAT 37612	Theory of Riemann Integration	C	PMAT 17543
		PMAT 37622	Mathematical Methods	C	PMAT 27583
		PMAT 37632	Geometry	C	PMAT 27583

4.5 Statistics

Subject: Statistics (STAT)					
Year	**Semester**	**Code**	**Title**	**Type**	**Pre-requisite**
1	I	STAT 16513	Fundamentals of Statistics	C	GCE (A/L)
		STAT 16522	Statistical Laboratory	C	GCE (A/L)
	II	STAT 17533	Probability Distributions and Applications I	C	STAT 16513
		STAT 17542	Optimization I	C	GCE (A/L)
2	I	STAT 26513	Probability Distributions and Applications II	C	STAT 17533
		STAT 26522	Optimization II	C	STAT 17542
	II	STAT 27533	Inferential Statistics	C	STAT 26513
		STAT 27542	Survey Methods & Sampling Techniques	C	STAT 26513/ STAT 27533
3	I	STAT 36513	Statistical Models	C	STAT 27533
		STAT 36522	Statistical Quality Control	C	STAT 17533/ STAT 27542
	II	STAT 37532	Non-parametric Statistics	C	STAT 27542
		STAT 37543	Time Series Analysis	C	STAT 36513

5. Detailed Curriculum

5.1 Applied Mathematics

Year	**1**
Semester	**I**
Course Code	**AMAT 16513**
Course Name	**Vector Analysis**
Credit Value	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**A/L Combined Mathematics**
Co-Requisites	**-**

Hourly Breakdown

Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the end of the course the student will be able to

- demonstrate knowledge of coplanarity of three vectors, orthogonal vectors, vector product
- calculate unit vectors, scalar and vector products, triple scalar & vector products, arc lengths, unit tangent and normal vectors
- define Gradient, Divergence, Curl Operators
- calculate derivatives of vector fields and normal and directional derivatives of surfaces
- identify conservative, solenoidal, rotational and irrotational vector fields
- apply Fundamental Theorem of Line Integrals to compute work
- establish the Divergence and Stoke's theorems.

Course Content:

Vector Algebra: Introduction to vectors, Condition for coplanarity of three vectors, Orthogonal triads of unit vectors, Scalar and vector products, Triple products, Solution of vector equations.

Vector Analysis: Scalar and vector fields, Differentiation of vector functions, sketch curves defined by position vectors, arc length, unit tangent and unit normal vectors of curves, Gradient, Divergence and Curl operators and identities involving them, Surfaces and normal, Directional Derivative, Conservative, solenoidal, rotational & irrotational vector Fields, Sketching 3D objects,

Line Integrals, Fundamental Theorem of Line Integrals, Area Integrals, Surface Integrals, Volume Integrals, Divergence and Stokes' theorems.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Based on tutorials, tests and end of course examination.

Continuous Assessment	25%
Final Assessment	75%
Details: Assignment 100%	Theory (%) 100
Practical (%)	Others (%)

References/Reading Materials:

1. Spiegel, M. and Lipschutz, S., (2nd edition, 2009) *Vector Analysis*, McGraw-Hill Education.
2. Chatterjee, D., (2009), *Vector Analysis,* PHI Learning private limited, India.
3. Davis, H.F. and Snider, A.D., (1992) *An Introduction to Vector Analysis*, C. Brown, New York.

Year	**I**
Semester	**I**
Course Code	**AMAT 16522**
Course Name	**Mechanics I**
Credit Value	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**A/L Combined Mathematics**
Co-Requisites	
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aims/Intended Learning Outcomes:

After the completion of this course unit, the student will be able to:

- consolidate the understanding of fundamental concepts in mechanics such as force, energy, momentum etc
- describe and apply concepts of inertial frames and transformations between inertial frames
- define properties of particle motion
- apply Newton's law for motion of particles under conservative forces
- describe and apply Kepler's law
- expand and exercise the Newton's laws in solving problems related to the motion of a particle in inertial frames, rotating frames and relative to the rotating earth.

Course Content:

Newtonian Kinematics: Inertial frames, Transformations between inertial frames (Lorentz and Galilean transformation), Relative motion of particles, Relative motion of frames of reference.

Motion of a Particle; Mass, Momentum, Torque and angular momentum, Velocity and acceleration in polar, cylindrical and spherical coordinates, Equation of motion in vectorial form, One dimensional motion, Integrals of motion, Work, kinetic energy and potential energy, Impulse, Motion under a conservative forces, Motion under a central force, Kepler's laws, Rotating frames of reference, Motion relative to rotating earth.

System of Particles: Centre of mass, External and internal forces, Integrals of motion, Momentum, Angular momentum, Work. kinetic energy & potential energy Conservative systems, Constants of motion.

Teaching/Learning Methods:

A combination of lectures. seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Details: Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical NA

Others NA

Recommended Reading:

I. Rao, A.V. (2006). Dynamics of Particles and Rigid Bodies: A Systematic approach, Cambridge University Press.

2 Charlton, F. (2nd Ed., 2019). Textbook of Dynamics, D. Van Nostrand

3 Chirgwin, B.H. & Plumpton, C. (2013). Advanced Theoretical Mechanics. A Course of Mathematics for Engineers and Scientists, Volume 6. Elsevier.

4. Desloge, E.A. (1982). Classical Mechanics, John Wiley, New York.

5 Greiner, W. (2nd Ed., 2010). Classical Mechanics: Systems of Particles and Hamiltonian Dynamics, Springer.

6. Goldstein, H., Poole, C. P. & Safko, J. (3rd Ed,, 2011). Classical Mechanics, Pearson.

7. Strauch D. (2009). Classical Mechanics, An Introduction, Springer

8. Rao. K.S. (2003). Classical Mechanics, Universities Press.

Year	**1**
Semester	**II**
Course Code	**AMAT 17532**
Course Name	**Vector Methods in Geometry**
Credit Value	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**AMAT 16513**
Co-Requisites	**-**

Hourly Breakdown

Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

- state the standard vector forms of lines and planes
- calculate the tangent, normal, binormal vectors of curves and the characteristics of curves such as curvature, torsion and radius of curvature
- explain osculating, normal ad rectifying planes of curves
- apply Frenet-Serret formulae
- calculate unit vectors and scalar factors of curvilinear coordinates
- describe the form of differential equations in curvilinear coordinates
- calculate tangent plane and normal vectors of surfaces.

Course Content:

Lines and planes: Vector form of lines and planes, Parameterized curves. Condition for planarity of two lines, bisecting the angle, between two given planes

Curves and Surfaces: Tangent, Normal and Binormal vectors, Curvature, torsion and radius of curvature, Frenet-Serret formulae, Osculating Plane, Normal Plane, Rectifying Plane

Curvilinear Coordinates : Scalar Factors and unit vectors for curvilinear coordinates, Differential operators in curvilinear coordinates, Length element, surface elements and volume elements in curvilinear coordinates, Scalar Factors and unit vectors for spherical and cylindrical coordinate systems.

Theory of Surfaces: Concept of a surface, Implicit Equation of a Surface, Parametric Equation, Parametric Curves, Curves on a Surface, Tangent Plane, Normal Vector, Surface of Revolution.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical NA

Others NA

References/Reading Materials:

1. Narayan, S. (2005). *Vector Algebra*, S. Chands and Company.
2. L, Brand. (2012). *Vector Analysis*. Courier Corporation.
3. L.R. Shorter. (2014). *Problems and Worked Solutions in Vector Analysis*. Courier Corporation.

Year	**1**
Semester	**II**
Course Code	**AMAT 17543**
Course Name	**Numerical Methods I**
Credit Value	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**AMAT 16513**
Co-Requisites	**-**
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the end of the course, the student should be able;

- explain the issues of accuracy in floating-point representation
- find roots of non-linear equations using appropriate numerical methods
- identify the error in a given data set
- apply appropriate interpolation and curve fitting techniques for a given application
- solve a system of equations using direct methods
- describe the limitations, advantages, and disadvantages of numerical methods.

Course Content:

Introduction: Floating point number system, error in numerical computation, strategies for minimizing round-off errors, Ill conditioning, condition number, the notion of an algorithm.

Solution of equations with one variable: Numerical solution of nonlinear equations using Bisection method, False Position method, Fixed-Point iteration method, Newton-Raphson method, Secant method and modified secant method, error analysis for iterative methods.

Difference Operators: Forward, Backward, Central and Averaging operators, symbolic relations of difference operators, difference table and error propagation, difference equations, factorial polynomials.

Interpolation: Collocation polynomial and its properties, Newton's Forward and Backward difference formulae, Gauss's Central Difference Formula, interpolation with unevenly spaced points: Lagrange's and Newton's interpolation, Spline Interpolation: Linear, Quadratic and Cubic Spline Interpolation.

Least-square curve fitting techniques: linear functions: normal equations, coefficient of determination, non-linear functions: exponential model, power model, Saturation Growth Rate model.

Solution of System of Linear Equations (Direct Methods): Matrix inversion, Naïve Gauss elimination, Gaussian elimination with partial pivoting, Ill conditioning Matrices, Operation counts, Matrix Decomposition Techniques: LU and QR Factorizations.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions

Assessment Strategy:

Based on tutorials, tests and end of course examination

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Details: Assignment 100%

Theory 100%

Practical NA

Others NA

References/Reading Materials:

1. Burden, R.L., Faires, J.D, Burden, A.M., (10th edition, 2015) *Numerical Analysis,* Cengage Learning.
2. Sastry, S. S., (5th edition, 2012) *Introductory Methods of* Numerical *Analysis,* Prentice Hall India.
3. Kreyszig, E., (10th edition, 2010) *Advanced Engineering Mathematics,* John Wiley.
4. Sauer, T. (2012). *Numerical Analysis*, Pearson.
5. Epperson, J.F. (2013). *An Introduction to Numerical Methods and Analysis*, Wiley.
6. Faul, A.C. (2016). *A Concise Introduction to Numerical Analysis*, Chapman and Hall/CRC.

Year	**2**
Semester	**I**
Course Code	**AMAT 26553**
Course Name	**Scientific Computing using appropriate software I**
Credit Value	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**AMAT 17543**
Co-Requisites	**-**
Hourly Breakdown	
Theory	15 hours
Practical Hours	45 hours
Independent Learning	40 hours

Course Aim/Intended Learning Outcomes:

At the end of the course, the student should be able

- use the software for interactive mathematical computations
- build 2D and 3D plots for a given application
- create script and function files using the software development environment
- use basic flow structures
- select appropriate numerical methods in the software environment for root finding applications.

Course Content:

Introduction to software: software as a calculator, basic mathematical functions, variables, vectors, accessing elements of arrays and array manipulation, built-in functions, scripts, plotting: 2D plot, sub-plot, 3D plot: mesh generation, surface plot, and contour plot.

Programming: data types, Boolean evaluation, decision structures: if, if-else, if-elseif and switch structures, good programming practices, function files, Loop: for and while, specific commands: break, continue and pause, error checking and displaying, calling function files: function handles, anonymous functions, passing parameters.

Data import and export: input methods: handle user response and data import from files, output methods: displaying output, writing, and amending output to a file.

Implementation of Numerical Methods: Roots of nonlinear equations using Graphical method, Bisection method, False Position method, Newton Raphson method, Secant method and modified Secant method, built-in functions for root finding problems, finding maxima and minima of functions using root-finding methods

Teaching/Learning Methods:

A combination of lectures, seminars, tutorial discussions and computer laboratory sessions.

Assessment Strategy: Based on tutorials, tests and end of course examination.

Continuous Assessment 25 %

Quizzes, tutorials

Final Assessment 75 %

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Chapra, S.C. (4th Ed., 2017). *Applied Numerical Methods with MATLAB for Engineers and Scientists*, McGraw-Hill.
2. Kiusalaas, J. (3rd Ed., 2015). *Numerical Methods in Engineering with MATLAB*, Cambridge University Press.
3. Otto, S.R. & Denier, J.P. (2005). *An Introduction to Programming and Numerical Methods in MATLAB,* Springer-Verlag London Limited

Year	**2**
Semester	**I**
Course Code:	**AMAT 26562**
Course Name	**Mechanics II**
Credit Value	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**AMAT 16522**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the end of the course the student should be able to

- describe and derive the moment of inertia of rigid bodies
- collect and organize the knowledge for solving problems in motion of lamina
- describe, derive and apply Euler's equation of motion

- collect and organize a sound knowledge of Lagrangian approach to mechanics
- determine the Lagrangian functions for a physical systems
- describe and derive the Lagrange equation of motion for impulsive motion.

Course Content:

Rigid Body Motion: Rigid bodies, Moments and products of inertia, Principal axes, Equimomental systems, Motion of a lamina, Instantaneous centre, Body and space centrodes, Uniplanar motion of a rigid body, Impulsive motion, Euler's equations of Motion.

Lagrangian Mechanics: Generalized coordinates, Lagrange's equations of motion for elementary systems, Constraint forces, Lagrange's equation of motion for holonomic systems, Determination of holonomic constraint forces, generalized force functions, Lagrange equations, Constants of motion in the Lagrangian formalism, Lagrange equation of motion for impulsive motion.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Other N/A

References/Reading Materials:

1. Chorlton, F. (2nd Ed., 2019). *Textbook of Dynamics*, D. Van Nostrand.
2. Desloge, E.A. (1982). *Classical Mechanics*, John Wiley, New York.
3. Gignoux C & Silvestre-Brac, B. (2014). *Solved Problems in Lagrangian and Hamiltonian Mechanics*, Springer Netherlands.
4. Goldstein, H. (2011). *Classical Mechanics,* Addison Wesley.
5. Kelley, J.D. & Leventhal, J.J. (2016). *Problems in Classical and Quantum Mechanics: Extracting the Underlying Concepts.* Springer.
6. Ramsey, A.S. (1975). *Dynamics, Parts I & II*, Cambridge University Press.

Year	**2**
Semester	**II**
Course Code	**AMAT 27572**
Course Name	**Numerical Methods II**
Credit Value	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**AMAT 17543**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the end of the course, the student should be able;

- define vector norm, matrix norm, and their general properties
- use numerical methods for differentiation and integration
- find numerical solutions to a system of equations using iterative methods
- calculate approximate solutions to ordinary differential equations using numerical methods
- discuss the convergence and stability of the solution.

Course Content:

Numerical Linear Algebra: Vector Norms, Matrix norms, General properties of vector and matrix norms, norm convergence.

Numerical Differentiation and Integration: Numerical differentiation, open and closed Newton-Cotes formulae, Trapezoidal, Simpson's 1/3 and 3/8 rules, Romberg integration method, Gaussian quadrature.

Solving Linear Systems of Equations (Iterative): Relative error bound, condition number, iterative and relaxation methods: Jacobi, Gauss-Seidel methods and their convergence, Richardson, SOR Iterative methods. Conjugate Gradient Method.

Numerical Solutions of Ordinary Differential Equations: Explicit and Implicit numerical schemes, Taylor-Series method, Picard's method of successive approximations, Euler's method, Heun's method, Midpoint method, Runge-Kutta methods, computation of error bound, stability of methods, predictor-corrector methods: Adams -Moulton, Adams-Bashforth, Milne's methods, global and local truncations errors.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Based on tutorials, tests, presentations and end of course examination.

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Other N/A

References/Reading Materials:

1. Burden, R.L., Faires, J.D, Burden, M.L. (10th Ed., 2016). *Numerical Analysis*, Cengage Learning.
2. Trefethen, L.N. & Bau, D. (1997). *Numerical Linear Algebra*, Philadelphia, USA.
3. Golub, H., Vanloan, C.F. (2013). *Matrix computations*, JHU Press.
4. Kreyszig, E. (10th Ed., 2010). *Advanced Engineering Mathematics*, John Wiley.
5. Sauer, T. (2012). *Numerical Analysis*, Pearson.
6. Epperson, J.F. (2013). *An Introduction to Numerical Methods and Analysis*, Wiley.
7. Faul, A.C. (2016). *A Concise Introduction to Numerical Analysis*, Chapman and Hall/CRC.

Year	**2**
Semester	**II**
Course Code	**AMAT 27582**
Course Name	**Scientific Computing using appropriate software II**
Credit Value	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**AMAT 26553**
Co-Requisites	**AMAT 27572**
Hourly Breakdown	
Theory	15 hours
Practical Hours	45 hours
Independent Learning	40 hours

Course Aim/Intended Learning Outcomes:

At the end of the course, the student should be able to

- develop computer programs for curve fitting applications
- use software environment for numerical integration and optimization
- define function files for solving linear systems of equations
- solve initial value problems numerically.

Course Content:

Curve Fitting: Linear Least-Squares Regression, Linearization of nonlinear relationships: exponential, power and Saturation Growth Rate models, interpolation, extrapolation, interpolation hazards: multiple curve fitting.

Numerical Integration: Trapezoidal, Simpson's methods, Gauss quadrature.

Optimization: One-Dimensional optimization and multidimensional optimization.

Solving Linear Systems: Solving linear algebraic equations using the software, Direct methods: naive Gauss elimination, pivoting, Gauss Elimination as LU Factorization, Iterative methods**:** Jacobi method, Gauss-Seidel method, Richardson method, and SOR methods.

Initial-Value Problems: Euler's method, Heun's method, Mid-point method, Runge Kutta Methods, adaptive methods for solving initial value problems, comparison of described methods.

Appropriate built-in functions in the software environment for selected numerical methods.

Teaching/Learning Methods:

A combination of lectures, seminars, tutorial discussions and computer laboratory sessions

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Other N/A

References/Reading Materials:

1. S.C. Chapra, (4th edition, 2017) *Applied Numerical Methods with MATLAB for Engineers and Scientists*, McGraw-Hill.
2. Jaan Kiusalaas, (3rd edition, 2015) *Numerical Methods in Engineering with MATLAB*, Cambridge University Press.
3. Otto, S.R. and Denier, J.P. (2005) *An Introduction to Programming and Numerical Methods in MATLAB,* Springer-Verlag London Limited.

Year	**3**
Semester	**I**
Course Code	**AMAT 36593**
Course Name	**Computational Mathematics**
Credit Value	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**AMAT 27582**
Co-Requisites	
Hourly Breakdown	
Theory	40 hours
Practical Hours	15 hours
Independent Learning	95 hours

Course Aim/Intended Learning Outcomes:

At the end of the course the student should be able to

- classify Partial Differential Equations (PDE)
- identify initial and boundary conditions of PDE
- calculate finite difference operators to approximate derivatives and corresponding truncation errors

- apply finite difference methods to obtain the approximate solution of PDEs together with prescribed boundary and/or initial conditions
- analyze the stability, consistency and convergence of numerical schemes
- compare the accuracy of the approximate solution obtained by finite difference scheme using simulation results
- solve boundary value problems using basic finite elements methods
- solve one dimensional PDEs using finite element method by using appropriate software.

Course Content:

Finite Difference Methods:

Introduction, Classification of Partial Differential Equations (PDE): parabolic, hyperbolic and elliptic, Taylor series expansion: analysis of truncation error.

Initial and boundary conditions: Dirichlet and Neumann boundary conditions.

Finite difference methods: Forward, Backward, Centered and Crank-Nicholson schemes, Implicit and Explicit methods.

Stability and Convergence analysis of numerical schemes: Von Neumann Analysis, Consistency and Stability, Lax Equivalent Theorem, Comparison of Numerical Schemes.

Finite Element Methods:

Introduction, Weak Formulation.

Solving one dimensional PDEs using finite element method: Weighted residual methods: Collocation method, least square method, Galerkin method.

Practical: Simulate the Finite Difference solutions using appropriate programming language

Teaching/Learning Methods:

A combination of lectures, seminars, tutorial discussions and computer laboratory sessions.

Assessment Strategy:

Based on tutorials, tests and end of course examination.

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Other N/A

References/Reading Materials:

1. Burden, R.L., Faires, J.D, Burden, M.L. (10th Ed., 2016). *Numerical Analysis,* Cengage Learning.
2. Smith, G. D. (3rd Ed., 1986). *Numerical Solution of Partial Differential Equations: Finite Difference Methods,* Clarendon press.
3. Evans, J., Blackledge, J., & Yardley, P. (2000). *Numerical Methods for Partial Differential Equation,* Springer.
4. Davies, A.J. (2nd Ed., 2011). *Finite Element Method: An Introduction to Partial Differential Equations,* OUP Oxford.
5. Desai, Y.M. (2011). *Finite Element Method with Applications in Engineering,* Pearson Education India.
6. Solin, P. (2013). *Partial Differential Equations and the Finite Element Method,* Wiley.

Year	**3**
Semester	**I**
Course Code	**AMAT 36603**
Course Name	**Mathematics for Finance I**
Credit Value	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 16522**
Co-Requisites	**-**
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the end of the course candidate will be able to

- define time value of money
- calculate present and future values of annuities and cash flows
- construct an investment portfolio to match present value and duration of a set of liability cash flows
- define basic types of financial derivatives
- identify appropriate derivative position for given investment circumstances
- evaluate the payoff and profit of basic derivative contracts
- apply put-call parity to identify arbitrage opportunities

Course Content:

Interest Theory: Time Value of Money: simple, compound Interest, comparing simple and compound interest, accumulation function, future value, current value, present value, net present value, discounting discount factor, rate of discount, interest payable monthly, quarterly, etc., nominal rate, effective rate, inflation and real rate of interest, force of interest, equation of value.

Annuities/cash flows: Annuity-immediate, annuity due, perpetuity, payable monthly or payable continuously, level payment annuity, arithmetic increasing/decreasing annuity, geometric increasing/decreasing annuity, term of annuity.

Loans: Principal, interest, term of loan, outstanding balance, final payment (drop payment, balloon payment), amortization, sinking fund.

Bonds: Price, book value, amortization of premium, accumulation of discount, redemption value, par value/face value, yield rate, coupon, coupon rate, term of bond, callable/non-callable.

General Cash Flows and Portfolios: yield rate/rate of return, dollar-weighted rate of return, time-weighted rate of return, current value, duration (Macaulay and modified), convexity (Macaulay and modified), portfolio, spot rate, forward rate, yield curve, stock price, stock dividend

Basic terms in Financial Markets: derivative, underlying asset, over the counter market, short selling, short position, long position, ask price, bid price, bid-ask spread, lease rate, stock index, spot price, net profit, payoff, credit risk, dividends, margin, maintenance margin, margin call, mark to market, no-arbitrage, risk-averse, type of traders.

Options: call option, put option, expiration, expiration date, strike price/exercise price, European option, American option, Bermudan option, option writer, in-the-money, at-the-money, out-of-the-money, covered call, naked writing, properties of stock options, factors affecting option prices, assumptions and notations, put-call parity.

Forwards and Futures: forward contract, futures contract, outright purchase, fully leveraged purchase, prepaid forward contract, synthetic forwards, cost of carry, implied repo-rate.

Teaching/Learning Methods: A combination of lectures, industrial presentations, seminars

Assessment Strategy:
Continuous Assessment 25%
Final Assessment 75%
Quizzes, tutorials
Theory 100%
Practical N/A
Other N/A

References/Reading Materials:

1. Kellison, S. (3rd Ed., 2008). *The Theory of Interest*, McGraw-Hill/Irwin.
2. Hull, J.C. (10th Ed., 2018). *Options, Futures and Other Derivatives*, Pearson.
3. McDonald, R.L. (3rd Ed., 2013). *Derivatives Markets,* Addison Wesley.
4. Kosowski, R. & Neftci, S.N. (3rd Ed., 2015). *Principles of Financial Engineering,* Academic Press.

Year	**3**
Semester	**II**
Course Code	**AMAT 37613**
Course Name	**Mathematical Modelling**
Credit Value	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 27572**
Co-Requisites	
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the end of the course the student should be able to

- explain how the general principles arise in the context of mathematical modeling
- analyze existing mathematical models using ordinary differential equations
- formulate simple ODE models for real world problems
- solve system of ordinary differential equations
- analyze the qualitative behavior of mathematical models
- identify the solutions of difference equations
- Solve system of linear difference equations using Putzer algorithm and Jordan form.

Course Content:

Introduction to Modeling: Philosophy of modeling, Modeling Methodology, Problem formulation, Mathematical Description, Analysis, Interpretation.

Mathematical Modeling Using Ordinary Differential Equations: Classification of ODE, Equilibrium points.
First order Differential Equations: Mixing, chemical reactions, Population models: Logistic growth model, Harvesting models, Traffic Dynamic models: Microscopic and macroscopic models.
System of Differential equations: Interacting population models (Predator–Prey models, Competition models), Compartment models (Dynamic of infectious disease, Age structured models, Reaction kinetics), Qualitative analysis of models.
Mathematical Modeling Using Difference Equations: First order difference equations, Equilibrium points, asymptotic stability of equilibrium points, System of linear difference equations: Autonomous systems, Discrete analogue of Putzer algorithm, Jordan form, linear periodic systems.

Teaching/Learning Methods:
A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:
Based on tutorials, tests and end of course examination.
Continuous Assessment 25%
Final Assessment 75%
Quizzes, tutorials
Theory 100%
Practical N/A
Other N/A

References/Reading Materials:

1. Kapur, J.N. (2015). *Mathematical Modeling*, New Age International.
2. Bender, A. (2012). *An introduction to Mathematical Modeling*, Courier Corporation.
3. Haberman, R. (1998). *Mathematical Models: Mechanical Vibrations, Population Dynamics and Traffic Flow.* SIAM.
4. Allen, L. (2006). *An Introduction to Mathematical Biology*, Pearson.
5. Elaydi, S. (2005). *An Introduction to Difference Equation*, Springer.

Year	**3**
Semester	**II**
Course Code	**AMAT 37623**
Course Name	**Introduction to Fluid Dynamics**
Credit Value	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 36593**
Co-Requisites	
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the end of this course the student will be able to

- identify fluid flow motions and their properties
- formulate equations of motions based on three conservation laws

- simplify equations of motions considering flow characteristics and apply them in real world problems
- identify appropriate boundary conditions
- make use of complex analysis for two-dimensional fluid motions
- distinguish the dominant terms through dimensional analysis.

Course Content:

Vector Analysis Review: Orthogonal curvilinear coordinates, Gradient, Divergence and curl.

Basic Principles of Fluid Dynamics: Fluids and fluid flow variables, Streamlines and path lines, Lagrangian and Euler approaches for describing fluid motions, Reynold's Transport Theorem, conservation of mass (equation of continuity), momentum and energy

Newtonian fluid: Inviscid and viscous fluids, Euler's equation of Motion, Vorticity, irrotational motion under conservative forces, Bernoulli's equation

Boundary condition: Inlet and outlet conditions, no slip condition, pressure boundary conditions, radial and axisymmetric boundary conditions.

Flow in Pipes: Laminar flow in pipes, Pressure drop and head loss, flows in non-circular and inclined pipes.

Two-Dimensional Motion: Stream function and plotting streamlines, Complex potential, Sources and sinks, Vortices, Doublets and image systems, Milne-Thompson theorem.

Axi-symmetric Motion: Stokes' stream function in three dimensional flows.

Dimensional Analysis and modeling: Nondimensionalization of equations

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions

Assessment Strategy:

Based on tutorials, tests and end of course examination.

Continuous Assessment 25%

Final Assessment 75%

Quizzes, tutorials

Theory 100%

Practical N/A

Other N/A

References/Reading Materials:

1. Ruban, A.I. & Gajjar, J.S.B. (1st Ed., 2014). *Fluid Dynamics (classical fluid dynamics),* Oxford.
2. Cengel, Y.A. & Cimbala, J.M. (2006). *Fluid Mechanics (Fundamentals and Applications),* McGraw Hill.
3. Feistauer, M. (1993). *Mathematical Methods in Fluid Dynamics*, Chapman and Hall/CRC.
4. Chorin, A.J. & Marsden, J.E. (2012). *A Mathematical Introduction to Fluid Mechanics*, Springer Science & Business Media.
5. Henningson, D.H. & Berggren, B. (2005). *Fluid Dynamics Theory and Computation*, Stockholm.
6. Chorlton, F. (2005). *Textbook of Fluid Dynamics*, CBS Publishers & Distributors.

5.2 Computer Science

Year	**1**
Semester	**I**
Course Code	**COSC 16012**
Course Name	**Computer Systems**
Credit Value	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**G.C.E. A/L**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:
At the end of this course the student will be able to

- evaluate techniques for representing and processing data and apply fundamental principles of digital logic design.
- assess CPU functionality and processing methodologies to determine their impact on computational efficiency.
- investigate the design and operation of memory, storage, and input/output systems within modern computing environments.
- examine the role of system software in managing resources, optimizing performance, and enabling networked communication.

Course Content:
Introduction: history and evolution of hardware and software, system types including embedded systems, personal computers, servers and cloud-based systems.

Number systems and encoding Schemes: binary, decimal, hexa-decimal, octal, ASCII, Unicode
Boolean algebra and logic design: laws, theorems, simplification, logic gates, circuit design, logic gates, circuit design.
CPU architecture: instruction cycles, fetch-decode-execute cycle, pipelining, parallelism, multi-core processors **Memory and storage systems:** RAM, ROM, cache, virtual memory, hard drives (HDDs), solid-state drives (SSDs), optical drives
Peripheral devices and interfaces: keyboards, mice, monitors, printers, USB, PCIe, HDMI, SATA, Expansion standards
Operating systems: functions, types, installation, and configuration, disk management, file compression, task automation
Networking fundamentals: LAN, WAN, routers, switches, IP addressing, network protocols
System setup and maintenance: assembling and configuring computer systems, diagnostic tools, troubleshooting hardware and software issues, preventive maintenance.

Teaching/Learning Methods:
A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:
Continuous Assessment 30%
Final Assessment 70%
Quizzes, tutorials
Theory 100%
Practical N/A
Other N/A

References/Reading Materials:

1. Matthews, S. J., Newhall, T., & Webb, K. C. (2022). *Dive into systems: A gentle introduction to computer systems.* No Starch Press.
2. Nisan, N., & Schocken, S. (2021). *The elements of computing systems: Building a modern computer from first principles* (2nd ed.). MIT Press.
3. Bryant, R. E., & O'Hallaron, D. R. (2015). *Computer systems: A programmer's perspective* (3rd ed.). Pearson.
4. Ram, B. (2005), *Computer Fundamentals: Architecture and organization.* 3rd Edition. New Age Publications, India.

Year	**1**
Semester	**I**
Course Code	**COSC 16023**
Course Name	**Introduction to Programming**
Credit Value	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**G.C.E. A/L**
Co-Requisites	
Hourly Breakdown	
Theory	30 hours
Practical	45 hours
Independent Learning	75 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- trace the evolution and classification of programming languages, recognizing their applications and characteristics.

- apply principles to design programs and implement algorithms in a high-level programming language.
- demonstrate foundational programming concepts, including data types, variables, expressions, and control structures, to develop solutions for computational problems.
- explore advanced programming concepts such as recursion, inheritance, and dynamic binding, and integrate them into practical coding tasks.
- work with structured and user-defined data types, including arrays and structures, and manage memory effectively in programming tasks.

Course Content:

Introduction: history and types of programming languages, program design principles, algorithm implementation in programming languages

High-level programming language fundamentals: data types, variables, expressions, control structures for decision-making and repetition

Functions and pointers: definition and usage, variable scope, storage classes, introduction to pointers, applications of pointers

Structured and user-defined data types: arrays, structures

Advanced programming concepts: recursion, inheritance, dynamic binding, file processing, memory management; **Practical programming skills:** error handling, debugging techniques, multi-file project development; Techniques for structured, efficient, and maintainable coding.

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment 30 %

Final Assessment 70 %

Details:

Quizzes, tutorials

Theory 70%

Practical 30%

Other (specify)NA

References/Reading Materials:

1. Kochan, S. G. (2014). *Programming in C* (4th ed.). Addison-Wesley Professional.
2. Griffiths, D., & Griffiths, D. (2012). *Head first C*. O'Reilly Medi
3. Schildt, H. (2000). *C: The complete reference* (4th ed.). McGraw-Hill Education.
4. Kelly, A. and Pohl, I. (1999). *A Book on C: Programming in C*. 4th Edition., Addison Wesley Longman Inc.
5. Gottfried, B.S. (2001). *Schaum's Outline of Theory and Problems of Programming in C*. 2nd Edition. McGraw Hill Professional Publishing.

Year	**1**
Semester	**II**
Course Code:	**COSC 17032**
Course Name:	**Software Engineering**
Credit Value:	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 16012**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30
Practical	NA
Independent Learning	70

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- explain core software engineering principles, processes, and best practices.
- apply Agile methodologies and other development strategies to manage software projects effectively.
- analyze and model system requirements using appropriate engineering techniques.
- design software solutions utilizing architectural and design patterns for moderate complexity projects.
- implement, test, and evaluate software to ensure reliability and quality.
- develop strategies for maintaining and evolving software systems over time.

Course Content:

Introduction: history and Software engineering principles, processes, and best practices

Software development methodologies: Agile practices, Scrum, Kanban, and Extreme Programming (XP)

Requirements engineering: elicitation, analysis, specification, and validation

System modeling: use case diagrams, class diagrams, sequence diagrams, and activity diagrams

Architectural patterns: layered architecture, client-server architecture, Model-View-Controller (MVC), microservices

Design patterns and implementation strategies: Singleton, Factory, Observer, coding standards, version control, and code review practices

Software testing: unit testing, integration testing, system testing, and acceptance testing, Test automation frameworks and tools

Software maintenance: corrective, adaptive, perfective, and preventive maintenance;

Best practices: Software quality assurance practices, techniques to design, develop, and test reliable, high-quality software solutions for moderately complex projects.

Teaching /Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 30 %

Final Assessment 70 %

Details:

Quizzes, tutorials

Theory 100%

Practical NA%

Other (specify)NA

References/Reading Materials:

1. Pressman, R. S., & Maxim, B. R. (2020). *Software Engineering: A Practitioner's Approach* (9th ed.). McGraw-Hill Education. Utilized by: University of Toledo.
2. Sommerville, I. (2016). *Software Engineering* (10th ed.). Pearson. Utilized by: Arizona State University.
3. Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1994). *Design Patterns: Elements of Reusable Object-Oriented Software*. Addison-Wesley Professional. Utilized by: Carnegie Mellon University.
4. Brooks, F. P. (1995). *The Mythical Man-Month: Essays on Software Engineering* (Anniversary ed.). Addison-Wesley. Utilized by: University of Toronto.
5. Laplante, P. A., & Kassab, M. (2022). *Requirements Engineering for Software and Systems* (4th ed.). CRC Press. Utilized by: University of Iowa.
6. IEEE Computer Society. (2024). *Guide to the Software Engineering Body of Knowledge (SWEBOK)* (Version 4). IEEE Computer Society. Utilized by: Stanford University.

Year	**1**
Semester	**II**
Course Code	**COSC 17043**
Course Name	**Object Oriented Programming**
Credit Value	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 16023**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Practical	45 hours
Independent Learning	75 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- explain the core principles and motivation behind Object-Oriented Programming (OOP) methodologies and their application in software development.
- develop software solutions using industry-standard Object-Oriented Programming Languages (e.g., Java) with appropriate use of classes, objects, and visibility modifiers.
- demonstrate proficiency in OOP constructs such as arrays of objects, looping structures, variable scope, and string manipulation.
- apply advanced OOP concepts, including encapsulation, inheritance, polymorphism, and abstraction, to create modular and reusable code.
- design, implement, and evaluate sophisticated OOP projects with a focus on maintainability and code reuse.

Course Content:

Introduction: Object-Oriented Programming (OOP) principles and techniques, Motivation behind object-oriented methods and benefits of OOP in software development, introduction to Java.

Core OOP features: class and object models, object creation, constructors, visibility modifiers (public, private, protected), static methods, and code reuse through inheritance and composition

Key programming constructs: arrays of objects, variable scope, storage classes, looping structures (for, while, do-while), primitive and reference data types, and strings

Advanced OOP concepts: method overloading, method overriding, data abstraction, encapsulation, inheritance, polymorphism, and interfaces

Error handling and memory management in OOP: exceptions and custom exception classes, garbage collection, memory allocation, and deallocation

Design real world project: Techniques to design, implement, and manage sophisticated, reusable, efficient OOP-based software solutions for medium to large-scale projects.

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment 30 %

Final Assessment 70 %

Details:Assignments 100%

Theory 70%
Practical 30%
Other (specify) NA

References/Reading Materials:

1. Wu, T., (2009). *An Introduction to Object-Oriented Programming with Java.* 5th Edition. McGraw Hill.
2. Sarcar, V. (2019). *Interactive object-oriented programming in Java: Learn and test your programming skills* (2nd ed.). Apress.
3. Sharan, K., & Davis, A. L. (2021). *Beginning Java 17 fundamentals: Object-oriented programming in Java 17* (3rd ed.). Apress.
4. Sierra, K., & Bates, B. (2022). *Head first Java* (3rd ed.). O'Reilly Media.
5. Eckel, B. (2006). *Thinking in Java* (4th ed.). Prentice Hall.
6. Gamma, E. (1995). *Design patterns: elements of reusable object-oriented software.* Pearson Education India.

Year	**2**
Semester	**II**
Course Code	**COSC 26052**
Course Name	**Computer Architecture and Operating Systems**
Credit Value	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 16012, COSC 16023**
Co-Requisites	
Hourly Breakdown	
Theory	30 hours
Practical	NA
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- explain the principles of computer architecture and operating systems and their roles in managing hardware and software.
- analyze the functionality of CPUs, memory hierarchies, and instruction set architectures.
- understand core OS concepts such as process management, memory management, file systems, and concurrency.
- evaluate advanced topics like virtual memory, scheduling algorithms, and virtualization.
- apply knowledge to optimize system performance and resource management.
- solve problems in system design using principles of architecture and operating systems.

Course Content:

Fundamentals of computer architecture: introduction, basic structure of computers

CPU organization and memory hierarchy: registers, ALU, control unit, cache, RAM, ROM, virtual memory; **Instruction set architecture:** RISC and CISC designs

Input/output mechanisms: device controllers, interrupt handling

Core operating system concepts: process management, process states, process synchronization, and inter-process communication (IPC)

Memory management: paging, segmentation, and memory allocation techniques

File systems: file organization, directory structures, and file access methods

Concurrency and scheduling algorithms: threads, multithreading, and synchronization primitives, preemptive and non-preemptive scheduling, round-robin, and priority-based scheduling;

Basics of virtualization: hypervisors and virtual machines

System performance: performance analysis and optimization of architectural and OS components, techniques to optimize system performance and resource management.

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Continuous Assessment30 %

Quizzes, tutorials

Details:Assignments 100%

Theory100%
Practical NA
Other (specify) NA

References/Reading Materials:

1. Silberschatz, A., Galvin, P. B., & Gagne, G. (2020). *Operating system concepts* (10th ed.). Wiley.
2. Hennessy, J. L., & Patterson, D. A. (2017). *Computer architecture: A quantitative approach* (6th ed.). Morgan Kaufmann.
3. Ledin, J. (2020). *Modern computer architecture and organization.* Packt Publishing.
4. Stallings, W. (2021). *Computer organization and architecture* (11th ed.). Pearson.
5. Stallings, W. (2018). *Operating Systems: Internals and Design Principles* (9th ed.). Pearson.

Year	**2**
Semester	**I**
Course Code	**COSC 26063**
Course Name	**Data Structures and Algorithms**
Credit Value	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 17043**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	45 hours
Independent Learning	75 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- understand and explain the principles of core data structures, including arrays, linked lists, stacks, queues, trees, and graphs.
- analyze and apply algorithmic concepts such as recursion and complexity analysis to evaluate computational efficiency.
- implement and assess the performance of sorting and searching algorithms for different use cases.
- select and utilize appropriate data structures and algorithms to solve real-world computational problems effectively.
- develop problem-solving strategies that integrate data structures and algorithms for optimized solutions.

Course Content:

Core data structures: arrays, linked lists (singly, doubly, circular), stacks, queues, trees (binary trees, binary search trees, heaps), graphs (directed, undirected, weighted, unweighted);

Algorithmic concepts: recursion, complexity analysis (time and space complexities, Big-O notation);

Sorting algorithms: bubble sort, selection sort, insertion sort, merge sort, quicksort, heap sort;

Searching algorithms: linear search, binary search; Graph algorithms: breadth-first search (BFS), depth-first search (DFS), shortest path algorithms (Dijkstra, Bellman-Ford);

Applications of data structures in problem-solving: data storage, manipulation, and retrieval, techniques for analyzing and selecting efficient algorithms for various computational tasks, Hands-on implementation of data structures and algorithms to solve real-world problems.

Teaching /Learning Methods:

Lectures - 25 hours,

Tutorials - 05 hours,

Number of Assignments - 6

Assessment Strategy:

Continuous Assessment 30 %

Quizzes, tutorials

Final Assessment 70 %

Theory70%

Practical30%

Other (specify)NA

References/Reading Materials:

1. Lewis, J., DePasquale, P., & Chase, J. (2016). *Java Foundations: Introduction to Program Design and Data Structures.* 4th Edition. Pearson.
2. Goodrich, M. T., Tamassia, R., & Goldwasser, M. H. (2020). *Data structures and algorithms in Java* (7th ed.). Wiley.
3. Wengrow, J. (2020). *A common-sense guide to data structures and algorithms: Level up your core programming skills* (2nd ed.). Pragmatic Bookshelf.
4. Karumanchi, N. (2016). *Data structures and algorithms made easy in Java: Data structure and algorithmic puzzles* (5th ed.). CareerMonk Publications.
5. Carrano, F.M., & Henry T.M. (2015). *Data Structures and Abstractions with Java.* 4th edition, Pearson.

Year	**2**
Semester	**I**
Course Code	**COSC 27072**
Course Name	**Computer Networks**
Credit Value	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 16012**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	NA
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- explain the foundational principles of network design, implementation, and management.
- describe the functions of the layers in the TCP/IP model, including Physical, Data Link, Network, Transport, and Application Layers
- identify and apply IP network principles to select and configure appropriate network parameters.
- analyze network behavior and evaluate its performance using core networking concepts.
- discuss advanced topics such as network management and Software Defined Networks (SDN).

Course Content:

Overview of computer networks: network types, topologies, and architectures;

TCP/IP model layers: Physical Layer (transmission media, signal encoding, hardware components), Data Link Layer (error detection, flow control, framing), MAC sublayer (addressing, Ethernet, ARP), Network Layer (IP addressing, routing protocols like OSPF, BGP), Transport Layer (TCP, UDP, congestion control), Application Layer (HTTP, FTP, DNS, SMTP)

Introduction to networks: design and implementation principles, network management by monitoring, troubleshooting, and optimizing performance

Advanced topics: Software Defined Networks (SDN), network virtualization

IP networks: addressing schemes (IPv4, IPv6), subnetting, NAT;

Selection of network parameters: bandwidth, latency, and reliability considerations, network behavior analysis and troubleshooting techniques

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Continuous Assessment 30 %

Quizzes, tutorials

Final Assessment 70 %

Theory 100%

Practical NA

Other (specify) NA

References/Reading Materials:

1. Stallings, W. (2021). *Data and computer communications* (11th ed.). Pearson.
2. Forouzan, B. A. (2017). *Data communications and networking* (5th ed.). McGraw Hill.
3. Peterson, L. L., & Davie, B. S. (2021). *Computer networks: A systems approach* (6th ed.). Morgan Kaufmann.
4. Kurose, J. F., & Ross, K. W. (2020). *Computer networking: A top-down approach* (8th ed.). Pearson.
5. Stallings, W. & Case, T (2012). *Business Data Communications- Infrastructure, Networking and Security.* 7th Edition. Pearson.

Year	**2**
Semester	**II**
Course Code	**COSC 27083**
Course Name	**Database Management Systems**
Credit Value	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 16023**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Practical	45 hours
Independent Learning	75 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- explain the role, architecture, and three-schema architecture of DBMS, including distinctions between conceptual, external, and physical schemas.
- provide an overview of the relational data model, database design process, and normalization principles.
- model data requirements using Entity-Relationship (ER) modeling and convert them into relational schemas.
- apply relational algebra and SQL operations to manipulate and retrieve data.
- implement database security measures, including views and discretionary access control.
- normalize relational data up to the 3rd normal form to ensure consistency and integrity.

Course Content:

Introduction: overview of Database Management Systems (DBMS), introduction to relational data models (entities, attributes, relationships). **Database design process:** conceptual design, logical design, physical design **Entity-Relationship (ER) and Enhanced entity-relationship (EER) modeling:** entity sets, attributes, relationships, cardinality, conversion of conceptual schema to relational schema **Relational algebra:** operations **SQL**: Introduction to SQL, complex queries with joins and subqueries **Three-schema architecture:** conceptual, external, physical schemas **Data normalization:** normal forms, functional dependencies **Data security:** discretionary access control, user privileges **Database views:** creation, manipulation, and use cases, database integrity and constraints **Hands-on activities:**

creating and managing databases, designing schemas, writing queries, and normalizing data.

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment30 %

Details: Quizzes, Tutorials

Final Assessment70 %

Theory 70%

Practical 30%

Other (specify)NA

References/Reading Materials:

1. Ricardo, C. M., & Urban, S. D. (2022). *Databases Illuminated* (4th ed.). Jones & Bartlett Learning.
2. Elmasri, R., & Navathe, S. B. (2020). *Fundamentals of Database Systems* (8th ed.). Pearson.
3. Coronel, C., & Morris, S. (2022). *Database Systems: Design, Implementation, & Management* (14th ed.). Cengage Learning.
4. Hoffer, J. A., Venkataraman, R., & Topi, H. (2021). *Modern Database Management* (14th ed.). Pearson.
5. Harrison, G. (2020). Next Generation Databases: NoSQL and Big Data (2nd ed.). Apress.

6. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2019). *Database System Concepts* (7th ed.). McGraw-Hill Education.
7. Garcia-Molina, H., Ullman, J. D., & Widom, J. (2008). *Database Systems: The Complete Book* (2nd ed.). Pearson.

Year	**3**
Semester	**I**
Course Code	**COSC 36092**
Course Name	**Information Security**
Credit Value	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 27072**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Practical	NA
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- explain core principles of information security and their application to safeguarding data.
- utilize hash functions, Message Authentication Codes (MAC), symmetric and asymmetric encryption, and key distribution protocols to secure data.
- assess security mechanisms in operating systems, databases, and application programs to identify vulnerabilities.
- identify security vulnerabilities and recommend effective solutions to mitigate risks in real-world scenarios.

Course Content:

Overview: information security principles and practices, essential concepts in information security (confidentiality, integrity, availability)

Cryptographic techniques: hash functions, Message Authentication Codes (MAC), symmetric encryption, asymmetric (public key) encryption

Introduction to Key concept: Key distribution protocols and secure key management

Security measures for operating systems: access controls, authentication, and audit logs

Database security: encryption, access control mechanisms, and secure query processing

Application program security: input validation, secure coding practices

Specialized topics: electronic payment systems, secure online transactions

Legal aspects of digital crime: cyber laws, intellectual property rights, and data privacy regulations

Identifying security vulnerabilities: penetration testing, vulnerability scanning, risk assessment

Implementing security solutions: intrusion detection systems, firewalls, and incident response strategies.

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Continuous Assessment 30 %

Quizzes, tutorials

Final Assessment 70 %

Theory 100%

Practical 30%

Other (specify) NA

References/Reading Materials:

1. Whitman, M. E., & Mattord, H. J. (2023). *Principles of information security* (7th ed.). Cengage Learning.
2. Kim, D., & Solomon, M. G. (2021). *Fundamentals of information systems security* (4th ed.). Jones & Bartlett Learning.
3. Stallings, W. (2020). *Cryptography and network security: Principles and practice* (8th ed.). Pearson.
4. Pfleeger, C. P., Pfleeger, S. L., & Margulies, J. (2015). *Security in computing* (5th ed.). Pearson.
5. Anderson, R. (2020). *Security engineering: A guide to building dependable distributed systems* (3rd ed.). Wiley.
6. Bishop, M. (2018). *Computer security: Art and science* (2nd ed.). Pearson.

Year	**3**
Semester	**I**
Course Code	**COSC 36103**
Course Name	**Web Technologies**
Credit Value	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 17043, COSC 27072, COSC 27083**
Co-Requisites	**-**

Hourly Breakdown

Theory	30 hours
Practical	45 hours
Independent Learning	75 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- define foundational concepts of the Internet and its underlying infrastructure.
- explain the role of client-side technologies and server-side scripting in web application development.
- develop interactive web pages using client-side technologies and implement server-side functionalities with database connectivity.
- assess emerging trends and best practices in modern web development for effective application in real-world projects.
- design and develop secure, efficient, and maintainable web applications using industry-standard tools and techniques.

Course Content:

Overview of the Internet and its underlying infrastructure: protocols, domain names, DNS, HTTP/HTTPS

Client-side technologies: HTML/XHTML for structuring content, CSS for styling and layout, JavaScript for dynamic interactivity

Document Object Model (DOM): manipulation, event handling, and integration with JavaScript, Cookies and local storage for state management and enhancing web interactivity

Server-side technologies: setting up and configuring web servers like Apache, server-side scripting with PHP, session management, user authentication, and database integration using MySQL

Web application development considerations: standards compliance, maintainability through modular design, performance optimization techniques, usability principles, accessibility guidelines, and basic security practices such as secure data transmission, input validation, and protection against SQL injection and cross-site scripting (XSS).

Hands-on activities: designing and implementing interactive web pages, creating database-driven web applications, optimizing performance, and managing usability, accessibility, and basic security in web solutions.

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Continuous Assessment 30 %

Final Assessment 70 %

Quizzes, tutorials

Theory70%

Practical 30%
Other (specify) NA

References/Reading Materials:

1. Connolly, R., & Hoar, R. (2015). *Fundamentals of web development* (2nd ed.). Pearson.
2. Welling, L., & Thomson, L. (2016). *PHP and MySQL web development* (5th ed.). Addison-Wesley.
3. Duckett, J. (2014). *HTML and CSS: Design and build websites*. Wiley.
4. Robbins, J. N. (2018). *Learning web design: A beginner's guide to HTML, CSS, JavaScript, and web graphics* (5th ed.). O'Reilly Media.
5. Flanagan, D. (2020). *JavaScript: The definitive guide* (7th ed.). O'Reilly Media.
6. Nixon, R. (2021). *Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5* (5th ed.). O'Reilly Media.

Year	**3**
Semester	**II**
Course Code	**COSC 37113**
Course Name	**Principles of Data Science**
Credit Value	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 26063**
Co-Requisites	
Hourly Breakdown	
Theory	30 hours
Practical	45 hours
Independent Learning	75 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- describe the essential concepts, tools, and techniques of data science for data-driven problem solving.
- perform data collection, cleaning, and preprocessing to prepare datasets for analysis.
- conduct exploratory data analysis (EDA) and create meaningful data visualizations to uncover insights.
- apply introductory machine learning algorithms to analyze structured and unstructured data.
- utilize popular Python libraries and frameworks for data science in hands-on projects.
- evaluate ethical considerations in data science, including data privacy, security, and responsible data usage.

Course Content:

Core concepts: essential concepts, tools, and techniques of data science

Data collection: sources, methods, and formats

Data cleaning and preprocessing: handling missing values, outlier detection, and data transformation

Exploratory data analysis (EDA): summary statistics, patterns, and trends

Data visualization: charts, graphs, and dashboards for insights

Introduction to machine learning algorithms: Basics of supervised and unsupervised learning

Working with data: structured data (tables, databases) and unstructured data (text, images)

Python programming for data science: libraries and scikit-learn

Ethical considerations in data science: data privacy, security, and responsible use

Hands-on activities: implementing data preprocessing workflows, performing EDA, creating visualizations, and applying basic machine learning algorithms, techniques for analyzing, interpreting, and making data-informed decisions.

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment 30 %

Final Assessment 70 %

Quizzes, tutorials
Theory 70%
Practical 30%
Other (specify)NA

References/Reading Materials:

1. Grus, J. (2019). *Data Science from Scratch: First Principles with Python* (2nd ed.). O'Reilly Media.
2. VanderPlas, J. (2016). *Python Data Science Handbook: Essential Tools for Working with Data*. O'Reilly Media.
3. Grolemund, G., & Wickham, H. (2017). *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data.* O'Reilly Media.
4. Downey, A. B. (2014). *Think Stats: Exploratory Data Analysis in Python* (2nd ed.). O'Reilly Media.
5. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* (2nd ed.). Springer.
6. Lau, S., Gonzalez, J., & Nolan, D. (2023). *Learning Data Science. O'Reilly Media*.

Year	**3**
Semester	**II**
Course Code	**COSC 37122**
Course Name	**Software Quality Assurance**
Credit Value	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**COSC 17032, COSC 36103**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	NA
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- explain the role of Software Quality Assurance (SQA) and testing practices throughout the software development life cycle.
- identify and apply various software testing processes, techniques, and test case design methodologies.
- conduct different levels of testing using the software testing life cycle framework.
- implement test automation using tools like Selenium, TestNG.
- integrate testing practices into CI/CD pipelines to ensure continuous quality delivery.

Course Content:

Introduction to SQA: Software Quality Assurance (SQA) principles and practices, integration of quality assurance and testing in the software development life cycle;

Software testing processes: test planning, test design, execution, and defect tracking

Test techniques: black-box, white-box, and exploratory testing;

Test case design: equivalence partitioning, boundary value analysis, and decision tables;

Levels of testing: unit, integration, system, and acceptance testing;

Software testing life cycle (STLC): phases and activities;

Quality control practices: review, inspection, and walkthrough;

Test automation principles: benefits, strategies, and tools;

Practical experience: XML-based test automation, web application testing using Selenium, and Java-based frameworks like TestNG

Advanced topics: Overview of continuous integration (CI) and continuous delivery (CD) pipelines

Teaching /Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Continuous Assessment 30 %

Quizzes, tutorials

Final Assessment 70 %

Theory 100%

Practical NA

Other (specify) NA

References/Reading Materials:

1. Galin, D. (2018). *Software quality assurance: From theory to implementation* (2nd ed.). Pearson.
2. Mathur, A. P. (2021). *Foundations of software testing.* Pearson.
3. Naik, K., & Tripathy, P. (2008). *Software testing and quality assurance: Theory and practice*. Wiley.
4. Fewster, M., & Graham, D. (2019). *Software test automation: Effective use of test execution tools* (Updated ed.). Addison-Wesley.
5. Black, R. (2009). *Managing the testing process: Practical tools and techniques for managing hardware and software testing* (3rd ed.). Wiley.
6. Whittaker, J. A. (2009). *Exploratory software testing: Tips, tricks, tours, and techniques to guide test design.* Addison-Wesley.

5.3 Career Based Work Training

Year	**3**
Semester	**I/II**
Course Code	**CBWT 38013**
Course Name	**Career Based Work Training**
Credit Value	**3**
Compulsory / Optional	**Optional**
Pre-Requisites	**All Year 1 and 2 Compulsory course modules**
Co-Requisites	
Hourly Breakdown	
Theory	NA
Practical	300 hours
Independent Learning	NA

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- apply professional skills and knowledge acquired during the degree program to the workplace environment
- develop critical and creative thinking skills by participating in the workplace of creative and cultural industry professionals
- analyse and evaluate their knowledge, skills and practices in the placement environment
- articulate an understanding of the social and professional contexts in which contemporary creative and cultural practice operates and of the role of the practitioner within these contexts

- produce products and/or materials and participate in activities at a professional standard
- analyse and evaluate their knowledge, skills and practices in the placement environment
- complete Risk Assessments and apply appropriate Work Health Safety competencies to the workplace environment.

Course Content:

The students will carry out related work/research relevant to the degree that they are undertaking for a total of 300 hours.

Teaching /Learning Methods:

Training under the supervision and guidance of a suitable trainer in a relevant industry

Assessment Strategy:

Continuous Assessment 70%

Details: Attendance (Weekly Diaries), trainer's report, trainee's report

Final Assessment 30 %

Theory NA

Practical NA

Other (specify) Oral Presentation

References/Reading Materials:

Reading and reference materials recommended/provided by the relevant industry.

5.4 Pure Mathematics

Year	**1**
Semester	**I**
Course Code:	**PMAT 16513**
Course Name:	**Discrete Mathematics I**
Credit Value:	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**A/L Combined Mathematics**
Co-Requisites	
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

- apply rules of propositional, predicate logic and methods of proof
- demonstrate working knowledge of sets
- demonstrate an understanding of relations and functions and be able to determine their properties
- define equivalence relations and equivalence classes
- define composite function
- explain the conditions for the existence of the inverse function
- use the Boolean algebra to simplify complex logic expressions.

Course Content:

Mathematical Logic: Propositional logic, Propositional equivalences, Predicates and quantifiers, Nested quantifiers, Rules of inference, Arguments, Normal forms, Methods of proof, Mathematical induction, Strong induction, Well ordering principle.

Sets: Set notations; Sets of numbers and intervals; Subsets and equal sets; Power set; Cartesian product of sets; Set operations; Algebra of sets.

Boolean Algebra: Boolean expressions and Boolean functions, Identities of Boolean Algebra, Duality, Logic gates, Combinations of gates, Examples of circuits, Minimization of circuits

Relations: Relations and their properties, Functions as relations, Relations on a set, Properties of Relations, Combining relations, n-ary relations, Equivalence relations, Equivalence classes and partitions,

Partial Orderings.

Functions: Function notation; One-to-one and onto functions; Composition of functions, Inverse function.

Teaching/Learning Methods:

A combination of lectures and tutorial discussions and seminars.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75 %

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Johnsonbaugh, R., (8th edition, 2017), *Discrete Mathematics*, Pearson.
2. Rosen, K.H., (8thEd., 2018), *Discrete Mathematics and Its Applications*, McGraw-Hill.

Year	**1**
Semester	**I**
Course Code:	**PMAT 16522**
Course Name:	**Matrix Algebra**
Credit Value:	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**A/L Combined Mathematics**
Co-Requisites	
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

- demonstrate the knowledge in the fundamentals of matrix algebra
- apply elementary row operations to a matrix to transform it into its row-echelon form and find the inverse of a square matrix
- develop system of linear equations and represent in matrix form and apply Gaussian and Gauss-Jordan method to solve simultaneous equations

- classify a system of linear equations into consistent (unique solution and infinitely many solutions) and inconsistent systems
- identify the determinant of a square matrix, evaluate determinant using co-factors and apply elementary row and column operations to evaluate determinants
- describe and apply Cramer's rule to solve system of linear equations
- develop system of linear equations related to real world problems
- explain and compute eigenvectors and eigenvalues of a matrix.

Course Content:

Matrices: Algebra of matrices, Special types of matrices, Transpose of a matrix, Symmetric and skew-symmetric matrices, Inverse of a square matrix; Elementary row and column operations, Elementary matrices and their properties, Inverse matrices using Elementary row and column operations, Properties of Inverse matrices

System of Linear Equations: Matrix representation of System of Linear equations, Row echelon form of a matrix, Gaussian and Gauss-Jordan Elimination, Solutions of System of Equations, Applications of System of Linear Equations.

Determinant of a matrix: Expansion by co-factors, Determinants of Triangular matrices, Evaluation of determinants by elementary row operations, Cramer's rule, and other applications of determinants.

Eigenvalues and Eigenvectors: Eigenvalues and eigenvectors of a matrix and their properties

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assignment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Larson, R. & Falvo, D.C. (8th Ed., 2016). *Elementary Linear Algebra*, Brooks Cole.
2. Andrilli, S. & Hecker, D. (5th Ed., 2016). *Elementary Linear Algebra,* Elsevier Science.
3. DeFranza, J. & Gagliardi, D. (2015). *Introduction to Linear Algebra with Applications*, Waveland Press.
4. Lay, D.C., Lay, S.R. & McDonald, J.J. (5th Ed., 2015). *Linear Algebra and Its Applications*, Pearson
5. Anton, H. & Rorers, C. (2014). *Elementary Linear Algebra Applications,* Wiley.

Year	**1**
Semester	**II**
Course Code:	**PMAT 17532**
Course Name:	**Discrete Mathematics II**
Credit Value:	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 16513**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

- demonstrate knowledge of topics including divisibility, prime numbers, congruences and Diophantine equations
- understand the logic and methods behind the major proofs in Number Theory
- apply various properties relating to the integers including the Well-Ordering Principle, primes, unique factorization, the division algorithm, greatest common divisors, and modular arithmetic
- understand and prove theorems/lemmas and relevant results in graph theory
- apply the basic concepts of graph theory, including Eulerian trails, Hamiltonian cycles, bipartite graphs, planar graphs, and Euler characteristics on solving problems
- apply algorithms and theorems in graph theory in real-world applications
- apply counting principles to solve problems.

Course Content:

Counting: Basic Principles of Counting, Pigeonhole Principle, Permutations and Combinations.

Number Theory: The Well Ordering Principle, Divisibility and Division Algorithm, The Greatest Common Divisor, The Euclidean Algorithm, Prime Numbers, Infinitude of Primes, The fundamental theorem of arithmetic, Linear Diophantine Equation, Modular Arithmetic: solving linear congruence.

Graph Theory: Graph Terminology, Special Types of Simple Graphs, Subgraphs, Euler Cycles, Hamiltonian Cycles, Representations of Graphs, Graph Isomorphism, Planar Graphs, Kuratowski's Theorem, Graph Coloring.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75 %

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Johnsonbaugh, R. (8^{th} Ed., 2017). *Discrete Mathematics,* Pearson.
2. Rosen, K.H. & Krithivasan, K. (8^{th} Ed., 2018). *Discrete Mathematics and Its Applications,* McGraw-Hill.
3. Rosen, K.H. (6^{th} Ed., 2010). *Elementary Number Theory and Its Applications*, Pearson

Year	**1**
Semester	**II**
Course Code:	**PMAT 17543**
Course Name:	**Theory of Calculus**
Credit Value:	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 16513**
Co-Requisites	**-**
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

- classify a real number as a natural, whole, integer, rational, or irrational number and demonstrate knowledge of the axiomatic description of the field of real numbers and prove theorems from the given set of axioms
- evaluate limits given analytic, graphical, numerical function information and describe in simple language the statements of limit laws and use these laws to evaluate limits and state the definition of continuity and use the definition to ascertain the continuity or dis-continuity of a function at a point
- state the limit definition of derivative of a function at a point and use the limit definition to calculate a derivative or identify where the derivative fails to exist at a point
- apply the Chain Rule to find the derivative of a composition of functions and interpret both continuous and differentiable func-

tions geometrically and analytically and apply Rolle's Theorem, the Mean Value Theorem

- explain indeterminant forms and use L'Hopital's rule to evaluate limits involving indeterminant forms
- describe upper and lower Darboux sums, Riemann sum and compare them and write the statement of the Fundamental Theorems of Calculus and explain what the theorems say about definite integrals
- visualize and sketch the surface generated by revolving a graph of a function about an axis of evolution and calculate the volume of a solid and volume of a solid revolution by using disk, washer and cylindrical shells methods
- classify improper integrals and determine the integrals, identify the types of improper integrals and rewrite them as proper integrals with a limits and use the words *convergent* and *divergent* to describe an improper integral.

Course Content:

Real Numbers: Field Structure, Ordered fields and their properties, Open and Closed sets, Maximum, Minimum, Supremum and Infimum of a set, Completeness axioms, Archimedean Property, Denseness of subsets of real numbers

Real Valued Functions of a Real Variable: Review of Polynomial, Rational, Algebraic, Trigonometric, exponential and Logarithmic Functions, Composite Functions, Piece-wise Functions

Functions and Limits: Limits of Functions, Left and Right-hand limits, Squeeze theorem, Continuous Functions, Asymptotes and limits involving infinity

Derivative and Applications: Derivative of a function, Chain rule, Logarithmic and Implicit differentiation, Higher order derivatives, Rolle's Theorem, Mean Value Theorem

Indeterminate Forms: L'hospital Rule.

Integrals: Darboux and Riemann Integrations, Fundamental Theorem of Calculus, Improper Integrals (First & second kind)

Applications of Integrals: Volumes and Solid revolutions, Volumes by Cylindrical Shells, Mean Value Theorem for Integrals, Arc Length, Area of a Surface of Revolution

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Stewart, J. (9th Ed., 2020). *Calculus Early Transcendentals*, Cengage Learning, Inc.
2. Larson, R. & Edwards, B.H. (11th Ed., 2018). *Calculus*, Brooks/Cole, Cengage Learning
3. Ross, K.S. (2nd Ed., 2015). *Elementary Analysis: The Theory of Calculus*, Springer.
4. Hass, J., Heil, C. & Weir, M.D. (14th Ed., 2017). *Thomas' Calculus: Early Transcendentals*, Single Variable, Pearson

Year	**2**
Semester	**I**
Course Code:	**PMAT 26553**
Course Name:	**Linear Algebra**
Credit Value:	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 16522**
Co-Requisites	**-**
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

Upon successful completion of the course students should be able to;

- demonstrate understanding of the concepts of vector space, subspace linear independence, span and basis
- determine eigenvalues and eigenvectors and solve eigenvalue problems
- describe algebraic and geometric multiplicities of eigenvalues and linearly independent eigenvectors
- apply principles of matrix algebra to linear transformations
- demonstrate an understanding of inner products and associated norms.

Course Content:

Vector Spaces: Vector Spaces, Subspaces, Spanning Sets and Linear Independence, Basis and Dimension, Extension Theorem, Coordinates, Change of Basis and Transition Matrix, Similarity, Dimensional Theorem.

Linear Transformations: Linear Transformation, Kernel and Range of Linear Transformation, Rank and Nullity Theorem, Isomorphisms, Matrix Representation of Linear Transformation, Applications of Linear Transformation.

Eigenvalues and Eigenvectors: Characteristic Polynomial, Eigenvalues and Eigenvectors, Eigen Spaces, Diagonalization, Inner Product Spaces, Gram-Schmidt Orthogonalization Process, Orthogonal Complement, Orthogonal Projections, Cayley-Hamilton Theorem, Minimum Polynomial of Matrices of Order Three

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Larson, R. & Falvo, D.C. (2016). *Elementary Linear Algebra*, Brooks Cole.
2. Andrilli, S. & Hecker, D. (2016). *Elementary Linear Algebra,* Elsevier Science.
3. DeFranza, J. & Gagliardi, D. (2015). *Introduction to Linear Algebra with Applications*, Waveland Press.
4. Lay, D.C., Lay, S.R. & McDonald, J.J. (5th Ed., 2015). *Linear Algebra and Its Applications*, Pearson

Level	**2**
Semester	**I**
Course Code:	**PMAT 26562**
Course Name:	**Infinite Series**
Credit Value:	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 17543**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the end of this course, the student should be able to;

- define the meaning of convergence of a real sequence of real numbers
- use definitions to discuss the behavior of a given sequence
- describe the nature of the convergence of infinite series and conditions under what differentiation and integration can be performed
- demonstrate knowledge on power series representation of a series.
- use applications of Taylor polynomial.

Course Content:Sequences:

Sequences: Limits and limit theorems for sequences, Monotone sequences and Cauchy sequences, Bounded sequences, Monotone sequence theorem, Subsequences, Bolzano-Weierstrass theorem

Series: Convergence of Infinite Series, Geometric series, Harmonic

Series, the Integral Test and Estimates of Sums, The Comparison Tests and Estimates of Sums, Alternating Series and estimates of Sums, Absolute and conditional Convergence, Ratio Test and Root Test

Power Series: Representation of Functions as Power Series, Differentiation and Integration of Power Series, Taylor and Maclaurin Series, Binomial Series, Applications of Taylor Polynomials

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Stewart. J. (2020) *Calculus Early Transcendentals*, Cengage Learning.
2. Knopp, K. (1956). *Infinite sequences and series*. Courier Corporation.
3. Knopp, K. (1990). *Theory and application of infinite series*. Courier Corporation.
4. Hirschman, I.I. (2014). *Infinite series*. Courier Corporation.
5. Bonar, D.D. & Khoury Jr., M.J. (2018). *Real infinite series* (Vol. 56). American Mathematical Soc.
6. Bromwich, T.J.I.A. (2005). *An introduction to the theory of infinite series* (Vol. 335). American Mathematical Soc.

Year	**2**
Semester	**II**
Course Code:	**PMAT 27573**
Course Name:	**Ordinary Differential Equations**
Credit Value:	**2**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 17543**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the end of this course, the student should be able to

- classify the differential equations with respect to their order and linearity
- find a particular solution of a differential equation using initial conditions
- solve first-order and higher-order linear ordinary differential equations
- examine the existence and uniqueness of a solution of an initial value problem
- solve linear differential equations using Laplace transform method
- solve differential equations involving real-life applications.

Course Content:

Introduction: Differential Equations, Ordinary Differential Equations (ODE), Order, Degree, classification of linear and non-linear ODEs, solution of a differential equation, Family of curves

First-Order ODEs: Separable ODEs., Homogeneous equations, Exact ODEs., Integrating Factors, Linear ODEs, Bernoulli Equation. Orthogonal Trajectories, Existence and Uniqueness of Solutions for Initial Value Problems, applications of first order ODEs.

Second/Higher Order Linear ODEs: Homogeneous Linear ODEs with Constant Coefficients, Homogeneous Linear ODEs of Second Order, method of order reduction, Existence and Uniqueness of Solutions, Wronskian, Differential Operators, Euler–Cauchy Equations, Nonhomogeneous ODEs, Solution by Variation of Parameters, Method of undetermined coefficients, applications of higher order ODEs.

The Laplace Transform: Definition of Laplace transforms, Basic properties, Inverse Laplace transform, Convolution theorem, Solve Linear Differential Equations with constant coefficients using Laplace transform method

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Kreyszig, E. (2018). *Advanced Engineering Mathematics*, Wiley.
2. Shepley, L.R, (1989). *Introduction to Ordinary Differential Equations*, John Wiley and Sons.
3. Nagle R.K., Saff, E.B. & Snider A.D. (2011) *Fundamentals of Differential Equations*, Pearson.
4. Krantz, S.G. (2014). *Differential equations: theory, technique and practice* (Vol. 17). CRC Press.
5. Tenenbaum, M. & Pollard, H. (1985). *Ordinary Differential Equations*, ý Dover Publications.
6. Murray, R., Murray, R., & Spiegal. (1974). *Theory and problems of Laplace transforms*. Shaum's Outline Series.

Year	**2**
Semester	**II**
Course Code:	**PMAT 27583**
Course Name:	**Functions of Several Variables**
Credit Value:	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 26553**
Co-Requisites	**-**
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the end of this course, the student should be able to

- appraise the geometrical aspects of functions of several variables in different coordinate systems
- parametrize curves and surfaces
- give an account of the concepts of limit, continuity, partial derivative, gradient and differentiability for functions of several variables
- prove and apply Young's Theorem, Schwarz's Theorem
- classify local and global extremes of functions of two variables
- determine local extremes under constrains using Lagrange Multiplier Method
- outline the definition of the multiple integral, compute multiple integrals and use multiple integrals to compute volumes in different coordinate system
- make use of change of variables to evaluate double integrals.

Course Content:

Geometrical Aspects: Domain and range of functions of several variables, Level curves, Parametric surfaces; Some special surfaces; planes, spheres, cylinders and cones; Surface area.

Analytical Aspects: Domain of a function of two variables; Neighborhoods in the Plane, Limits and Continuity; Partial derivatives; Clairaut's Theorem (Young's Theorem), Schwarz Theorem, Differentials, Differentiability; Tangent planes and linear approximations; Chain rules; Gradient of a Function, Directional Derivative, Tangent Planes and Normal lines, Maxima and Minima; Critical Points and Second Partial Test, Lagrange multipliers.

Coordinate Systems: Cartesian, Polar, Spherical and Cylindrical Coordinate Systems Multiple Integrals: Double integrals and Volume; Iterated integrals; Fubini's Theorem, Double integrals over general regions, Double integrals in Polar coordinates, Change of variables in double integrals, Triple integrals in Cartesian, Cylindrical and Spherical coordinates.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Stewart, J. (2020). *Calculus Early Transcendental*, Cengage Learning, Inc.
2. Larson, R. & Edwards, B.H. (2018). *Calculus*, Brooks/Cole, Cengage Learning
3. Ross, K.S. (2015). *Elementary Analysis: The Theory of Calculus*, Springer.
4. Malik, S.C. & Arora, S. (2017). *Mathematical Analysis*, New Age International.

Year	**3**
Semester	**I**
Course Code:	**PMAT 36593**
Course Name:	**Complex Variables**
Credit Value:	**3**
Compulsory/Optional	**Compulsory**
Pre-Requisites	**PMAT 27583**
Co-Requisites	**-**
Hourly Breakdown	
Theory	45 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the end of this course, the student should be able to

- Perform basic mathematical operations with complex numbers in cartesian and polar form
- demonstrate knowledge of complex numbers and complex valued functions
- analyze and discuss limit, continuity and differentiability of complex valued functions
- analyze and interpret results of complex numbers and complex valued functions in applications
- evaluate real integrals using complex integrals.

Course Content:

Complex Numbers: Basic Algebraic Properties, Exponential Form, De Movers' Theorem, n^{th} root of unity, Roots of Complex Numbers, Argand Diagram, Regions in the Complex Plane.

Analytic Functions: Complex Valued Functions, Limits, Theorems on Limits, Continuity and Uniform continuity, Derivatives, Differentiation Formulas, Cauchy–Riemann Equations, Sufficient Conditions for Differentiability, Analytic Functions, Harmonic Functions.

Elementary functions: Polynomial functions, rational functions, exponentials, trigonometric functions, hyperbolic functions, logarithmic functions, power series.

Integrals: Definite Integrals of Complex-Valued Function of a Complex Variable, Contour Integrals, Properties of integrals, Cauchy Theorem, Cauchy Integral Formula.

Series: Taylor Series, Laurent Series, Classification of Singular Points.

Residues and Poles: Residues, Residues at Poles, Cauchy's Residue Theorem, Residue at Infinity.

Applications of Residues: Evaluation of Real Integrals.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Brown, J.W. & Churchill, R.V. (9th Ed., 2014). *Complex variables and applications*, McGraw-Hill

2. Spiegel, M., Lipschutz, S. & Schiller, J. (2nd Ed., 2009). *Schaum's Outline of Complex Variables*, McGraw-Hill
3. Hann, L. & Epstein, B. (1st Ed., 1996). *Classical Complex Analysis*, Jones and Bartlett Publishers
4. Ponnusamy, S. (2nd Ed., 2005). *Foundation of Complex Analysis*, Alpha Science

Year	**3**
Semester	**I**
Course Code:	**PMAT 36602**
Course Name:	**Abstract Algebra**
Credit Value:	**2**
Compulsory/Optional	**Optional**
Pre-Requisites	**PMAT 26553**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the end of this course, the student should be able to

- demonstrate factual knowledge including mathematical notation and terminology used in this course
- analyze and use basic definitions in Abstract algebra including binary operations, groups, subgroups, homomorphism, rings and ideals
- examine the fundamental principles including the laws and theorems arising from the concepts covered in this course

- develop and apply the fundamental properties of abstract algebraic structures, the substructures, their quotient structures and their mappings
- build experience and confidence in proving theorems about the structure size and nature of groups, subgroups, rings, subrings ideals and the associated mappings
- apply course materials along with techniques and procedures covered in this course to solve problems
- develop specific skills, competencies and thought processes sufficient to support further studies or work in this or related fields.

Course Content:

Binary Operations: Definition and properties

Groups: Definition and Examples, Basic properties, Subgroups, Cyclic Groups, Abelian Groups, Finite & Infinite Groups, order of a group, order of an element

Normal subgroups: Definition and examples, Quotient groups, Cosets, Lagrange theorem

Group isomorphism: Definition of Group Homomorphism, Kernel of a homomorphism, Image of a homomorphism, Group Isomorphism

Rings: Definition and examples, Basic properties, Subrings, Characteristic of a ring, Ideals, Integral domains; Fields.

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Fraleigh, J.B. (8th Ed., 2020). *First Course in Abstract Algebra*, Pearson.
2. Dummit, D.S. & Foote, R.M. (3rd Ed., 2011). *Abstract Algebra,* Wiley.
3. Pinter, C.C. (2nd Ed., 2010). *A Book of Abstract Algebra*, Dover.

Year	**3**
Semester	**II**
Course Code:	**PMAT 37612**
Course Name:	**Theory of Riemann Integration**
Credit Value:	**2**
Compulsory/Optional	**Optional**
Pre-Requisites	**PMAT 17543**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

After the completion of this course unit, the student will be able to:

- identify the Darboux integrability considering the convergence of upper and lower Darboux sums.
- make use of first and second Cauchy's to decide the integrability of a function
- compare Riemann and Darboux integrals of a function and discuss the properties of Riemann Integrable functions
- prove and apply Intermediate Value Theorem for Integrals, Dominated Convergence Theorem and Monotone Convergence Theorem, and distinguish the Fundamental theorem of calculus and Second Mean Value Theorem for Integral
- categorize various types of improper integrals based on the locally integrability and make use of properties of improper integrals
- appraise improper integrals of nonnegative functions using given tests and determine absolute and conditional convergence of improper integrals
- identify appropriate change of variables to simplify improper integrals.

Course Content:

Darboux Integration: Upper and Lower Darboux sum, Darboux Integrability, Properties of darboux Integrability, First and Second Cauchy criterion for Integrability.

Riemann Integration: Riemann sum and the Riemann integral, Relationship between Darboux Integrability and Riemann Integrability, Properties of the Riemann integrability, Intermediate Value Theorem for Integrals, Dominated Convergence Theorem, Monotone Convergence Theorem,

Fundamental theorem of calculus, Second Mean Value Theorem for Integral, Change of Variables.

Improper Integrals

Improper Integrals of first and second kind based on locally integrability,

Improper integrals of unbounded functions (at left end, right end, both end and an interior point) with a finite domain of integral, Comparison test, Limit comparison test, Cauchy test, absolute and conditional convergence, convergence of beta function.

Improper integrals of bounded functions with infinite domain of integrals, convergence at infinity, Comparison test, Limit comparison test, Absolute and conditional convergence, convergence of Gamma function, Abel's test, Dirichlet's test.

Teaching/Learning Methods:

A combination of lectures and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical N/A

Others N/A

References/Reading Materials:

1. Ross, K.A. (2nd Ed., 2015). *Elementary Analysis. The Theory of Calculus*, Springer.

2. Trench, W.F. (Hyperlinked Edition 2.04 December 2013), *Introduction to Real Analysis*, Library of Congress Cataloging-in-Publication Data.
3. Widder, D.V. (2nd Ed., 2012). *Advanced Calculus.* Courier Corporation.

Year	**3**
Semester	**II**
Course Code:	**PMAT 37622**
Course Name:	**Mathematical Methods**
Credit Value:	**2**
Compulsory/Optional	**Optional**
Pre-Requisites	**PMAT 27583**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

After the completion of this course unit, the student will be able to:

- classify partial differential equations using various techniques learned
- solve hyperbolic, parabolic and elliptic equations using fundamental principles
- apply range of techniques to find solutions of standard PDEs
- demonstrate accurate and efficient use of Fourier analysis techniques and their applications in the theory of PDE's
- solve real world problems by identifying them appropriately from the perspective of partial derivative equations.

Course Content:

Partial Differential Equations (PDEs): Classification of PDE, First order partial differential equations: Lagrange's method and Charpit's method,

Second order partial differential equations: Linear Partial Differential Equations with Constant Coefficients, Partial Differential Equations of Order two with Variables Coefficients, Classification of Partial Differential Equations Reduction to Canonical or Normal Form: Parabolic, elliptic and hyperbolic partial differential equations.

Fourier Series: Fourier Series, Even and Odd Functions, Half-Range Expansions, Fourier Integral, Fourier Cosine and Sine Transforms

Solutions of PDEs: Separations of variables, Fourier Transforms, Laplace Transforms, D'Alembert's Solution of the Wave Equation

Teaching/Learning Methods:

A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:

Continuous Assessment 25%

Quizzes, tutorials

Final Assessment 75%

Theory 100%

Practical NA

Others NA

References/Reading Materials:

1. Kreyszig, E. (10th Ed., 2011). *Advanced Engineering Mathematics,* Wiley.

2. Zill, D.G. (7th Ed., 2020). *Advanced Engineering Mathematics*, Jones & Bartlett Learning.
3. Raisinghania, M.D. (19th Ed., 2018). *Advanced Differential Equations*, S.Chands, India.

Year	**3**
Semester	**II**
Course Code:	**PMAT 37632**
Course Name:	**Geometry**
Credit Value:	**2**
Compulsory/Optional	**Optional**
Pre-Requisites	**PMAT 27583**
Co-Requisites	**-**
Hourly Breakdown	
Theory	30 hours
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

Upon successful completion of the course students should be able to

- develop an intuitive understanding of the nature of general equation of second degree
- apply transformations and use symmetry to analyze mathematical situations.
- define conic sections and their properties
- explain and use various techniques for calculating tangents, normal, pair of tangents, pole and polar of conic sections
- compute lines, plane, cone, sphere, ellipsoid and hyperboloid in three dimensions

- analyze characteristics and properties of two dimensional and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
- demonstrate the knowledge of geometry and its applications in the real world.

Course Content:
Analytical Geometry in Two Dimensions: Pairs of straight lines, General equation of second degree, Translations and rotations of axes, Invariants of transformations
Conic sections: Classifying general equation of second degree into Parabolas, Ellipses, Hyperbolas, eccentricity. Equation of tangent, Pairs of tangents and chords of contact, Harmonic conjugates, Pole and Polar, Parametric treatment, Degenerate conic, Properties of conic.
Analytical Geometry in Three Dimension: Coordinate system, Direction cosines and direction ratios of a line, Angle between two lines, Parallel lines, Perpendicular lines, Plane and Straight line, Shortest distance between two-non intersecting lines, Skewed lines, General Equation of the second degree, Sphere, Cone, Ellipsoid and hyperboloid, Tangent plane, Normal, Pole and Polar.

Teaching/Learning Methods:
A combination of lectures, seminars and tutorial discussions.

Assessment Strategy:
Continuous Assessment 25%
Quizzes, tutorials
Final Assessment 75%
Theory 100%
Practical N/A
Others N/A

References/Reading Materials:

1. Chatterjee, D. (2008). *Analytical Geometry,* Alpha Science International.
2. Thomas, G.B. & Finney, R.L. (2008). *Calculus and Analytic Geometry.*
3. Maxwell, E.A. (1962). *Elementary Coordinate Geometry,* Oxford University press.
4. Jain, P.K. & Ahmad, K. (1994). *Analytical Geometry of Two Dimensions,* Wiley.
5. Kishan, H. (2006). *Coordinate Geometry of Two Dimensions.* Atlantic Publishers & Dist.
6. Jain, P.K. (2005*). A Textbook of Analytical Geometry of Three Dimensions.* New Age International.
7. McCrea, W.H. (2006). *Analytical Geometry of Three Dimensions*, Dover Publications, INC.

5.5 Statistics

Year	**1**
Semester	**1**
Course Code:	**STAT 16513**
Course Name:	**Fundamentals of Statistics**
Credit Value:	**4**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**A/L Combined Mathematics/ Mathematics**
Co-Requisites	**STAT 16521**
Hourly Breakdown	
Theory	45 hours
Practical	NA
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

On successful completion of this course unit the student should be able to:

- describe a given set of data in terms of the measurements of central tendency, dispersions,
- study given real-life situations by constructing appropriate statistical analysis and applying concepts and procedures in statistical decision making to those applications,
- demonstrate the importance of Statistics in making decisions on day-to-day life problems.

Course Content:

Introduction: Rationale for learning Statistics, How the Statistics serves the scientists, Basic terminology, Essence of Science, Types of measurement and Statistical approach.

Descriptive Statistics: Techniques of data presentation, Measures of Central Tendency, Measures of Dispersion and Shapes of distributions.

Probability: Algebra of sets, Permutations and Combinations, Random or non-deterministic experiment, Sample space, Events and event space, Classical, frequency and axiomatic definitions of probability, Conditional probability, Partition of a sample space, Total probability and Bayes' Theorem.

Probability Models: Bernoulli, Binomial, Poisson and Normal models.

Fitting a theoretical distribution to set of observed values: Binomial, Poisson and Normal distributions.

Sampling and sampling distributions: Random sampling, Stratified sampling, Sampling error, Sampling distributions and Degrees of freedom.

Tests of Hypotheses: Basic terminology of scientific research, Rationale of scientific decision making, Limitations of scientific decisions and the ways that they may be in error.

Decisions about relationships: Introduction to Correlation, Relationship between interval/ratio variables, Geometric appearance of relationship, Product-Moment Correlation.

Teaching /Learning Methods:

A combination of lectures and Assignments.

Assessment Strategy:

Assignments, End of Semester examination.

Continuous Assessment 30%

Final Assessment 70%

Details:Assignment (100%)

Tutorials , Quizzes, Mid term test

Theory 100%

Practical NA

Other (specify) NA

References/Reading Materials:

1. Runyon Richard P., Harber Andrey, Pittenger David J., Coleman Kay, 8th edition, (2002), *Fundamentals of Behavioural Sciences*, McGraw-Hill.
2. Anderson, D.R., Sweeney, D.J. and William, T.A, 3nd Edition, (1994), *Introduction to Statistics Concepts and Applications*, West Publishing Company.
3. Erricker B. C., (1977), Reprint, *Advanced General Statistics*, Alden Press Oxford.
4. Ross, S.M., 5nd Edition, (2014), *Introduction to Probability and Statistics for Engineers and Scientists*, Harcourt Academic Press.
5. Jessica, M. U. 3rd Edition (2005), *Seeing through Statistics*, Thomson Learning.

Year	**1**
Semester	**1**
Course Code:	**STAT 16522**
Course Name:	**Statistical Laboratory**
Credit Value:	**1**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**A/L Combined Mathematics/ Mathematics**
Co-Requisites	**STAT 16514**
Hourly Breakdown	
Theory	00 hours
Practical	60 hours
Independent Learning	40 hours

Course Aim/Intended Learning Outcomes:

On successful completion of this course module, the students will be able to

- apply techniques provided in Statistical Packages to solve problems in Statistics.
- interpret statistical outputs to a diverse audience

Course Content:

Descriptive Statistics: Applications of data presentation techniques, Uses of Central Tendency and Dispersion measures in real world applications, Detection of outliers, missing value imputation, Identifying relationships among variables

Probability sampling: simple random sampling, sampling with and without replacement, identifying the sampling distribution

Probability distributions: simulate standard probability distributions, Applications of standard probability distributions

Introduction to statistical programming

Teaching /Learning Methods:

Practical sessions using appropriate statistical software and assignments.

Assessment Strategy:

End of course practical examination and assignments

Continuous Assessment 30%

Details:Assignments (100%):Assignments using Statistical Software

Final Assessment 70%

Theory NA

Practical 100%

Other (%)(specify) NA

References/Reading Materials:

1. Manuals relevant to statistical packages
2. Runyon Richard P., Harber Andrey, Pittenger David J., Coleman Kay, 8th edition, (2002), *Fundamentals of Behavioural Sciences*, McGraw-Hill.
3. Horvath Theadore, (1985), *Basic Statistics for Behavioural Sciences*, LittleBrown & Company.
4. Jessica, M. U. 3rd Edition (2005), *Seeing through Statistics*, Thomson Learning.

Year	**1**
Semester	**II**
Course Code:	**STAT 17533**
Course Name:	**Probability Distributions and Applications I**
Credit Value:	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 16513**
Co-Requisites	**None**
Hourly Breakdown	
Theory	45 hours
Practical	NA
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

On successful completion of this course unit the student should be able to

- define probability distributions and density functions for random variables in general and discuss their properties,
- explain different types of probability distributions with their properties,
- use probability distributions to calculate different probabilities in order to solve problems arising from a wide range of disciplines.

Course Content:

Probability: Axiomatic definitions of probability, and rigorously prove basic propositions of probability theory;

Random variables: Rationale for the introduction of random vari-

ables, Definition of a random variable, Types of random variable.
Distributions: Discrete probability density function (d.p.d.f) of a discrete random variable, Properties of d.p.d.f., Probability density function (p.d.f.) of a continuous random variable, Properties of p.d.f., Cumulative probability distribution function (c.p.d.f.) of a random variable and Properties of c.p.d.f.
Expectation of a function of a random variable: General definition, Properties of expectation, Mean, Variance and Standard deviation, Moments, Moment generating function, Probability generating function and Characteristic function, Tshebysheff's Lemma or Chebychev's theorem, Generalized form of Bienayme-Tchebycheff Inequality, Tchebycheff Inequality, Bernoulli's Law of Large Numbers.
Transformation: find the distribution of transformed random variables;
Discrete Probability Distributions: Discrete uniform, Bernoulli, Binomial, Poisson, Geometric, Hypergeometric and Negative binomial distributions, Poisson approximation to Binomial distribution.
Continuous Probability Distributions: Uniform, Normal, Negative exponential, Gamma, Beta and Log-normal distributions, Normal approximation to Binomial distribution, Normal approximation to Poisson distribution.
Probability integral transform.
Applications of probability in other disciplines.

Teaching /Learning Methods:

A combination of lectures and tutorials.

Assessment Strategy:

Assignments and End of semester examination.

Continuous Assessment 30%

Details:

Assignments (100%):

Tutorials, Quizzes, Midterm test

Final Assessment 70%

Theory 100%

Practical NA

Other (specify) NA

References/Reading Materials:

1. Alexander M. Mood., Franklin A. Graybill, Pittenger Duane C. Boes, 3rd edition, Reprint (2005), *Introduction to the Theory of Statistics*, McGraw-Hill.
2. Ronald E. Walpole, Raymand H.Mayers, 9th Edition (2012), *Probability and Statistics for Engineers and Scientits*, Prentice Hall.
3. Dennis Wackerly, William Mendenhall, Richard L. Scheaffer, 7th edition (2008), *Mathematical Statistics with Applications*, Thomson Learning.
4. George Casella and Roger L. Berger, 2nd edition, (2001), *Statistical Inference*, Thomson Learning.

Year	**1**
Semester	**II**
Course Code:	**STAT 17542**
Course Name:	**Optimization I**
Credit Value:	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**A/L Combined Mathematics/ Mathematics.**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	15 hours
Independent Learning	55 hours

Course Aim/Intended Learning Outcomes:

At the end of this course unit the student should be able to

- translate real life situations involving linear relationship into Linear Programming (LP) Models,
- apply Optimization techniques in solving LP models.

Course Content:

Overview: outline of Operations Research Modelling Approach.

Linear Programming: Introduction to Linear Programming, Construction of Mathematical Models,

Solution Techniques: Graphical Method, Simplex Method**;** Algebraic Approach**,** Tabulation Approach**.**

Duality and Sensitivity Analysis: Essence of duality theory, Economic interpretation of duality, Primal-dual relationships , Role of duality theory in sensitivity analysis, Essence of sensitivity analysis, and Applying sensitivity analysis.

Teaching /Learning Methods:

A combination of lectures, practical sessions using appropriate software and tutorials

Assessment Strategy:

Assignments and End of semester examination
Continuous Assessment 30%
Final Assessment 70%
Details:
Assignments (100 %)
Tutorials, Quizzes ,Midterm test
Theory 100%
Practical NA
Other (specify) NA

References/Reading Materials:

1. Fredrick S. Hiller, Gerald J. Lieberman, 8th Edition, (2005), *Introduction to Operations Research*, Mc-Graw Hill.
2. Hamdy A. Taha, 8th Edition, (2007), *Operations Research*, Tara Mc-Graw Hill.
3. Bazaraa M.S., Javis J.J., Sherali H. D., 3rd Edition, (2010), *Linear programming and network flows*, John Wiley & Sons.

Year	**2**
Semester	**I**
Course Code:	**STAT 26513**
Course Name:	**Probability Distributions and Applications II**
Credit Value:	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 17533**
Co-Requisites	**None**
Hourly Breakdown	
Theory	45 hours
Practical	NA
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

On successful completion of this course unit the student should be able to

- explain the properties of joint probability distribution, joint density functions and marginal density functions,
- carry out probabilistic calculations to determine whether specified events, or specified random variables, are dependent or independent,
- use joint probability distributions to calculate different probabilities in order to solve problems arising from a wide range of disciplines.

Course Content:

Two-dimensional Random variables: Rationale for the introduction of two-dimensional random variables,

Cumulative distribution function of two-dimensional random variable: Definition, Properties of bivariate cumulative distribution function, Joint density functions, Marginal density functions, Conditional probability distributions, Independence and related theorems.

Expectations: Expectation of a function of two-dimensional random variable, Covariance and correlation coefficient, Conditional expectation and related theorem, Conditional variance and related theorem, Joint moments, Joint moment generating function, Uncorrelated random variables and Cauchy-Schwartz Inequality.

Distributions of functions of random variables and Expectations: Distributions of sum, difference, product and quotient of two continuous random variables, Expectations and related theorems.

Cumulative distribution function techniques: Probability distributions of maximum and minimum of a set of random variables.

Moment generating function techniques: Distribution of sum of independent random variables, Central limit theorem.

Transformations: The joint probability density function of random variables

Sampling and sampling distributions: Sampling, Distribution of a sample, Sample moments, Sample variance, Law of Large Numbers, Concept of Convergence of random variables, Central Limit theorem, sampling from Normal distribution, Chi-square distribution, Student's t - distribution and F - distribution.

Teaching /Learning Methods:

A combination of lectures and tutorials.

Assessment Strategy:

Assignments and End of semester examination.

Continuous Assessment 30%

Details:

Assignments (100 %):

Tutorials, Quizzes , Midterm test

Final Assessment 70%

Theory 100

Practical NA

Other (specify) NA

References/Reading Materials:

1. Alexander M. Mood, Franklin A..Graybill , Pittenger Duane C. Boes, 3rd Edition, Reprinted (2005), *Introduction to the Theory of Statistics*, McGraw-Hill.
2. Ronald E. Walpole, Raymand H.Mayers, 9th Edition (2012), *Probability and Statistics for Engineers and Scientits*, Prentice Hall.
3. Dennis Wackerly, William Mendenhall, Richard L. Scheaffer, 7th edition (2008), *Mathematical Statistics with Applications*, Thomson Learning.

Year	**2**
Semester	**I**
Course Code:	**STAT 26522**
Course Name:	**Optimization II**
Credit Value:	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 17542**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	15 hours
Independent Learning	55 hours

Course Aim/Intended Learning Outcomes:

At the end of this course unit the students should be able to

- solve real life problems using optimization techniques in Transportation, Assignment, Networks,
- apply Integer programming models and Game theory to real life situations,
- plan and control project using PERT and CPM,
- identify queue characteristics using Kendal notation and study the long term behaviour of queuing systems using balance equations.

Course Content:

Transportation Problem: Transportation models, Transportation algorithms, Streamlined simplex method for the transportation problem.

Assignment Problem: Introduction to Assignment Problem**,** Construction of Model and Solution Procedures.

Network Optimization Models: Terminology of Networks, Shortest-Path Problem, Minimum Spanning Tree Problem, Maximum Flow Problem, Minimum Cost Flow Problem.

Project Management: Project planning and control with PERT-CPM: Reliable Construction co. Project, Project Networks, Scheduling a Project with PERT/CPM, Dealing with Uncertain Activity Durations, Considering Time-Cost Trade-Offs, Scheduling and Controlling Project Costs, Scheduling and Controlling Project Costs and Evaluation of PERT/CPM**.**

Queuing Theory: Queuing Systems, Queue Characteristics, Poisson Process, and M/M/1 System, Other Systems (M/M/s, M/M/1/k, and M/M/s/k).

Teaching /Learning Methods:

A combination of lectures, Practical sessions using appropriate software and tutorials.

Assessment Strategy:

Assignments and End of semester examination.

Continuous Assessment 30%

Final Assessment 70%

Details:

Assignments (100%):

Tutorials, Quizzes ,Midterm test100

Theory 100%

Practical NA

Other (specify)NA

References/Reading Materials:

1. Fredrick S. Hiller, Gerald J. Lieberman, 8th Edition, (2005), *Introduction to Operations Research,* Mc-Graw Hill.
2. Hamdy A. Taha, 8th Edition, (2007), *Operations Research*, Tara Mc-Graw Hill.
3. Bazaraa M.S., Javis J.J., Sherali H. D., 3rd Edition, (2010), *Linear programming and network flows*, John Wiley & Sons.

Year	**2**
Semester	**II**
Course Code:	**STAT 27533**
Course Name:	**Inferential Statistics**
Credit Value:	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 26513**
Co-Requisites	**None**
Hourly Breakdown	
Theory	45 hours
Practical	NA
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to

- derive point estimators for a given statistical models using method of moments,
- perform likelihood based point estimation for a variety of statistical models,

- use the key properties of the estimators to identify the most appropriate estimators of a statistical model,
- derive interval estimates of parameters in simple statistical models,
- formulate hypothesis tests in some common contexts, correctly using the terms null hypothesis, alternative hypothesis, test statistic, rejection region, significance level, power, p-value,
- perform common hypothesis tests, with due regard to the underlying assumptions.

Course Content:

Point Estimation: Introduction to Point Estimation**,**

Methods of Point Estimation: Methods of Moments, Maximum Likelihood Method.

Properties of Point Estimators: Closeness, Mean – Squared Error, Unbiasedness, Consistency and BAN, Sufficiency.

Unbiased Estimators: UMVUE, Cramer-Rao inequality, Sufficiency and Completeness, Exponential family of distributions, Rao-Blackwell theorem, Lehmann-Scheffe theorem.

Interval Estimation: Introduction to intervals, Pivotal quantity method**.**

Sampling from Normal Distribution: Confidence intervals for mean, variance, proportion, Simultaneous confidence region for the mean and variance, Confidence interval for difference in means, Approximate confidence intervals.

Test of Hypotheses: Introduction and terminology to hypotheses, Simple versus simple, Simple verses composite

Most Powerful Test: Definition**,** Neyman-Pearson criteria, Neyman-Pearson Lemma**.**

Composite Hypotheses: Generalized Likelihood ratio test, Uniformly most powerful test.
Sampling from the Normal Distribution: Tests on the mean, Test on the variance, Tests on the several Means, Tests on several variances.

Teaching /Learning Methods:
A combination of lectures and tutorials

Assessment Strategy:
Assignments and End of semester examination.
Continuous Assessment 30%
Details:
Assignments (100 %)
Tutorials, Quizzes, Midterm test
Final Assessment 70%
Theory 100%
Practical NA
Other (specify) NA

References/Reading Materials:

1. Alexander M. Mood, Franklin A..Graybill , Pittenger Duane C. Boes, 3rd Edition, Reprinted (2005), *Introduction to the Theory of Statistics*, McGraw-Hill.
2. Ronald E. Walpole, Raymand H. Mayers, 9th edition (2012), *Probability and Statistics for Engineers and Scientits***,** Prentice Hall.
3. George Casella and Roger L. Berger, *Statistical Inference*, 2nd edition(2001), Cengage Learning.

Year	**2**
Semester	**II**
Course Code:	**STAT 27542**
Course Name:	**Survey Methods and Sampling Techniques**
Credit Value:	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 26513**
Co-Requisites	**STAT 27533**
Hourly Breakdown	
Theory	30 hours
Practical	NA
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the end of this course unit the student should be able to

- plan and conduct a survey for a given study,
- apply the most appropriate sampling techniques, analyse the results and disseminate the findings to the general audience.

Course Content:

Survey Methods: General concepts of surveys, Introduction to different survey methods, Advantages and disadvantages of the methods,

Principal steps in a sample survey: Techniques of data collection, Questionnaire design, Validation and the reliability, Selection of proper sample design, determination of sample size, Organization of field work, Pilot survey, Analyze the results and draw conclusions

Sampling Techniques: Introduction and terminology, Probability vs Non-Probability Sampling,
Probability Sampling Techniques: Simple Random Sampling, Stratified Random Sampling, Systematic sampling, Cluster sampling and Multi stage sampling, Sample Size Calculations

Teaching /Learning Methods:
A combination of lectures case studies and tutorials

Assessment Strategy:
Assignments and End of Semester examination.
Continuous Assessment 30%
Details:
Assignments (100%):
Tutorials, Quizzes, Case studies,Midterm test
Final Assessment 70%
Theory 100%
Practical NA
Other (specify) NA

References/Reading Materials:

1. Cochran, W.G., 3rd Edition, (1977), *Sampling Techniques*, John Wiley & Sons
2. Scheaffer, R.L., Mendenhall, W.,Ott, R.L., 6th Edition (2006), *Elementary Survey Sampling*, Thomson Brooks/Cole
3. Barnet, V., 3rd Edition, (1974), *Elements of Sampling Theory*, London: The English University Press Ltd
4. Sharon Lohr, 2nd Edition, (2010), *Sampling: Design and Analysis*, Cengage.

Year	**3**
Semester	**I**
Course Code:	**STAT 36513**
Course Name:	**Statistical Models**
Credit Value:	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 27533**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	30 hours
Independent Learning	90 hours

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to

- identify the main variables of interest in a regression problem.
- effectively apply regression techniques to build statistical models for the real life problems.
- assess the assumptions underlying regression models.
- identify the best possible experimental design for a given scenario.
- apply theory and methods to obtain objective conclusions of variety of applications.
- evaluate designs using common optimality criteria and use them to critically compare competing designs.

Course Content:

Simple linear regression: Parameter estimation, Gauss-Markov Theorem, Statistical inferences, Prediction, Analysis of variance approach, Regression in matrix form, Model adequacy, Lack of fit.

Multiple linear regression: Parameter estimation, Statistical inferences, Model adequacy, diagnostics for leverage and influential observations, Multicolinearity, Heteroscedasticity, Transformations, Prediction, Variable selection and model building procedures, categorical predictor variables, interaction terms.

Non-Linear Regression: Parameter Estimation in a Nonlinear System, Statistical Inference in Nonlinear Regression, logistic regression.

Design and Analysis of Experiments: Principles of design, Analysis of variance for one-way classification and two-way classification, Missing values, Multiple comparisons.

Teaching /Learning Methods:

A combination of lectures, tutorial and practical sessions using suitable statistical software

Assessment Strategy:

Assignments and End of Semester examination.

Continuous Assessment 30%

Details:

Assignments (100 %):

Tutorials, Quizzes, Midterm test

Final Assessment 70 %

Theory 100

Practical NA

Other (specify) NA

References/Reading Materials:

1. Draper, N.R and smith, 3rd Edition, (1998), *Applied Regression Analysis*, John Wiley & Sons.
2. Montgomery, D.C., Peck, E. A. and Vining, G. G. 5th Edition, (2012), *Introduction to Linear Regression Analysis*, John Wiley & Sons.
3. Chatterjee, S., Hadi, A. S. 5th Edition, (2013), *Regression Analysis by Example*, John Wiley & Sons.
4. Montgomery, D.C., 8th Edition, (2013), *Design and Analysis of Experiments*, John Wiley & Sons.
5. Hicks, C.R., Kenneth, V., Turner, Jr., 5th Edition, (1999), *Fundamental Concepts in Design of Experiments*, Oxford University Press.

Year	**3**
Semester	**I**
Course Code:	**STAT 36522**
Course Name:	**Statistical Quality Control**
Credit Value:	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 17533, STAT 27542**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	NA
Independent Learning	70 hours

Course Aim/Intended Learning Outcomes:

At the end of this course unit the student should be able to

- describe the concepts underlying statistical quality control.
- apply the techniques to design and improve the quality control processes in industries

Course Content:

Definition and Terminology: Definitions of Quality, Dimensions of Quality, Quality Characteristics, Quality Costs, Quality Assurance, Philosophies

Concepts of Statistical Quality Control: Chance Causes and Assignable Causes**,** Magnificent seven, Sample size and Sampling frequency, Rational Subgrouping,

Control Charts for Variables: Control charts for the mean and range, Control charts for mean and standard deviation, Changing sample size on control charts, Control Chart for individual measurements

Control Charts for Attributes: Control Chart for Fraction Nonconforming, Control Chart for Number Nonconforming

Further Aspects in Quality Control: Process Capability Ratios, **Acceptance** sampling, Average Run Lengths, OC-curves, Process curve, Methods of choosing sampling plans, Cumulative sum charts, Decision rules, Continuous sampling plans, Process trouble shooting.

Teaching /Learning Methods:

A combination of lectures and tutorials

Assessment Strategy:

Assignments and End of Semester examination

Continuous Assessment 30%

Details:

Assignments (100%):

Tutorials, Quizzes, Midterm test

Final Assessment 70%

Theory 100 %

Practical NA

Other (specify) NA

References/Reading Materials:

1. Douglas C. Montgomery, 8th Edition, (2019), *Introduction to Statistical Quality Control,* John Wiley and Sons.
2. Qiu, P. (2014), *Introduction to statistical process control*, Boca Raton, FL : CRC Press,

Year	**3**
Semester	**II**
Course Code:	**STAT 37532**
Course Name:	**Non- parametric Statistics**
Credit Value:	**2**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 27542**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	15 hours
Independent Learning	55 hours

Course Aim/Intended Learning Outcomes:

On completion of this course student should be able to:

- explain nonparametric statistical techniques and explain basis properties of nonparametric techniques,
- analyse a given data set using appropriate nonparametric statistical techniques.

Course Content:

Introduction: Nonparametric statistics, Nonparametric estimation of distribution functions and quintiles, A confidence band for Confidence intervals for the distribution function at a fixed point, Confidence intervals for quantiles using order statistics,

Goodness-of-Fit Tests: Simple GoF using the Empirical CDF, Chi-Square-type GoF tests, Probability Plotting and Quantile -Quantile Plots,

Tests based on Signs, Runs and Ranks: Two sample test procedures, Paired sample procedures, Ranks, The Wilcoxon Signed-Rank Test, The General Two-Sample Problem, The Wald-Wolfowitz Runs Test, The Wilcoxon Rank-Sum Test, Median Test, Sign Test, Nonparametric Behrens-Fisher problem in paired data

Nonparametric Behrens-Fisher Problem: Brunner-Munzel test,

Measures of Association: Towards General Measures of Association, Kendall's Tau, Spearman correlation , Kruskal-Wallis test and multiple testing procedures.

Teaching /Learning Methods:

A combination of lectures and tutorials

Assessment Strategy:

Assignments and End of Semester examination

Continuous Assessment 30%

Details:

Assignments 100 %: Tutorials, Quizzes, Midterm test

Final Assessment 70%

Theory 100%
Practical NA
Other (specify) NA

References/Reading Materials:

1. Alexander M. Mood, Franklin A. Graybill , Pittenger Duane C. Boes, 3rd Edition, Reprinted (2005), *Introduction to the Theory of Statistics*, McGraw-Hill.
2. Higgins, J. (2003). *Introduction to Modern Nonparametric Statistics*, Duxbury.
3. Larry Wasserman, (2006), *All of Nonparametric Statistics*. Springer
4. Ronald E. Walpole, Raymand H. Mayers, 6th edition, (1997), *Probability and Statistics for Engineers and Scientits*.
5. Brunner, E., Bathke, A. C., & Konietschke, F. (2018). *Rank and Pseudo-Rank Procedures for Independent Observations in Factorial Designs*. Springer International Publishing

Year	**3**
Semester	**II**
Course Code	**STAT 37543**
Course Name	**Time Series Analysis**
Credit Value	**3**
Compulsory / Optional	**Compulsory**
Pre-Requisites	**STAT 36513**
Co-Requisites	**None**
Hourly Breakdown	
Theory	30 hours
Practical	15 hours
Independent Learning	105 hours

Course Aim/Intended Learning Outcomes:

At the end of this unit students should be able to

- recognize time series processes and their characteristics,
- fit suitable models to the real world time series data,
- use forecasting techniques to predict future values of the model under consideration,
- use statistical software for predictive inferences.

Course Content:

An introduction to Time Series, Stationary time series, Components of a time series,

Estimation and Elimination of Trend and Seasonal Components

Simple forecasting techniques: Moving averages, Exponential smoothing, Holt-Winters procedure,

Introduction to Auto-Covariance function, Auto-Correlation function, partial autocorrelation function

Models of time series: Auto Regressive models, Moving Average models, Auto Regressive Moving Average models, and Auto Regressive Integrated Moving Average models, Seasonal ARIMA models Tentative identification of a model for a real world time series and estimation of model parameters using R software , Model checking and forecasting, Case Studies.

Teaching /Learning Methods:

A combination of lectures, tutorials and practical sessions using suitable statistical software

Assessment Strategy:

Assignments and End of Semester examination

Continuous Assessment 30%

Details:

Assignments 100 %:

Tutorials, Quizzes, Midterm test

Final Assessment 70%

Theory 100%

Practical NA

Other (specify) NA

References/Reading Materials:

1. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, 2nd Edition (2015), *Introduction to Time Series Analysis and Forecasting*, John Wiley.
2. Brockwell and Davis, 2nd Edition, (1991), *Time Series-Method and Forecasting*, Springer.
3. DeLurgio, S.A., (1998), *Forecasting Principles and Applications*, McGraw Hill.
4. Chatfield, C., 2nd Edition, (1980), *Analysis of Time Series*, Chapman-Hall.

06. Pathway Table

6.1 BSc Degree External Programme – Year 1 (SLQF LEVEL 3)

Course code	Course unit combination		
	1	2	3
AMAT 16513	C	C	
AMAT 16522	C	C	
AMAT 17532	C	C	
AMAT 17543	C	C	
COSC 16012		C	C
COSC 16023		C	C
COSC 17032		C	C
COSC 17043		C	C
PMAT 16513	C	C	C
PMAT 16522	C	C	C
PMAT 17532	C	C	C
PMAT 17543	C	C	C
STAT 16513	C		C
STAT 16522	C		C
STAT 17533	C		C
STAT 17542	C		C
No of Credits from Compulsory Units	**30**	**30**	**30**

6.2 BSc Degree Programme – Year 2 (SLQF LEVEL 4)

Course code	Course unit combination		
	1	2	3
AMAT 26553	C	C	
AMAT 26562	C	C	
AMAT 27572	C	C	
AMAT 27582	C	C	
COSC 26052		C	C
COSC 26063		C	C
COSC 27072		C	C
COSC 27083		C	C
PMAT 26553	C	C	C
PMAT 26562	C	C	C
PMAT 27573	C	C	C
PMAT 27583	C	C	C
STAT 26513	C		C
STAT 26522	C		C
STAT 27533	C		C
STAT 27542	C		C
No of Credits from Compulsory Units	**30**	**30**	**31**

6.3 BSc Degree Programme – Year 3 (SLQF LEVEL 5)

Course code	**Course unit combination**		
	1	**2**	**3**
AMAT 36593	C	C	
AMAT 36603	C	C	
AMAT 37613	C	C	
AMAT 37623	C	C	
COSC 36092		C	C
COSC 36103		C	C
COSC 37113		C	C
COSC 37122		C	C
PMAT 36593	C	C	C
PMAT 36602	C	C	C
PMAT 37612	C	C	C
PMAT 37622	C	C	C
PMAT 37632	C	C	C
STAT 36513	C		C
STAT 36522	C		C
STAT 37532	C		C
STAT 37543	C		C
CBWT 38013	O	O	O
No of Credits from Compulsory Units	**33**	**33**	**31**
No of Credits from Optional Units	**03**	**03**	**03**

7. Assessment Criteria

7.1 Assessment Procedure

Student performance at a course unit is generally assessed through assignments, reports, presentations, practical examinations, and end of course examinations. The method of assessment will be announced by the relevant Department at the commencement of a course unit.

7.2 Grading System

Marks obtained in respect of a course unit will be graded according to the following grading system. A grade point value as indicated below is assigned to each grade.

Marks	Grade	Grade Point Value
85-100	A+	4.00
70-84	A	4.00
65-69	A-	3.70
60-64	B+	3.30
55-59	B	3.00
50-54	B-	2.70
45-49	C+	2.30
40-44	C	2.00
35-39	C-	1.70
30-34	D+	1.30
25-29	D	1.00
00-24	E	0.00

Students should complete all course units that they are registered for and if they fail to complete a particular course unit, it will be indicated in the transcript as "absent" and a zero (0.0) grade point value will be assigned to it.

7.3 Repeating a Course Unit Examination

A student who does not obtain a grade C or better in a particular course unit may re-sit the examination of that course unit in the following academic year for the purpose of improving the grade. The best grade obtainable by a student in this instance would be C. In the event a student obtains a lower grade while attempting to better the grade, he/she will be entitled to the previous grade.

7.4 Grade Point Average

Grade Point Average (GPA) is the credit-weighted arithmetic mean of the Grade Point Values, which is determined by dividing the total credit-weighted Grade Point Value by the total number of credits. GPA shall be computed to the second decimal place.

Example: A student who has completed one course unit with two credits, three course units each of three credits and two course units each of 1 credit with grades A, C, B, D, C+ and A+ respectively would have the GPA of 2×48 as calculated below.

$$\frac{(2\times 4\cdot 0)+(3\times 2\cdot 0)+(3\times 3\cdot 0)+(3\times 1\cdot 0)+(1\times 2\cdot 3)+(1\times 4\cdot 0)}{2+3+3+3+1+1}=\frac{32\cdot 3}{13}= \quad 2\cdot 4846$$

Grade Point Average = 2.48

Grade point values and credit values of all registered course units in a study programme of a student shall be taken into account in calculating the final GPA, unless stated otherwise.

7.5 Award of the Bachelor of Science (External) Degree

7.5.1 Eligibility for the Award of the Bachelor of Science (External) Degree

To be eligible for the BSc (External) Degree a student must

i. accumulate grades of D or better in course units, aggregating to at least 60 credits during the first two academic years, and aggregating to at least 90 credits during the entire three academic year period, of which at least 30 credits must be from each academic year separately,

ii. obtain grades of C or better in course units aggregating to at least 72 credits, of which at least 48 must be from two subjects with at least 24 credits from each of them, and grades of D or better in course units aggregating to at least further 18 credits, considered under above

iii. obtain a GPA of 2.00 or greater, and

iv. complete the relevant requirements within a period of five consecutive academic years.

7.5.2 Award of Classes

7.5.2.1 First Class

A student who is eligible for the BSc (External) Degree may be awarded First Class provided he/she

(i) obtains grades of C or better in course units aggregating to at least 90 credits, considered under 2.5.1 (ii),

(ii) obtains grades of A or better in course units aggregating to at least half the number of total credits for the course units considered under 2.5.1 (ii),

(iii) obtains a GPA of 3.70 or greater, and

(iv) completes the relevant requirements within three consecutive academic years.

7.5.2.2 Second Class (Upper Division)

A student who is eligible for the BSc (External) Degree may be awarded Second Class (Upper Division) provided he/she

(i) obtains grades of C or better in course units aggregating to at least 80 credits and grades of D or better in the remaining course units, considered under 2.5.1 (ii),

(ii) obtains grades of B or better in course units aggregating to at least half the number of total credits for the course units considered under 2.5.1(ii),

(iii) obtains a GPA of 3.30 or greater, and

(iv) completes the relevant requirements within three consecutive academic years.

7.5.2.3 Second Class (Lower Division)

A student who is eligible for the BSc (External) Degree may be awarded Second Class (Lower Division) provided he/she

(i) obtains grades of C or better in course units aggregating to at least 80 credits and grades of D or better in the remaining course units, considered under 2.5.1(ii),

(ii) obtains grades of B or better in course units aggregating to at least half the number of total credits for the course units considered under 2.5.1(ii),

(iii) obtains a GPA of 3.00 or greater, and

(iv) completes the relevant requirements within three consecutive academic years