	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) Mathematics**
Course Name	**Actuarial Mathematics**
Type of Course	**DSE**
Course Code	**MG3DSEMAT200**
Course Level	**200-299**
Course Summary	Mathematical and statistical techniques and models are very useful to analyse and manage financial risks and to create and interpret financial models to assess the impact of different scenarios and decisions. This course provide some actuarial skills relevant for risk management, data science/analysis, valuation of future assets and liabilities and risk analysis.

Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		4	0	0	0	**60**
Pre- requisites, If any	Linear Algebra, Probability, Random variable, Random Process					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand Random variables as models of financial entities	U	1,2,3,4,10

2	Understand and apply the Finite-state Markov Chains	A	1,2,5,9,10
3	Understand and apply Poisson processes and Brownian motion	A	1,2,3,4,10
4	Apply the multi-state models to multi-state annuities & reserves	A	3,6,7,9,10
5	Analyse the features of Financial Markets using Mathematical concepts.	An	1,2,4,9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO NO:	Hours
1	1.1	Probability and Random Variables, "Time until Termination" as a Random Variable, "Number of Claims" as a Random Variable, "Claim Amount" as a Random Variable, "Total Claims" as a Random Variable	1	18
	1.2	"Rate of Interest" as a Random Variable, The Importance of Expected Values, Actuarial Interest in Human Mortality	1	
	1.3	An introduction to Stochastic Processes, Markov Chains: Definitions and Examples, Martingales	2	
	1.4	Finite-state Markov Chains, The transition matrix, Multi-period transitions, Distributions, Limiting distributions, Recurrent and transient states	2	
	Text 2 : Chapter III – Sections: 1 to 8; Text 1: Chapter 18 – Sections: 18.1 to 18.4			
2	2.1	Poisson Processes, Waiting times, Nonhomogeneous Poisson processes	3	
	2.2	Introduction to Brownian motion, The main definition, Connection with Random walks,	3	12

		Hitting times		
	2.3	Conditional distributions, Brownian motion with drift, Geometric Brownian motion	3	
	Text 1: Chapter 18 – Sections: 18.6 & 18.7			
3	3.1	Introduction to multi-state models, The discrete-time model, Non-stationary Markov Chains, Discrete-time multi-state insurances, Multi-state annuities	4	**18**
	3.2	The continuous-time model, Forces of transition, Path-by-path analysis, Numerical approximation	4	
	3.3	Stationary continuous time processes, Some methods for non-stationary processes, Extension of the common shock model, Insurance/annuity applications in continuous time	4	
	3.4	Recurrence equations for multi-state reserves, Differential equations for multi-state reserves	4	
	Text 1: Chapter 19 – Sections: 19.1 to 19.4			
4	4.1	Mathematics of Financial Markets, Modelling prices in financial markets, Arbitrage, Option contracts, Option prices in the one-period binomial model	5	**12**
	4.2	The multi-period binomial model, American options, A general financial market, Arbitrage-free condition	5	
	4.3	Existence and uniqueness of risk-Neutral measures, Linear algebra background, The space of contingent claims, Fundamental theorem of asset pricing completed, Completeness of markets, The Black–Scholes–Merton formula for pricing	5	
	Text 1: Chapter 20 – Sections: 20.1 to 20.12			

5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Lectures, Interactive instruction, Seminar, Group assignment, Group Discussion, Debate, Materials collection, Essay writing, Poster/Paper presentation					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**				
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**				
		Module	Part A	Part B	Part C	Total
			2 Marks	**6 Marks**	**10 Marks**	
		I	2	2	2	**6**
		II	2	2	2	**6**
		III	2	2	1	**5**
		IV	2	2	1	**5**
		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

REFERENCES:

1. S. David Promislow, Fundamentals of Actuarial Mathematics (Third Edition), John Wiley & Sons, 2015
2. Charles L. Trowbridge, Fundamental Concepts of Actuarial Science (Revised Edition), Actuarial Education and Research Fund, 1989

SUGGESTED READINGS

1. Bower NL, Gerber HU, Hickman JC, Jones DA, Nesbitt CJ, *Actuarial Mathematics*, 1997.
2. Brealy and Myers. *Corporate Finance*, Mc Graw Hill, 2023.
3. Lerner and Zima, *Business Mathematics*, Schaum's Outline Series.
4. Leuenberger. *Investment Science*, Oxford University Press, Second Edition, 2013

Mahatma Gandhi University

Kottayam

Programme						
Course Name	**Essentials of Applied Mathematics**					
Type of Course	**DSC B**					
Course Code	**MG3DSCMAT202**					
Course Level	**200-299**					
Course Summary	This Mathematics minor course complements and enhances the undergraduate programmes by enabling the students to understand and apply the concepts of complex numbers and analytic functions, to solve differential equations of different types, to identify different conic sections and its applications in possible areas and to determine unit tangent vector, principal normal vector, and curvature of different curves.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Basic awareness of coordinate systems, vectors, functions, derivatives, and integrals					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand and apply the concepts of complex numbers and complex functions	A	1
2	Analyse the nature of a differential equation and solve using appropriate methods.	E	2
3	Identify conic sections from their cartesian and polar equations.	A	1

4	Understand and apply the concepts of vector calculus	A	3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Complex Functions**		**20**
	1.1	Complex Numbers, Sums and Products, Algebraic Properties, moduli, conjugates, Exponential and Polar Forms, Products and Powers in Exponential form	1	
	1.2	Functions of Complex Variables, Separation into Real and Imaginary parts, Limits and Continuity	1	
	1.3	Derivatives, Analytic Function, Cauchy-Riemann Equations, Laplace Equation, Harmonic Function	1	
		Problems (Practicum)	1	
	Text 1: Chapter 1 – Sections: 1 to 7; Chapter 2 – Sections: 12, 15 to 22, 24 to 26 **Theorems – Statements Only**			
2		**Differential Equations**		**18**
	2.1	Degree, Order, Solution of Differential Equations, Variable Separable method	2	
	2.2	First order Linear Differential Equations	2	
	2.3	Exact Differential Equations	2	
		Problems (Practicum)	2	
	Text 2: Chapter 1 – Sections: 1.1 to 1.5 **Theorems – Statements Only**			
3		**Analytic Geometry**		**17**
	3.1	Polar coordinates	3	
	3.2	Conic sections	3	
	3.3	Conic section in polar coordinates	3	
		Problems (Practicum)	3	
	Text 3: Chapter 11 – sections: 11.3,11.6 & 11.7			

	Theorems – Statements Only			
4		**Vector Calculus**		**20**
	4.1	Curves in Space and tangents, Velocity and Acceleration, Arc length in space	4	
	4.2	Curvature and Normal vectors of a curve	4	
	4.3	Directional derivatives and gradient vectors	4	
		Problems (Practicum)	4	
	Text 3: Chapter 13 – Sections: 13.1,13.3,13.4; Chapter 14 – Section: 14.5 Theorems – Statements Only			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
Practicum is designed to provide supervised practical application of theoretical knowledge and skills. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co-operative Learning,

<table>
<tr><td rowspan="15">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) 30 Marks</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE) 70 marks</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>2 Marks</td><td>6 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>2</td><td>3</td><td>1</td><td>6</td></tr>
<tr><td>II</td><td>2</td><td>1</td><td>2</td><td>5</td></tr>
<tr><td>III</td><td>2</td><td>2</td><td>1</td><td>5</td></tr>
<tr><td>IV</td><td>2</td><td>2</td><td>2</td><td>6</td></tr>
<tr><td>Total no of questions</td><td>8</td><td>8</td><td>6</td><td>22</td></tr>
<tr><td>Number of questions to be answered</td><td>5</td><td>5</td><td>3</td><td>13</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

TEXT BOOKS:

1. James Ward Brown, Ruel V. Churchill. *Complex Variables and Applications, Eighth Edition,* McGraw Hill, *2009*
2. Simmons, G.F., Krantz, S.G. *Differential Equations*, Tata McGraw Hill-New Delhi, 2007.
3. Thomas, George B Jr. *Thomas' Calculus, Twelfth Edition*, Pearson, 2010

SUGGESTED READINGS:

1. Grewal, B. S., *Higher Engineering Mathematics*, 42nd Edition, Khanna Publishers
2. Anton, H., Bivens, Devis. *Calculus,* 10th Edition, Wiley India.
3. Kreyszig,E. *Advanced Engineering Mathematics*, 9th edition Wiley, India.
4. Siddiqi, A.H., Manchanada, P. *A first course in Differential Equations*, Mc Millan.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proofs of theorems from module 1, 2, 3 & 4
- Solution of equations in Complex variables, Regions in the Complex plane
- Homogeneous Differential equations, Bernoulli's Equations, Integrating Factors
- Visualization of curves and conic section, Obtaining Points of farthest and closest approach of Planets/ Satellites, given their elliptical path.
- Integration in vector fields, Finding Work done, Flow, circulation and flux

Mahatma Gandhi University

Kottayam

Programme						
Course Name	**Essentials of Quantitative Decision Making**					
Type of Course	**DSC B**					
Course Code	**MG3DSCMAT203**					
Course Level	**200-299**					
Course Summary	This course provides a comprehensive introduction to mathematical techniques that form the foundation of advanced computational methods focusing on statistical methods and optimization Techniques. It enables students to comprehend and apply various problem-solving strategies to address both theoretical and practical challenges in computer science.					
Semester	**3**	**Credits**			**4**	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		3	0	1		75
Pre-requisites, if any	A basic knowledge of algebra, arithmetic and geometry.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand and apply the concepts of measures of central tendency and dispersion in problem solving	A	2,3
2	Understand and Analyse Correlation and Regression Models	An	2,3
3	Formulate and solve linear programming problems, including graphical solutions and simplex method techniques.	E	1,2
4	Understand and apply the transportation model solving methods to optimize resource allocation.	A	1, 2

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Measures of Central Tendency and Dispersion**		
	1.1	Introduction , Frequency Distribution Averages- Arithmetic mean , Median, Mode, Geometric mean and Harmonic mean	1	20
	1.2	Measures of absolute dispersion – Range, Mean deviation and Standard Deviation	1	
	1.3	Relative measures of dispersion- Coefficient of variation	1	
		Problems (Practicum)	1	
	Text 1: Chapter 2 – Sections: 2.2 , 2.4 , 2.5, 2.6, 2.7, 2.8, 2.9 ,2.12 ,2.13 & 2.14 (Only formula and problem-solving for all the topics)			
2		**Correlation and Regression Analysis**		
	2.1	Introduction, Meaning of Correlation	2	18
	2.2	Methods of Studying Correlation – Scatter Diagram, Karl Pearson's Coefficient of Correlation	2	
	2.3	Rank correlation	2	
	2.4	Meaning and Significance of Regression	2	
	2.5	Linear regression and Regression Equations	2	
		Problems (Practicum)	2	
	Text 1: Chapter 10 – Sections :10.1 ,10.2 ,10.3 ,10.4 & 10.7 Chapter 11 – Sections :11.1 & 11.2 (Only formula and problem-solving for all the topics)			

3		**Linear Programming Problem**		
	3.1	Linear programming:- Introduction, Mathematical formulation of LPP	3	20
	3.2	Graphical method of solving LPP	3	
	3.3	General form of LPP, Slack and surplus variables, Standard form of LPP	3	
	3.4	Simplex Algorithm and Important definitions	3	
		Problems (Practicum)	3	
	Text 2: Chapter 2 - Sections: 2.1, 2.2, 2.3, 2.4 ,2.5 & 2.6 Chapter 3 – Sections 3.1& 3.3 (Artificial variable Techniques excluded)			
4		**Transportation problem**		
	4.1	Introduction ,Mathematical formulation of TP	4	17
	4.2	Methods for Initial Feasible Solution:- North-West Corner Method, Least cost matrix method, Vogel's Approximation Method	4	
	4.3	Optimality Test (MODI Method)	4	
	4.4	Unbalanced and maximization cases in TP	4	
		Problems (Practicum)	4	
	Text 2: Chapter 6- Sections 6.1, 6.2, 6.5, 6.7, 6.8 & 6.9			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* This content will be evaluated internally			

Practicum

Practicum is designed to provide supervised practical application of theoretical knowledge and skills.

It's purpose is to encourage creativity and develop Problem solving skills.

The practicum component is to be done in the classroom under the strict guidance of the teachers.

A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Direct instruction: Lecture Method, Tutorial ,Brainstorming Lectures, Explicit Teaching Interactive instructions: Active Cooperative Learning, Library Work and Group Discussion, Peer Learning, Authentic Learning					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) 30 Marks**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE) 70 marks**				
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**				
		Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
		I	2	2	1	**5**
		II	2	2	2	**6**
		III	2	2	2	**6**
		IV	2	2	1	**5**

		Total no of questions	**8**	**8**	**6**	**22**
		Number of questions to be answered	**5**	**5**	**3**	**13**
		Total Marks	**10**	**30**	**30**	**70**

TEXT BOOKS

1) S C Gupta and V K Kapoor, Fundamentals of mathematical statistics, eleventh edition, Sultan chand & sons
2) Kanti Swarup ,P K Gupta, Man Mohan ,Operations Research, Sultan Chand and sons

References

1. S Kalavathy, Operations Research with C Programmes, Third edition, Vikas publishing house pvt ltd,
2. J K Sharma , Operations Research Theory and Applications, Second edition, Macmillan India Limited
3. Taha Hamdy A., Operations Research An Introduction

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Essentials of Financial Mathematics**					
Type of Course	**DSC B**					
Course Code	**MG3DSCMAT204**					
Course Level	**200-299**					
Course Summary	Mathematical methods and theories applicable in economics and business to analyse real-life problems are included in the course. The course provides an understanding of the way in which financial calculations are worked out. Also, it deals with the mathematical modelling of various business problems and the different ways to solve the situation.					
Semester	3	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	Total Hours
		3	0	1	0	**75**
Pre- requisites, If any	Functions, Graphing functions, Basics of differential and integral Calculus					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		
1	Understand the difference between simple and compound interest, recognize a geometric progression and calculate the future value of a principal under various circumstances.	E	1, 2, 3
2	Analyse the real-life problems in business and economics and to model it mathematically	An	1, 2, 3
3	Solve linear programming problem using graphical method	E	2

4	Apply elementary algebra and calculus in economics and business problems and solve it mathematically	E	2, 3

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO NO:	Hours
1		**Mathematics of Finance**		
	1.1	Compound Interest	1	**15**
	1.2	Geometric Series	1	
	1.3	Investment Appraisal	1	
		Problems (Practicum)	1	
	Text 2 – Chapter 3 – Sections : 3.2 to 3.4			
2		**Mathematical Economics**		
	2.1	Introduction to System of Equations	2	**25**
	2.2	Graphical Solutions	2	
	2.3	Supply-and-Demand Analysis	2	
	2.4	Break-Even Analysis	2	
	2.5	Elimination and Substitution Methods	2	
	2.6	Income Determination Models	2	
	2.7	IS-LM Analysis	2	
		Problems (Practicum)	2	
	Text 1 : Chapter 4 – Sections : 4.1 to 4.7			
3		**Linear Programming Using Graphs**		
	3.1	Use of Graphs in LPP, Maximization Using Graphs	3	**15**
	3.2	The Extreme-Point Theorem	3	
	3.3	Minimization Using Graphs	3	
	3.4	Slack and Surplus Variables	3	
		Problems (Practicum)	3	

	Text 1 : Chapter 7 – Sections : 7.1 to 7.5			
4		**Optimization Methods**		
	4.1	Optimization of Functions, The Successive-Derivative Test	4	**20**
	4.2	Marginal Concepts in Economics	4	
	4.3	Optimizing Economic Functions for Business	4	
	4.4	Relationship Among Total, Marginal, and Average Functions	4	
		Problems (Practicum)	4	
	Text 1 : Chapter 10 – Sections : 10.6 to 10.10			
5	**Teacher Specific Contents** **(This can be either classroom teaching, practical session, field visit etc as specified by the teacher concerned)** **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**	
	Direct Instruction, Brain Storming Approach, Interactive instruction, Group Discussion, Presentation by individual student/ group representatives	
Assessment Types	**MODE OF ASSESSMENT**	
	A	**Continuous Comprehensive Assessment (CCA)**
	Components	Mark Distribution
	Module Test - I	5 Marks
	Module Test – II	5 Marks
	Module Test – III	5 Marks
	Module Test - IV	5 Marks
	Assignment/ Seminar	5 Marks
	Quiz/ Viva voce	5 Marks
	B	**End Semester Examination (ESE) 70 marks**

Question Pattern

[Maximum Time 2 Hours, Maximum Marks 70]

Module	Part A	Part B	Part C	Total
	2 Marks	**6 Marks**	**10 Marks**	
I	2	2	1	5
II	2	3	2	7

		III	2	1	1	4
		IV	2	2	2	6
		Total no of questions	8	8	6	22
		Number of questions to be answered	5	5	3	13
		Total Marks	10	30	30	70

TEXT BOOKS

1. Edward T Dowling, *Mathematical Methods for Business and Economics*, Schaum's Outline Series, McGraw Hill
2. Ian Jacques, *Mathematics for Economics and Business*, 5th Edition, Prentice Hall(2006).

SUGGESTED READINGS

1. Taro Yamne, *Mathematics for Economists-An elementary survey,* Prentice -Hall, Inc.
2. Robert Brechner, *Contemporary Mathematics for Business and Consumers,* Fifth Edition
3. Das, N. G., Das, J K. *Business Mathematics and Statistics*, Tata McGraw-Hill (2012).
4. Martin Anthony, Norman Biggs, *Mathematics for economics and finance Methods and Modelling,* Cambridge University Press (2012).

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Applicable mathematics in economics and business using spreadsheets