Semester 2

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT100				
Course Title	Theory of equations, Differential Calculus and Geometry				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3		2	5
Pre-requisites	1. Awareness on polynomials 2. Knowledge on the concepts of functions, differentiation and basic geometry				
Course Summary	This course includes theory of equations, differential calculus, polar co-ordinates and conic sections				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Differential calculus I**		**9**
	1	Related Rates, Analysis of functions - Increasing, Decreasing and Concavity, Relative Extrema excluding analysis of polynomials, Relative Maxima and minima, first derivative test, second derivative test, geometric implications of multiplicity	
	Chapter2: Section 2.8 and Chapter 3: Section 3.1, 3.2 of Text[1]		
II	**Differential calculus II**		**9**
	2	Absolute maxima and minima (for finite closed intervals only), Applied maximum minimum problems (excluding application to economics), Mean value theorem, Rolle's Theorem	

Module	Unit	Contents	Hrs
	Chapter 3: Section 3.4, 3.5, 3.8 of Text[1]		
III	**Exponential and logarithmic function**		**9**
	3	Exponential and logarithmic function, L'Hôpilal's Rule, indeterminate forms.	
	Chapter 6: Section 6.1, 6.5 of Text[1]		
IV	**Parametric representation of curves**		**9**
	4	Parametric equation, Tangent lines to parametric curves, arc length of parametric curves, polar coordinate systems, relationship between polar and rectangular coordinates, graphs in polar coordinates (exclude symmetry tests), family of curves	
	Chapter 10: Section 10.1 10.2of Text[1]		
V	**Teacher designed module - suggested topics**		**9**
	For internal assessment examinations only.		
	5	The following topics are suggested: Introduction, General Properties, Solution of cubic Equations- Cardan's Method, Newtons Method, Descarte's rule, absolute maxima and minima on infinite intervals, absolute maxima and minima on open intervals, problems involving intervals that are not both finite and closed	
	These topics can be found in Chapter 1: Sections 1.1, 1.5 of Text [2], Chapter 3: Sections 3.4, 3.5 of Text [1]		

Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant π
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them
   Ref: P3 or section 1.4 of P4

4. `diff` command to find derivatives of standard functions, polynomials, including higher order derivatives
   Ref: Section 3.1 of P4

5. Solving polynomial equations and equations involving standard functions
   Ref : Section 2.2 of P7

6. Sketching graphs of curves using `plot`
   Ref : Section 6.1 of P2

7. Finding maxima, minima using first and second derivative tests.
   Ref : Section 4.2 of P4

8. Finding points of inflection and sketching them
   Ref : Section 4.2 of P4

9. Mean value theorem – verification and demonstration via sketching the curve and tangent
   Ref : P9

10. Using `integrate` command to compute indefinite and definite integrals
    Ref : Section 3.3.4 of P2

11. Defining parametric functions, sketching the graphs
    Ref: P5, Section 6.1 of P2

12. Find arc length of parametric curves

13. Plotting in polar co-ordinates
    Ref: Section 3.3 of P7

14. Conversion between various co-ordinate systems

15. Finding the number of roots of a polynomial using Descartes' rule of signs

16. Solving cubic by Cardan's method

17. Finding approximate roots by Newton's method
    Ref : Section 4.4 of P4

18. Sketching family of circles, rose curves

Problems for the practical examination

1. Defining polynomials, polynomial functions, evaluating them

2. Solving polynomial equations and equations involving standard functions

3. Sketching graphs of curves using plot with various styling options (thickness, line style, color etc)

4. Finding maxima, minima using first and second derivative tests.

5. Finding points of inflection and sketching them

6. Mean value theorem verification, and sketching

7. Plotting in polar co-ordinates

8. Finding the number of roots of a polynomial using Descartes' rule of signs

9. Sketching family of circles

10. Finding approximate roots by Newton's method

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbooks

1. H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012
2. B.S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers, 2012.

References

1. Barnard and Child, Higher Algebra, Mac Millan, 2000.
2. Joel Hass, Maurice D. Weir, Thomas' Calculus Early Transcendentals, 12th Edition, Addison-Weseley Publishing Company, 2004.
3. T. K. Manicavachagom Pillay, T. Natarajan, K.S. Ganapathy, Algebra Volume I Ananda Book Depot, 1996.
4. J Stewart, Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited, 2004.
5. G B Thomas, R L Finney, Calculus, 9th Edition, Addison-Weseley Publishing Company, 2004.

Resources for practical sessions

P1. Sagemath documentation – Introductory Sage Tutorial https://doc.sagemath.org/html/en/prep/Intro-Tutorial.html

P2. Saskia Roos, Michael Jung, *An Introductory Course on Sage, Lecture Notes* https://www.math.uni-potsdam.de/fileadmin/user_upload/An_Introductory_Course_on_Sage.pdf

P3. Sagemath documentation – Symbolic variableshttps://doc.sagemath.org/html/en/reference/calculus/sage/calculus/var.html

P4. Tuan A. Le, Hieu D. Nguyen, SageMath Advice for calculus https://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

P5. Sagemath documentation – Parametric plots https://doc.sagemath.org/html/en/reference/plot3d/sage/plot/plot3d/parametric_plot3d.html#sage.plot.plot3d.parametric_plot3d.parametric_plot3d

P6. P. Zimmermann *et al*, Computational Mathematics with SageMath, https://www.sagemath.org/sagebook/english.html

P7. Gregory V. Bard, Sage for Undergraduates http://www.people.vcu.edu/~clarson/bard-sage-for-undergraduates-2014.pdf

P8. SageMath documentation – 3D Graphics https://doc.sagemath.org/html/en/reference/plot3d/index.html

P9. Ajit Kumar, One Variable Calculus with SageMath https://ajitmathsoft.wordpress.com/wp-content/uploads/2019/07/cal_onevar_sage.pdf

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Describe algebraic techniques to solve polynomial equations and to identify conic sections	PSO2, PO1, PO2, 3, 4, 7, 8	U,E	F,P	L	
CO 2	Apply differentiation techniques to analyse extrema of functions and solving real life problems	PSO4, PO1, 2, 3, 4, 7, 8	U,An	F,P	L	
CO 3	Sketching parabola, ellipse and hyperbola, and relating polar and cartesian co-ordinates	PSO5, PO1, 2, 3, 7, 8	U,E	F,P	L	
CO 4	Analysing parametric representation of curves	PSO2, PO1, 2, 3, 4, 6, 7, 8	R,An	F,P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	2	1	1	3	3	2	1			1	2
CO2	2	2	2	3	2	1	3	2	2	1			1	2
CO3	2	2	2	2	3	1	3	2	3	1			2	1
CO4	2	3	2	2	2	1	3	2	2	1		1	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT101				
Course Title	Integration and Multivariate Calculus				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3	-	2	5
Pre-requisites	1. Derivative of functions 2. Vectors				
Course Summary	This course equip the students to find the integral of functions, its applications, partial derivatives of functions and to know about the basic concepts of vector valued functions				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Integration**		**9**
	1	The Indefinite Integral: Antiderivatives, The Indefinite Integrals, Integration formulas, Properties of the indefinite integral, Integral curves.	
	2	Integration by substitution (excluding Integration using computer algebra systems)	
	3	Evaluation of definite integral by substitution	
	4	Integrals of logarithmic Functions	
	5	Integrals of exponential functions	
	Chapter 4: Section 4.2, 4.3, 4.9 Chapter 6: section 6.2 (integration only), 6.3 (integration only) of Text[1]		

Module	Unit	Contents	Hrs
II	**Applications of Integration**		**9**
	6	Area between two curves	
	7	Volume by Slicing: (excluding other axis of revolution)	
	8	Length of a plane curve(excluding finding arc length by numerical methods)	
	Chapter 5: Section 5.1, 5.2, 5.4 of Text[1]		
III	**Vector Calculus 1**		**9**
	9	Introduction to vector valued functions: Parametric curves in 3-space, vector-valued functions, vector form of a line segment	
	10	Calculus of vector valued functions (excluding antiderivatives of vector-valued functions)	
	11	Unit tangent and normal vectors(excluding binormal vectors in 3-space)	
	Chapter 12: Section 12.1, 12.2, 12.4 of Text[1]		
IV	**Partial Differentiation**		**9**
	12	Functions of two or more variables(Notation and terminology only	
	13	Partial derivatives(excluding estimating partial derivatives from tabular data, partial derivatives and continuity, equality of mixed partials, wave equations)	
	14	The Chain rule	
	15	Maxima and minima of functions of two variables	
	Chapter 13: Section 13.1, 13.3, 13.5, 13.8 of Text[1]		
V	**Teacher designed module - suggested topics**		**9**
	For internal assessment examinations only.		
	16	An overwiew of area problem	
	17	Volume by other axis of revolution	
	18	Area of a surface of revolution	
	19	Curvature	
	20	Equality of mixed partials, wave equations	
	21	Langrange mutipliers	
	Sections from Text [1]		

Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant π
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them Ref: P3 or section 1.4 of P4

4. Using `integrate` command to compute indefinite and definite integrals
   Ref : Section 3.3.4 of P2

5. Sketching graphs of curves using `plot`
   Ref : Section 6.1 of P2

6. Defining curves, finding area between two curves
   Ref : Section 6.1 of P4

7. Finding volumes of solids of revolution, finding arc length
   Ref : Section 6.3 of P4

8. Defining parametric functions, sketching the graphs
   Ref: P5, Section 6.1 of P2

9. `diff` command to find derivatives of standard functions, polynomials
   Ref: Section 3.1 of P4

10. Finding derivatives of vector valued functions

11. Defining vectors, finding their dot and cross products, finding norm of vectors
    Ref: Section 3.3.5 of P2

12. Computing unit tangent and normal vectors, sketching the curve and plotting these vectors
    Ref : P6

13. Defining functions of multiple variables, evaluating them at certain points, differentiating them

14. Solving polynomial equations and equations involving standard functions
    Ref : Section 2.2 of P7

15. Computing maxima and minima of multivariable functions
    Ref : Section 4.3 of P4

16. Computing maxima and minima using Lagrange multiplier technique
    Ref : Section 4.18 of P8

17. Plotting in 3-dimension, marking optimal points on the plots obtained through the maxima minima problems
    Ref : P9, Section 7.1 of P2

Problems for the practical examination

1. Computing indefinite and definite integrals of standard functions (trigonometric, log, e, polynomials)

2. Demonstrate the plot command with various options (line style, color, thickness etc)

3. Finding area between two curves, sketching them

4. Finding volumes of solids of revolution, sketching the curves and solids
5. Defining multivariable functions, evaluating them, differentiation them
6. Defining and solving polynomial equations, evaluating them
7. Defining vectors, finding their dot, cross products, norm
8. Computing unit tangent vectors plotting them on the vector curves
9. computing maxima and minima directly (w/o Lagrange multiplier)
10. computing maxima and minima directly using Lagrange multiplier

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbooks

1. Howard Anton, Irel Bivens, Stephens Davis, *Calculus* 10^{th} Edition Wiley, 2012.

References

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10^{th} Edition Wiley, 2018.
2. Ian Sneddon, *Elements of Partial Differential Equations*, Mc Graw- Hill, 2013.
3. Peter. V. O Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.
4. M. D. Raisinghaniya, *Ordinary and Partial Differential Equations*, S Chand 18^{th} Edition, 2008.
5. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw-Hill, 2003.
6. G. B. Thomas, R. L. Finey, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

Resources for practical sessions

P1. Sagemath documentation – Introductory Sage Tutorial https://doc.sagemath.org/html/en/prep/Intro-Tutorial.html

P2. Saskia Roos, Michael Jung, *An Introductory Course on Sage, Lecture Notes* https://www.math.uni-potsdam.de/fileadmin/user_upload/An_Introductory_Course_on_Sage.pdf

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P5. Sagemath documentation – Sage Quickstart for Multivariable Calculus https://doc.sagemath.org/html/en/prep/Quickstarts/Multivariable-Calculus.html

P6. Sagemath documentation – Parametric plots https://doc.sagemath.org/html/en/reference/plot3d/sage/plot/plot3d/parametric_plot3d.html#sage.plot.plot3d.parametric_plot3d.parametric_plot3d

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P9. SageMath documentation – 3D Graphics https://doc.sagemath.org/html/en/reference/plot3d/index.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the fundamental concepts of Integration and Vector valued function.	PSO1, 2 PO1, 3, 6, 7, 8	U, Ap	F,C	L	
CO 2	Analyze the various techniques both in Integration and in Vector Calculus	PSO 2,3 PO1, 2, 3, 6, 7, 8	U, An	C,P	L	
CO 3	Develop problem-solving techniques	PSO 1,2,3,4, PO1, 2, 3, 6, 7, 8	An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	2	2	3	3	3	-	1	-	-	2	1	1
CO2	1	3	1	2	1	1	1	1	3	-	-	2	1	1
CO3	1	3	2	3	2	3	1	3	3	-	-	3	1	1

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- End Semester Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	—-	—-	✓
CO2	✓	✓		✓
CO3	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT102				
Course Title	Integration and Applications of differentiation				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3	-	2	5
Pre-requisites	1. Integration of elementary functions 2. Differentiation				
Course Summary	This course enables the student to understand the applications of differentiation and evaluate the integrals				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Applications of Derivatives**	**9**
	1	Related Rates, Analysis of functions - Increasing, Decreasing and Concavity, Relative Extrema excluding analysis of polynomials, Relative Maxima and minima, first derivative test, second derivative test, geometric implications of multiplicity	
	Chapter 2: Section 2.8 and Chapter 3: Section 3.1, 3.2 of Text[1]		
II		**Maximum Minimum Problems**	**9**
	2	Absolute maxima and minima (for finite closed intervals only), Applied maximum minimum problems (excluding application to economics), Mean value theorem, Rolle's Theorem	
	Chapter 3: Section 3.4, 3.5 and 3.8 of Text[1]		

Module	Unit	Contents	Hrs
III		**Definite Integral**	**9**
	3	Integration by Substitution, The Definite Integral	
	Chapter 4: Sections 4.3, 4.5 of Text [1]		
	4	Evaluating Definite Integrals by Substitution	
	Chapter 4: Sections 4.9 of Text [1]		
IV		**Evaluation of Integrals**	**9**
	5	Integration by Parts	
	Chapter 7: Section 7.2 of Text [1]		
	6	Integrating Trigonometric Functions	
	Chapter 7: Section 7.3 of Text [1]		
V		**Suggestions for teacher designed module**	**9**
	For internal assessment examinations only.		
	7	The following topics are suggested: Absolute maxima and minima on infinite intervals, absolute maxima and minima on open intervals, problems involving intervals that are not both finite and closed, Average Value of a Function and its Applications,Trigonometric Substitutions	
	These topics can be found in Chapter 3: Sections 3.4, 3.5, Chapter 4 Section 4.8, Chapter 7: Section 7.4 of Text [1])		

Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant π
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them
   Ref: P3 or section 1.4 of P4

4. `diff` command to find derivatives of standard functions, polynomials, including higher order derivatives
   Ref: Section 3.1 of P4

5. Solving polynomial equations and equations involving standard functions
   Ref : Section 2.2 of P7

6. Sketching graphs of curves using `plot`
   Ref : Section 6.1 of P2

7. Finding maxima, minima using first and second derivative tests.
   Ref : Section 4.2 of P4

8. Finding points of inflection and sketching them
   Ref : Section 4.2 of P4

9. Mean value theorem – verification and demonstration via sketching the curve and tangent
   Ref : P9

10. Using `integrate` command to compute indefinite and definite integrals
    Ref : Section 3.3.4 of P2

11. Finding average value of a function over an interval, sketch it to demonstrate its relation with the MVT
    Ref : Section 6.2 of P4

Problems for the practical examination

1. Defining polynomials, polynomial functions, evaluating them
2. Solving polynomial equations and equations involving standard functions
3. Sketching graphs of curves using plot with various styling options (thickness, line style, color etc)
4. Finding maxima, minima using first and second derivative tests.
5. Determine if the curve is concave up or down, sketch it.
6. Finding points of inflection and sketching them
7. Plotting tangent of a curve at specified point on the curve
8. Mean value theorem verification, and sketching
9. Integrate various standard functions (indefinite and definite)
10. Finding avarage value of function

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10^{th} Edition, John Wiley & Sons.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.

2. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2004.

3. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

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P5. Sagemath documentation – Sage Quickstart for Multivariable Calculus https://doc.sagemath.org/html/en/prep/Quickstarts/Multivariable-Calculus.html

P6. Sagemath documentation – Parametric plots https://doc.sagemath.org/html/en/reference/plot3d/sage/plot/plot3d/parametric_plot3d.html#sage.plot.plot3d.parametric_plot3d.parametric_plot3d

P7. P. Zimmermann *et al*, Computational Mathematics with SageMath, https://www.sagemath.org/sagebook/english.html

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P9. Ajit Kumar, One Variable Calculus with SageMath https://ajitmathsoft.wordpress.com/wp-content/uploads/2019/07/cal_onevar_sage.pdf

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of integration	PSO 1	U	F, C	L	
CO 2	Evaluation of integrals of functions and learn its physical interpretation through various examples	PSO 2, 4	Ap, An	P	L	
CO 3	Define maxima, minima, critical points and points of inflection	PSO 1	U	F, C	L	
CO 4	Apply the concept of differentiation in real life situation	PSO 3, 4	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	3	-	3	-	-	-	3	2	-	-	-	-	-
CO3	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO4	-	-	3	3	-	-	-	3	2	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT103				
Course Title	Integral Calculus and Vectors				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3	-	2	5
Pre-requisites	1. Integral of elementary functions 2. Vectors				
Course Summary	This course enable the students to find the integrals and know about the vector valued functions				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Definite Integral**	**9**
	1	Integration by Substitution, The Definite Integral *(Chapter 4: Sections 4.3, 4.5 of Text [1])*	
	2	Evaluating Definite Integrals by Substitution *(Chapter 4: Sections 4.9 of Text [1])*	
II		**Evaluation of Integrals**	**9**
	3	Integration by Parts *(Chapter 7: Section 7.2 of Text [1])*	
	4	Integrating Trigonometric Functions *(Chapter 7: Section 7.3 of Text [1])*	
III		**Vector Algebra**	**9**
	5	Three dimensional space, vectors, Cylindrical surfaces, algebra of vectors, norm of a vector, vectors determined by length and angle, vectors determined by length and a vector in the same direction, resultant of two Concurrent forces. *(Chapter 11: Sections 11.1, 11.2 of Text [1])*	

Module	Unit	Contents	Hrs
	6	Dot Product, Projections, Algebraic properties of dot product, Angle between vectors, Direction angles *(Chapter 11: Section 11.3 of Text [1])*	
IV	**Cross product and Vector Valued Functions**		**9**
	7	Cross product - Algebraic and geometric properties of cross product, scalar triple product, Algebraic and geometric properties of scalar triple product *(Chapter 11: Section 11.4 of Text [1])*	
	8	Introduction to vector valued Functions, Parametric Curves in 3-Space - The parametric equations (introduction only) vector valued functions (introduction only) vector form of a line segment (introduction only) *(Chapter 12: Sections 12.1 of Text [1])*	
V	**Suggestions for teacher designed module**		**9**
	For internal assessment examinations only.		
	9	Average Value of a Function and its Applications Trigonometric Substitutions Calculus of vector-valued Functions Limits and Continuity, Geometric interpretations of limits Derivatives, Geometric interpretation of the derivative, derivative rules Derivatives of dot and cross products (fundamentals only) Integrals of vector valued functions and integral rules (fundamentals only) Unit Tangent, Normal and Binormal vectors (introduction only) Normal and Tangential Components of Acceleration	
	These topics can be found in Chapter 4: Section 4.8, Chapter 7: Section 7.4, Chapter 12: Sections 12.2, 12.4 of Text [1].		

Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant π
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them
   Ref: P3 or section 1.4 of P4

4. `diff` command to find derivatives of standard functions, polynomials, including higher order derivatives

Ref: Section 3.1 of P4

5. Sketching graphs of curves using `plot`
   Ref : Section 6.1 of P2

6. Defining vectors, finding their dot and cross products, scalar triple product, finding norm of vectors, find angle between them
   Ref: Section 3.3.5 of P2

7. Defining parametric functions, sketching the graphs
   Ref: P5, Section 6.1 of P2

8. Find arc length of parametric curves

9. Computing unit tangent and normal vectors, sketching the curve and plotting these vectors
   Ref : P6

10. Plotting in polar co-ordinates
    Ref: Section 3.3 of P7

11. Plotting cylindrical surfaces
    Ref: Section 7.1 of P2

Problems for the practical examination

1. Computing indefinite and definite integrals of standard functions (trigonometric, log, e, polynomials)

2. Demonstrate the plot command with various options (line style, color, thickness etc)

3. Defining and solving polynomial equations, evaluating them

4. Defining vectors, finding their dot product, norm

5. Finding angle between vectors

6. Defining vectors, finding their cross products

7. Defining vectors finding scalar triple product

8. Computing unit tangent vectors plotting them on the vector curves

9. Polar co-ordinate plotting

10. Plotting cylindrical surfaces

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbook

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.
2. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2008.
3. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

Resources for practical sessions

P1. Sagemath documentation – Introductory Sage Tutorial https://doc.sagemath.org/html/en/prep/Intro-Tutorial.html

P2. Saskia Roos, Michael Jung, *An Introductory Course on Sage, Lecture Notes* https://www.math.uni-potsdam.de/fileadmin/user_upload/An_Introductory_Course_on_Sage.pdf

P3. Sagemath documentation – Symbolic variableshttps://doc.sagemath.org/html/en/reference/calculus/sage/calculus/var.html

P4. Tuan A. Le, Hieu D. Nguyen, SageMath Advice for calculus https://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

P5. Sagemath documentation – Sage Quickstart for Multivariable Calculus https://doc.sagemath.org/html/en/prep/Quickstarts/Multivariable-Calculus.html

P6. Sagemath documentation – Parametric plots https://doc.sagemath.org/html/en/reference/plot3d/sage/plot/plot3d/parametric_plot3d.html#sage.plot.plot3d.parametric_plot3d.parametric_plot3d

P7. P. Zimmermann *et al*, Computational Mathematics with SageMath, https://www.sagemath.org/sagebook/english.html

P8. Gregory V. Bard, Sage for Undergraduates http://www.people.vcu.edu/~clarson/bard-sage-for-undergraduates-2014.pdf

P9. SageMath documentation – 3D Graphics https://doc.sagemath.org/html/en/reference/plot3d/index.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of integration	PSO 1	U	F, C	L	
CO 2	Describe the integration of a function and learn its physical interpretation through various examples.	PSO 2, 4	Ap, An	P	L	
CO 3	Understand the concepts of three dimensional space, vectors, different vector operations, vector valued functions and calculus of vector valued functions	PSO 1	U	F, C	L	
CO 4	Able to find limits, derivatives of vector valued functions	PSO 2	Ap	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	3	2	3	-	-	-	3	2	-	-	-	-	-
CO3	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO4	-	3	3	-	-	-	3	2	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments

- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT104				
Course Title	Integral Calculus and Ordinary Differential Equations				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3	-	2	5
Pre-requisites	1. Integration 2. Differentiation				
Course Summary	This course enable the students to find the integrals and to solve certain differential equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Definite Integral**	**9**
	1	Integration by Substitution, The Definite Integral *(Chapter 4: Sections 4.3, 4.5 of Text [1])*	
	2	Evaluating Definite Integrals by Substitution *(Chapter 4: Sections 4.9 of Text [1])*	
II		**Evaluation of Integrals**	**9**
	3	Integration by Parts *(Chapter 7: Section 7.2 of Text [1])*	
	4	Integrating Trigonometric Functions *(Chapter 7: Section 7.3 of Text [1])*	
III		**Differential Equations**	**9**
	5	Solution curves without a solution (not meant for examination purpose), Separable Equations *(Chapter 2: Sections 2.1, 2.2 of Text [2])*	
	6	Linear Equations, Exact Equations *(Chapter 2: Section 2.3, 2.4 of Text [2])*	

Module	Unit	Contents	Hrs
	7	Solutions by Substitutions, A Numerical Method *(Chapter 2: Section 2.5, 2.6 of Text [2])*	
IV	**Higher Order Differential Equations**		**9**
	8	Initial-Value and Boundary-Value Problems, Homogeneous Equations, Nonhomogeneous Equations, *(Chapter 3: Sections 3.1 of Text [2])*	
	9	Homogeneous Linear Equations with Constant Coefficients *(Chapter 3: Section 3.3 of Text 2)*	
V	**Suggestions for teacher designed module**		**9**
	For internal assessment examinations only.		
	10	Average Value of a Function and its Applications Trigonometric Substitutions Linear Models, Nonlinear Models Reduction of Order Cauchy–Euler Equations	
	These topics can be found on Chapter 4: Section 4.8, Chapter 7 Section 7.4 of Text [1] and Chapter 2: Section 2.7, 2.8, Chapter 3: Section 3.6 of Text [2]		

Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant π
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them Ref: P3 or section 1.4 of P4

4. Using `integrate` command to compute indefinite and definite integrals
   Ref : Section 3.3.4 of P2

5. Finding average value of a function over an interval, sketch it to demonstrate its relation with the MVT
   Ref : Section 6.2 of P4

6. `diff` command to find derivatives of standard functions, polynomials
   Ref: Section 3.1 of P4

7. Solving differential equations (de) using `desolve`
   Ref : P11

8. Solving linear ODE of first order
   Ref : Section 1.4 of P10, Section 10.1 of P2

9. Solving separable ODE of first order
   Ref : Section 1.4 of P10, Section 10.1 of P2

10. ODE Initial value problems
    Ref : Section 1.2 of P10

11. Solving Higher order constant coefficient linear homogeneous ODEs
    Ref : Section 1.3 of P10

12. Numerical solutions to ODE
    Ref : Section 1.6 of P10

Problems for the practical examination

1. Computing indefinite and definite integrals of standard functions (trigonometric, log, e, polynomials)

2. Demonstrate the plot command with various options (line style, color, thickness etc)

3. Defining and solving polynomial equations, evaluating them

4. Finding avarage value of function using integration

5. Solving differential equations

6. Solving linear ODE of first order

7. Solving separable ODE of first order

8. ODE Initial value problems

9. Solving Higher order constant coefficient linear homogeneous ODEs

10. Numerical solutions to ODE

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10^{th} Edition, John Wiley & Sons, 2012

2. Dennis G. Zill, *Advanced Engineering Mathematics* 6^{th} Edition, Jones & Bartlett Learning, 2016.

References

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10th Edition, 2018.

2. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.

3. Peter V. O. Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.

4. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw- Hill, 2003.

5. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2008.

6. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

Resources for practical sessions

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P2. Saskia Roos, Michael Jung, *An Introductory Course on Sage, Lecture Notes* https://www.math.uni-potsdam.de/fileadmin/user_upload/An_Introductory_Course_on_Sage.pdf

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P9. Ajit Kumar, One Variable Calculus with SageMath https://ajitmathsoft.wordpress.com/wp-content/uploads/2019/07/cal_onevar_sage.pdf

P10. David Joyner, Marshall Hampton, *Introductory Differential Equations using Sage* http://www.sandal.tw/upload/Introduction%20to%20Differential%20Equations%20Using%20Sage%20[David%20Joyner,%20Marshall%20Hampton.pdf

P11. Sagemath documentation – Sage Quickstart for Differential Equations https://doc.sagemath.org/html/en/prep/Quickstarts/Differential-Equations.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of integration	PSO 1	U	F, C	L	
CO 2	Describe the integration of a function and learn its physical interpretation through various examples.	PSO 2, 4	Ap, An	P	L	
CO 3	Demonstrate a thorough understanding of basic concepts in ordinary differential equations and initial value problems.	PSO 1	U	F, C	L	
CO 4	Able to solve various types of first-order, second order ordinary differential equations, including separable equations, linear equations and equations with constant coefficients	PSO 2, 5	Ap	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	3	-	2	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	3	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT105				
Course Title	Applications of Differentiation and Ordinary Differential Equations				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3	-	2	5
Pre-requisites	Differentiation, Integration				
Course Summary	This course enable the students to understand the applications of differentiation and to solve certain differential equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Applications of Derivatives**	**9**
	1	Related Rates, Analysis of functions - Increasing, Decreasing and Concavity, Relative Extrema excluding analysis of polynomials, Relative Maxima and minima, first derivative test, second derivative test, geometric implications of multiplicity	
	Chapter 2: Section 2.8 and Chapter 3: Section 3.1, 3.2 of Text[1]		
II		**Maximum Minimum Problems**	**9**
	2	Absolute maxima and minima (for finite closed intervals only), Applied maximum minimum problems (excluding application to economics), Mean value theorem, Rolle's Theorem	
	Chapter 3: Section 3.4, 3.5 and 3.8 of Text[1]		

Module	Unit	Contents	Hrs
III		**Differential Equations**	**9**
	3	Solution curves without a solution (not meant for examination purpose), Separable Equations	
	Chapter 2: Sections 2.1, 2.2 of Text [2]		
	4	Linear Equations, Exact Equations	
	Chapter 2: Section 2.3, 2.4 of Text [2]		
	5	Solutions by Substitutions, A Numerical Method	
	Chapter 2: Section 2.5, 2.6 of Text [2]		
IV		**Higher Order Differential Equations**	**9**
	6	Initial-Value and Boundary-Value Problems, Homogeneous Equations, Nonhomogeneous Equations	
	Chapter 3: Sections 3.1 of Text [2]		
	7	Homogeneous Linear Equations with Constant Coefficients	
	Chapter 3: Section 3.3 of Text [2]		
V		**Suggestions for teacher designed module**	**9**
	For internal assessment examinations only.		
	8	Absolute maxima and minima on infinite intervals Absolute maxima and minima on open intervals Problems involving intervals that are not both finite and closed Linear Models Nonlinear Models Reduction of Order Cauchy–Euler Equations	
	These topics can be found on Chapter 2: Section 2.7, 2.8, Chapter 3: Section 3.6 of Text [2])		

Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant π
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them
   Ref: P3 or section 1.4 of P4

4. `diff` command to find derivatives of standard functions, polynomials, including higher order derivatives
   Ref: Section 3.1 of P4

5. Solving polynomial equations and equations involving standard functions
   Ref : Section 2.2 of P7

6. Sketching graphs of curves using `plot`
   Ref : Section 6.1 of P2

7. Finding maxima, minima using first and second derivative tests.
   Ref : Section 4.2 of P4

8. Finding points of inflection and sketching them
   Ref : Section 4.2 of P4

9. Mean value theorem – verification and demonstration via sketching the curve and tangent
   Ref : P9

10. `diff` command to find derivatives of standard functions, polynomials
    Ref: Section 3.1 of P4

11. Solving differential equations (de) using `desolve`
    Ref : P11

12. Solving linear ODE of first order
    Ref : Section 1.4 of P10, Section 10.1 of P2

13. Solving separable ODE of first order
    Ref : Section 1.4 of P10, Section 10.1 of P2

14. ODE Initial value problems
    Ref : Section 1.2 of P10

15. Solving Higher order constant coefficient linear homogeneous ODEs
    Ref : Section 1.3 of P10

16. Numerical solutions to ODE
    Ref : Section 1.6 of P10

Problems for the practical examination

1. Solving polynomial equations and equations involving standard functions

2. Sketching graphs of curves using plot with various styling options (thickness, line style, color etc)

3. Finding maxima, minima using first and second derivative tests.

4. Determine if the curve is concave up or down, sketch it.

5. Finding points of inflection and sketching them

6. Mean value theorem verification, and sketching

7. Solving linear ODE of first order

8. Solving separable ODE of first order
9. ODE Initial value problems
10. Numerical solutions to ODE

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbooks

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2. Dennis G. Zill, *Advanced Engineering Mathematics* 6th Edition, Jones & Bartlett Learning, 2016.

References

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3. Peter V. O. Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007.
4. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw- Hill, 2003.
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6. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

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P11. Sagemath documentation – Sage Quickstart for Differential Equations https://doc.sagemath.org/html/en/prep/Quickstarts/Differential-Equations.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define maxima, minima, critical points and points of inflection	PSO 1	U	F, C	L	
CO 2	Apply the concept of differentiation in real life situation	PSO 3, 4	Ap, An	P	L	
CO 3	Demonstrate a thorough understanding of basic concepts in ordinary differential equations and initial value problems.	PSO 1	U	F, C	L	
CO 4	Able to solve various types of first-order, second order ordinary differential equations, including separable equations, linear equations and equations with constant coefficients	PSO 2, 5	Ap	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	3	-	-	3	-	-	-	-	-	-	-
CO2	-	-	2	3	-	-	-	3	2	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	3	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT106				
Course Title	Linear Algebra and Graph Theory				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Matrices 2. Linear equations				
Course Summary	This course aims to solve systems of linear equations and to understand the basic concepts of graph theory				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Matrices and Systems of linear equatios**		**12**
	1	Linear systems of equations, Gauss elimination, linear Independence, rank of a matrix. *(Chapter7: Sections 7.2, 7.4 of Text [1] (vector space is not included))*	
	2	Solutions of linear systems: existence, uniqueness *(Chapter 7: Section 7.5 of Text [1] (proofs of theorems are not required))*	
II	**Eigenvalues and Eigenvectors**		**12**
	3	The Matrix Eigenvalue Problem. Determining Eigenvalues and Eigenvectors *(Chapter 8: Section 8.1 of Text [1])*	
	4	Symmetric, Skew-Symmetric, and Orthogonal Matrices *(Chapter 8: Section 8.3 of Text [2])*	

Module	Unit	Contents	Hrs
III	**Graphs**		**12**
	5	Basic Concepts of graph theory, Graph terminology and special types of graphs Representation of graphs, *(Chapter 1: Sections 1.1 to 1.5 of Text [2])*	
	6	Graph isomorphism, connected graphs, disconnected graphs, definitions and examples of Euler's path, circuits, *(Chapter 2: Sections 2.1, 2.5, 2.6 of Text [2])*	
IV	**Trees and Spanning Trees**		**12**
	7	Trees, properties, pendant vertices, distance and centers, spanning trees, *(Chapter 3: Sections 3.1 to 3.5 and 3.7 of Text [2])*	
	8	Fundamental circuits, finding all spanning trees in a graph, spanning trees in a weighted graph *(Chapter 3: Section 3.8, 3.9, 3.10 of Text [2] (proofs of theorems are not required))*	
	9	Incidence matrices, path matrices and adjacency matrices of graphs (definitions and examples only) *(Chapter 7: Sections 7.1, 7.8, 7.9 of Text [2] (proofs of theorems are not required))*	
V	**Suggestions for teacher designed topics**		**12**
	For internal assessment examinations only.		
	10	Determinants Cramer's Rule Diagonalization Quadratic Forms Hamiltonion Path, Hamiltonian circuits Rooted and binary trees	
	The topics can be found on Chapter 7: Section 7.7 of Text [1] , Chapter 8: Section 8.4 of Text [1] (eigen bases is not included), Chapter 2: Section 2.9 of Text [2], Chapter 3: Section 3.5 of Text [2]		

Textbook

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10^{th} Edition, 2018.

2. Narasingh Deo, *Graph Theory with Applications to Engineering and Computer Science*, PHI, 1974.

References

1. R. Balakrishnan, K. Ranganathan, *A Text book of Graph Theory*, Second Edition, Springer, 2012.

2. T S Blyth, E F Robertson, *Linear Algebra*, Second Edition, Springer, 2013.

3. David C Lay, *Linaer algebra*, Pearson, 2003.

4. Gary Chartrand and Ping Zhang, *Introduction to Graph Theory*, New Delhi, New York: Tata McGraw-Hill Pub. Co., 2006.

5. Lee W. Johnson, R Dean Riess, Jimmy T. Arnold, *Introduction to Linear Algebra*, Fifth Edition, Addison Wesley, 2019.

6. Robin J. Wilson, *Introduction to Graph Theory*, Pearson Education Asia, 5^{th} Edition, 2010.

7. Thomas Banchoff, John Wermer, *Linear Algebra Through Geometry*, 2^{nd} Edition, Springer, 2003.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concepts of Matrix operations their algebraic properties, System of linear equations and their Matrix representation, Gauss Elimination	PSO 1	U	F, C	L	
CO 2	Able to find the eigen values, powers of matrices and diagonalization of matrices	PSO 2, 4	Ap, An	P	L	
CO 3	To define and understand the fundamental concepts of graph theory	PSO 1	U	F, C	L	
CO 4	To apply the concepts and theorems that are treated in the course for problem-solving	PSO 2, 4	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	1	1	-	-	1	2	-	-
CO2	-	2	-	2	-	-	2	2	-	-	-	2	-	-
CO3	2	-	-	-	-	-	1	1	-	-	1	1	-	-
CO4	-	2	-	3	-	-	2	1	1	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT107				
Course Title	Mathematics for Social Sciences - II				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1.Knowledge of functions, particularly, demand functions, revenue functions and cost functions				
Course Summary	This course includes Differential calculus, its applications in matrix theory and game theory				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Basics of Differentiation**		**12**
	1	One variable Differentiation, Basic Definition, Process of differentiation, Rules of differentiation, Some Standard rules (without proof)	
	2	Derivative of higher order with simple problems involving polynomial functions(except trignometric and logarithmic functions)	
	Chapter 6: 6.3, 6.4, 6.5 of Text [1].		
II	**Applications of Derivatives**		**12**
	3	Sign of differential coefficients, Second derivative and nature of curve, Maximum and minimum value of a function, Order Condition for maximum-minimum extreme values.	
	Chapter 6: Sections 6.3, 6.4, 6.5, of Text [1]		

Module	Unit	Contents	Hrs
III	**Matrices**		**12**
	4	Addition, subtraction of Matrices, matrix multiplication, transpose of a matrix properties of transpose of a matrix	
	5	determinants, inverse of a matrix (cofactor method only)	
	Chapter 5: Sections 5.1, 5.2, 5.3, 5.5, 5.6, 5.7, 5.10 and 5.13 of Text [1]		
IV	**Game Theory**		**12**
	6	Basic concepts of Game theory Classification and Description of games Pay-off matrix,	
	7	Saddle point solutions (Strictly Determined Games)	
	Chapter 20: Sections 20.1, 20.2, 20.3, 20.4 of Text [1]		
V	**Suggestions for teacher designed module**		**12**
	For internal assessment examinations only.		
	8	Applications of simple derivatives: Differential Coefficient and elasticity of demand Some special form of square matrices	
	The topics can be found on Chapter 7: Section 7.1 of Text [1] and Chapter 5: Section 5.15 of Text [1]		

Textbook

1. B.C. Mehta, G.M.K. Madnani, Mathematics for Economics. Sultan Chand & Sons, 1976.

References

1. Agarwal B.M, Business Mathematics and Statistics, Vikas Publishing House,New Delhi, 2009.

2. Allen, R.G.D. , Mathematical Analysis for Economists. New Delhi: AITBS Publishers, 2008.

3. Yamane, Taro., Mathematics for Economists: An Elementary Survey. New Delhi: Prentice Hall of India, 2012.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concepts of derivatives, Maxima-minima	PSO1	R, U	F,C	L	
CO 2	Apply the concepts of differentiation in real life situations	PSO3, 5	Ap	C	L	
CO 3	The basic concepts of matrices	PSO3	U	P	L	
CO 4	The basic concepts of game theory	PSO1, PO1	U	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	2	2	1	3	3	2	1	3
CO2	-	-	3	-	3	-	2	3	1	-	-	-	-	1
CO3	-	-	3	-	-	-	3	3	3	2	3	2	1	3
CO4	3	-	-	-	-	-	3	2	-	-	2	1	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT108				
Course Title	Integral Calculus and Series				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3	-	2	5
Pre-requisites	Differential Calculus				
Course Summary	The course deals with Integrals, applications of integrals and the fundamental theorem of calculus. The intuitive idea of Infinite series and Taylor's theorem is also explained.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Integration**		**9**
	1	The Indefinite Integral: Antiderivatives, The Indefinite Integrals, Integration formulas, Properties of the indefinite integral, Integral curves.	
	2	Integration by substitution (excluding Integration using computer algebra systems)	
	3	Evaluation of definite integral by substitution	
	4	Integrals of logarithmic Functions	
	5	Integrals of exponential functions	
	Chapter 4: Section 4.2, 4.3, 4.9 chapter 6: section 6.2(integration only), 6.3(integration only) of Text[1]		

Module	Unit	Contents	Hrs
II	**Applications of Integration**		**9**
	6	Area between two curves	
	7	Volume by Slicing: (excluding other axis of revolution)	
	8	Length of a plane curve(excluding finding arc length by numerical methods)	
III	**Infinite series**		**9**
	9	Sequences, Monotone sequences, Infinite series, Convergence tests, Comparison, ratio test	
	Chapter 9: Section 9.1, 9.2, 9.3, 9.4, 9.5 of Text [1]		
IV	**Taylors theorem**		**9**
	10	Maclaurin and Taylor polynomials and series, Power series (except functions defined by power series), Convergence of Taylor series	
	Chapter 9: Section 9.7, 9.8, 9.10 of Text [1]		
V	**Suggestions for teacher designed module**		**9**
	For internal assessment examinations only.		
	11	An overview of area problem Volume by other axis of revolution Area of a surface of revolution Alternating series Absolute and conditional convergence Root test Convergence of Taylor series Differentiating and integrating power series	
	These topics can be found on Chapter 4: Section 4.1, Chapter 5: Sections 5.2. 5.5, Chapter 9: Sections 9.6, 9.7, 9.8 of Text [1]		

Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant π
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them Ref: P3 or section 1.4 of P4

4. Using `integrate` command to compute indefinite and definite integrals
   Ref : Section 3.3.4 of P2

5. Sketching graphs of curves using `plot`
   Ref : Section 6.1 of P2

6. Find area of surface of revolution of curves
7. Find length of a plane curve
8. Defining curves, finding area between two curves
   Ref : Section 6.1 of P4
9. Finding volumes of solids of revolution, finding arc length
   Ref : Section 6.3 of P4
10. `diff` command to find derivatives of standard functions, polynomials, including higher order derivatives
    Ref: Section 3.1 of P4
11. Finding Taylor series representation of a function using differentiation (without usitng `taylor` function)
12. Finding McClaurin series representation of a function using differentiation
13. Finding Taylor series representation of a function using differentiation using `taylor` function
14. Plot the graph of the function, and its Taylor series approximation

Problems for the practical examination

1. Computing indefinite and definite integrals of standard functions (trigonometric, log, e, polynomials)
2. Demonstrate the plot command with various options (line style, color, thickness etc)
3. Finding area between two curves, sketching them
4. Find area of surface of revolution of curves
5. Find length of a plane curve
6. Finding volumes of solids of revolution, sketching the curves and solids
7. Defining various functions and finding derivatives of various orders
8. Finding Taylor series representation of a function using differentiation (without usitng `taylor` function)
9. Finding Taylor series representation of a function using differentiation using `taylor` function, and plot the graph of the function, and its Taylor series approximation
   Ref : Section 3.3 of P2
10. Finding McClaurin series representation of a function using differentiation

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbook

1. Howard Anton, Irel Bivens, Stephens Davis, *Calculus* 10^{th} Edition Wiley, 2012.

References

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10^{th} Edition, 2018.

2. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12^{th} Edition, Addison-Weseley Publishing Company, 2004

3. J Stewart, *Calculus with Early Transcendental Functions*, 7^{th} Edition, Cengage India Private Limited, 2008

4. G B Thomas, R L Finney, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

Resources for practical sessions

P1. Sagemath documentation – Introductory Sage Tutorial https://doc.sagemath.org/html/en/prep/Intro-Tutorial.html

P2. Saskia Roos, Michael Jung, *An Introductory Course on Sage, Lecture Notes* https://www.math.uni-potsdam.de/fileadmin/user_upload/An_Introductory_Course_on_Sage.pdf

P3. Sagemath documentation – Symbolic variableshttps://doc.sagemath.org/html/en/reference/calculus/sage/calculus/var.html

P4. Tuan A. Le, Hieu D. Nguyen, SageMath Advice for calculus https://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

P5. Sagemath documentation – Sage Quickstart for Multivariable Calculus https://doc.sagemath.org/html/en/prep/Quickstarts/Multivariable-Calculus.html

P6. Sagemath documentation – Parametric plots https://doc.sagemath.org/html/en/reference/plot3d/sage/plot/plot3d/parametric_plot3d.html#sage.plot.plot3d.parametric_plot3d.parametric_plot3d

P7. P. Zimmermann *et al*, Computational Mathematics with SageMath, https://www.sagemath.org/sagebook/english.html

P8. Gregory V. Bard, Sage for Undergraduates http://www.people.vcu.edu/~clarson/bard-sage-for-undergraduates-2014.pdf

P9. SageMath documentation – 3D Graphics https://doc.sagemath.org/html/en/reference/plot3d/index.html

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understands the basic concept of Integrals and fundamental theorem of Calculus	PSO1, 2, PO1	U	F,C	L,T	
CO 2	Realise the concept of area between two curves	PSO2, PO3, 4	R, U	F	L,T	
CO 3	Develop a concrete idea about sequences and series	PSO1,3, PO2, 3	U,An	C	L,T	
CO 4	Use convergence tests to find limits	PSO3, PO3	Ap	C,P	T	As
CO 5	Apply integration in Modeling Taylor series	PSO1,3, PO3	Ap	C,P	T	As

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1					3							
CO2		2							1	3				
CO3	2		3					2	2					
CO4			2					3						
CO5	2		1					3						

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓			✓
CO3	✓	✓		✓
CO4	✓			✓

University of Kerala

Descipline	Mathematics				
Cours Code	UK2DSCMAT109				
Course Title	Matrices and Linear Equations				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	Matrices				
Course Summary	This is a brief introductory course on matrices and system of linear equations				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Matrices**		**10**
	1	Introduction to System of Linear equations, (Matrices and Matrix Operations, Inverses; Algebraic Properties of Matrices- review only). Elementary matrices and method for finding inverse, more on linear systems and invertible matrices, diagonal, triangular and symmetric matrices	
	Chapter 1: Section 1.1, 1.3 to 1.7 of the Text[1]		
II	**Determinanats**		**12**
	2	Determinants by cofactor expansion, evaluating determinants by row reduction, properties of determinants, Cramer's rule	
	Chapter 2: Sections 2.1, 2.2 and 2.3 of Text [1]		
III	**Systems of linear equations**		**12**

Module	Unit	Contents	Hrs
	3	Linear Systems of Equations, Gauss Elimination, Linear Independence, Rank of a Matrix. *(Sections 7.2, 7.4 of Text [2] (avoid vector space))*	
	4	Solutions of Linear Systems: Existence, Uniqueness *(Chapter 7 Section 7.5 of Text [2] (omit proofs of theorems))*	
IV	**Eigen values and Eigen vectors**		**14**
	5	The Matrix Eigenvalue Problem. Determining Eigenvalues and Eigenvectors *(Chapter 8 Section 8.1 of Text [2])*	
	6	Symmetric, Skew-Symmetric, and Orthogonal Matrices *(Chapter 8 Section 8.3 of Text [2])*	
	7	Diagonalization *(Chapter 8 Section 8.4 of Text [2] except eigen bases)*	
V	**Suggestions for teacher designed module**		**12**
	For internal assessment examinations only.		
	8	Matrix transformations Orthogonality Geometry of linear systems Orthogonal Matrices Quadratic Forms	
	These topics can be found on Chapters 1 and 3 of Text [1] and Chapter 8 of Text [2]		

Textbook

1. H Anton, C Rorres, Elementary linear algebra, 11th Edition, John Wiley & Sons, 2013.

2. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10^{th} Edition, 2018.

References

1. David Poole, Linear Algebra, a modern introduction, Brooks/Cole Cengage learning, 2005.

2. Lee W.Johnson, R. Deanriess, Jimmy Arnold, Introduction to Linear Algebra, Fifth edition, Addison Wisely, 2019.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Understands system of linear equations	PSO1,2, PO1	U	F,C	L,T	
CO 2	Perform various operations on matrices and determinants	PSO2, PO3, 4	An	F	L,T	
CO 3	Understand the concept of vectors in Euclidean spaces	PSO1,3, PO2, 3	U,An	C	L,T	
CO 4	Apply matrices to soleve system of linear equations	PSO1,3	Ap	C	L,T	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1					3							
CO2		2							1	3				
CO3	2		3					2	2					

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1		✓		✓
CO2		✓		✓
CO3	✓			✓
CO4	✓			✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT110				
Course Title	Partial Differentiation and Analytic functions				
Type of Course	DSC				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	4	-	-	4
Pre-requisites	1. Integration 2. Differentiation				
Course Summary	Integration and applications of Differentiation				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Multivariate Calculus**	**16**
	1	Functions of Two or More Variables, Limits and Continuity *(Chapter13: Sections 13.1, 13.2 of Text[1])*	
	2	Partial Derivatives, The Chain Rule *(Chapter 13: Section 13.3, 13.5 of Text [1])*	
	3	Directional derivatives, Maxima and Minima of Functions of Two Variables *(Chapter 13: Sections 13.6, 13.7 of Text [1])*	
II		**Analytic functions**	**12**
	4	Complex Numbers and Their Geometric Representation *(Chapter 13: Section 13.1 of Text [2] (review only))*	
	5	Polar Form of Complex Numbers-Powers and Roots *(Chapter 13: Section 13.2 of Text [2]*	
	6	Derivative-Analytic Function, Cauchy–Riemann Equations Laplace's Equation *(Chapter 13: Section 13.3, 13.4 of Text [2])*	

Module	Unit	Contents	Hrs
III	**Cauchy's Integral Theorem**		**12**
	7	Line Integral in the Complex Plane and is properties (Except Existence of Complex Line integrals & ML Inequality) *(Chapter 14: Section 14.1 of Text [2])*	
	8	Cauchys Integral Theorems (without proof) Caucy's Integral Formula (without proof) Derivative of Analytic Functions *(Chapter 14: Sections 14.2, 14.3 of Text [2])*	
IV	**Derivatives of Analytic Functions**		**8**
	9	Derivatives of Analytic Functions, Lioville's Theorem and Morreras theorem *(Chapter 14: Section 14.4 of Text [2])*	
V	**Suggestions for teacher designed module**		**12**
	For internal assessment examinations only.		
	10	Geometry of Analytic Functions, Conformal Mapping, Principle of Inverse Mapping *(Chapter 17: Section 17.1 of Text [2] all theorems without proof)* Möbius Transformations, Extended Complex Plane, Fixed Points *(Chapter 17: Section 17.2 of Text [2] all theorems without proof)* Special Linear Fractional Transformations, Mapping of Standard Domains *(Chapter 17: Section 17.3 of Text [2] all theorems without proof)*	

Textbooks

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley and Sons, 2012.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, 10th Edition, 2018.

References

1. Anant R Shastri, *Basic Complex Analysis of One Variable*, Macmillan, 2010.
2. Edward B. Saff, Arthur David Snider, *Fundamentals of Complex Analysis with Applications to Engineering and Science*, 3rd Edition, Pearson Education India, 2017.
3. James Ward Brown and Ruel V Churchill, *Complex Variables And Applications*, Eighth Edition, McGraw Hill International Edition, 2001.
4. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12th Edition, Addison-Weseley Publishing Company, 2004.
5. John H Mathews and Russel W Howell, *Complex Analysis for Mathematics and Engineering*, Sixth Edition, Jones and Bartlett Publishers, 2012.
6. J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2018.

7. G B Thomas, R L Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company, 2004.

8. B S Tyagi, *Functions of A Complex Variable*, Kedar Nath Ram Nath, 2021.

E-resources

1. https://www.geogebra.org/m/VMa4z2RU

2. https://www.geogebra.org/m/wcjfy77h

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define the concept of functions of two or more variables	PSO 1	U	F, C	L	
CO 2	Illustrate derivatives of multivariate functions	PSO 2, 4	Ap, An	P	L	
CO 3	Understand the algebraic operations of complex numbers, complex functions, limits, continuity, differentiablilty of complex functions and conformal mapping.	PSO 1	U	F, C	L	
CO 4	Able to find line integrals, integrals using Cauchy's integral formula	PSO 2, 4	Ap, An	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	2	1	-	-	-	3	-	-
CO2	-	-	3	3	-	-	2	1	-	-	-	3	-	-
CO3	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO4	-	3	3	-	-	-	-	3	2	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2DSCMAT111				
Course Title	Differential and Integral Calculus				
Type of Course	DSC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3	-	2	5
Pre-requisites	1. Integral of elementary functions 2. Vectors				
Course Summary	This course enable the students to find the integrals and know about the vector valued functions				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Differentiation**	**9**
	1	Limits, one-sided limits, relations between one-sided and two-sided limits, The derivative function	
	2	Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions	
	Chapter 1 1.1 Chapter 2 Sections 2.1, 2.2, 2.3, 2.4, 2.5 of Text [1]		
II		**Chain rule**	**9**
	3	The Chain Rule, Implicit Differentiation *(Chapter 2 Sections 2.6, 2.7 of Text 1)*	
	4	Derivatives involving Exponential and logarithmic functions *(Chapter 6 Section 6.2 of Text 1)*	
	Chapter 2 Sections 2.6, 2.7, Chapter 6 section 6.1, 6.2 of Text [1]		

Module	Unit	Contents	Hrs
III	**Definite Integral**		**9**
	5	Integration by Substitution, The Definite Integral	
	6	Evaluating Definite Integrals by Substitution	
	Chapter 4: Sections 4.3, 4.5, 4.9 of Text [1]		
IV	**Evaluation of Integrals**		**9**
	7	Integration by Parts *(Chapter 7: Section 7.2 of Text [1])*	
	8	Integrating Trigonometric Functions *(Chapter 7 Section 7.3 of Text 1)*	
	Chapter 7: Sections 7.2, 7.3 of Text [1]		
V	**Suggestions for teacher designed topic**		**9**
	For internal assessment examinations only.		
	9	Computing limits Continuity Tangent lines Rate of change Exponential and logarithmic functions Integration Trigonometric Substitutions	
	These topics can be found on Chapter 1: Section 1.2, 1.5, Chapter 2: Section 2.1, Chapter 6: Section 6.1, Chapter 7: Section 7.4 of Text [1]		

Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant π
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them
   Ref: P3 or section 1.4 of P4

4. Computing two sided limits of various functions
   Ref : Section 2.2 of P4

5. Computing one sided limits of various functions
   Ref : Section 2.2 of P4

6. `diff` command to find derivatives of standard functions, polynomials
   Ref: Section 3.1 of P4

7. Using `integrate` command to compute indefinite integrals
   Ref : Section 3.3.4 of P2

8. Using `integrate` command to compute definite integrals
   Ref : Section 3.3.4 of P2

9. Sketching graphs of curves using `plot`
   Ref : Section 6.1 of P2

10. Sketching tangent lines of curves at specific points using `plot`
    Ref : Section 3.1.1 of P4

Problems for the practical examination

1. Demonstrate the basic arithmetic
2. Demonstrate using standard trigonometric, log, exponential functions, their evaluation
3. Defining and accessing lists
4. Defining and accessing dictionaries
5. Define polynomials of various order, evaluate them
6. Define functions, and evaluate two-sided limits
7. Define functions, and evaluate one-sided limits
8. Demonstrate the plot command with various options (line style, color, thickness etc)
9. Define functions, find their derivatives
10. Computing indefinite and definite integrals of standard functions (trigonometric, log, e, polynomials)

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbook

1. H Anton, I Bivens, S Davis, *Calculus*, 10^{th} Edition, John Wiley & Sons, 2012.

References

1. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, 12^{th} Edition, Addison-Weseley Publishing Company, 2004.
2. J Stewart, *Calculus with Early Transcendental Functions*, 7^{th} Edition, Cengage India Private Limited, 2008.
3. G B Thomas, R L Finney, *Calculus*, 9^{th} Edition, Addison-Weseley Publishing Company, 2004.

Resources for practical sessions

P1. Sagemath documentation – Introductory Sage Tutorial https://doc.sagemath.org/html/en/prep/Intro-Tutorial.html

P2. Saskia Roos, Michael Jung, *An Introductory Course on Sage, Lecture Notes* https://www.math.uni-potsdam.de/fileadmin/user_upload/An_Introductory_Course_on_Sage.pdf

P3. Sagemath documentation – Symbolic variables https://doc.sagemath.org/html/en/reference/calculus/sage/calculus/var.html

P4. Tuan A. Le, Hieu D. Nguyen, SageMath Advice for calculus https://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

P5. P. Zimmermann *et al*, Computational Mathematics with SageMath, https://www.sagemath.org/sagebook/english.html

P6. Gregory V. Bard, Sage for Undergraduates http://www.people.vcu.edu/~clarson/bard-sage-for-undergraduates-2014.pdf

E-resourses

1. https://www.geogebra.org/m/z3jEUrvv
2. https://www.geogebra.org/m/ngfvakga
3. https://www.geogebra.org/m/AzVR5uU7
4. https://www.geogebra.org/m/yyu2my9w

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand the concept of limit, differentiation	PSO 1	U	F, C	L	
CO 2	Describe derivative of a function and learn its physical interpretation through various examples.	PSO 2, 4	Ap, An	P	L	
CO 3	Understand the concept of integration	PSO 1	U	F, C	L	
CO 4	Describe the integral of a function and learn its physical interpretation through various examples	PSO 2	Ap	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	3	2	3	-	-	-	3	2	-	-	-	-	-
CO3	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO4	-	3	3	-	-	-	3	2	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2MDCMAT100				
Course Title	Numerical Ability - II				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic Arithmetic Operations				
Course Summary	This course is primarily meant for students who have not undergone a Mathematics course beyond their secondary school. The course is expected to equip the student tackle basic arithmetic problems. The student is further expected to form linear and quadratic equations from simple real world problems on their own and solve the same.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Series and Progression**		**12**
	1	Arithmetic Series, Geometric series, Arithmetic Series of different orders, Arithmetico-Geometric series, Geometrico-Arithmetic Series. Problems involving the above concepts *(Chapter 23 of Text [1])*	
II	**Interest Calculation**		**9**
	2	Simple Interest, Problems involving Simple Interest *(Chapter 17 of Text [1])*	
	3	Compound Interest, Problems involving Compound Interest *(Chapter 18 of Text [1])*	

Module	Unit	Contents	Hrs
III	**Equations**		**6**
	4	Linear Equation in one variable, Linear equation in two variables, Solving two simultatneous linear equations. Consistent and inconsistent equations. *(Chapter 27 of Text [1])*	
	5	Quadratic Equation, Solution of a quadratic equation. *(Chapter 28 of Text [1])*	
IV	**Permutations, Combinations**		**9**
	6	Fundamental principle of counting, Permutations, Permutations under restrictions, Combinations. *(Chapter 31 of Text [1])*	
V	**Suggestions for the teacher designed module**		**9**
	For internal assessment examinations only		
	7	Harmonic progression Consistent and inconsistent equations Nature of roots Relation between roots and coefficients Formation of a quadratic equation with given roots.	
	These topics can be found on Chapters 29, 27 and 28 of Text [1]		

Textbook

1. Dinesh Khattar, *Quantitative Aptitude for Competitive Examinations*, Fourth Edition, Pearson, 2016.

References

1. H Kruglak, JT Moore, RA Mata-Toledo, *Schaum's outline of theorey and problems of Basic Mathematics, with Applications to Science and Technology*, Second Edition, McGraw-Hill, 1998.

2. Rajesh Verma, *Fast Track Objective Arithmetic*, Arihant, 2018.

3. Steven T Karris, *Mathematics for Business, Science and Technology*, Third Edition, Orchard Publications, 2007.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand basic level mathematics used in real life situations	PSO1, PSO2, PSO3, PO1, PO2, PO5	U, An, E	C, P	L	
CO 2	Do maths problems quickly using ready to use formulae	PSO3, PO2	R, Ap	P	L	
CO 3	Converting real world problems to mathematical problems	PSO1, PSO2, PSO3, PSO5, PO1, PO2, PO5, PO6	U, An, E	C, P	L	
CO 3	Understand the concepts of probability and compute it	PSO1, PSO2, PSO3, PO1, PO2	U, An, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	-	-	-	3	2	-	-	2	-	-	-
CO2	-	-	3	-	-	-	-	2	-	-	-	-	-	-
CO3	2	3	2	-	2	-	3	2	-	-	2	2	-	-
CO4	2	3	2	-	-	-	3	2	-	-	-	-	-	-

(- -Nil, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓			✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2MDCMAT101				
Course Title	Business Mathematics				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic algebra				
Course Summary	The course covers methods for finding simple interest and compound interest using different period of compounding concepts like index numbers, time series, trend arc - introduced and different ways for finding these are dealt in detail.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Basic Mathematics of Finance**		**9**
	1	Nominal rate of Interest and effective rate of interest, Continuous Compounding, force of interest, compound interest calculations at varying rate of interest (Chapter 8: Sections: 8.1, 8.2, 8.3, 8.4. 8.5, 8.6, 8.7, 8.9 of text [1])	
II	**Depreciation and discounting**		**9**
	2	Present value, interest and discount, Nominal rate of discount, effective rate of discount, force of discount, Depreciation (Chapter 8: Sections: 8.1, 8.2, 8.3, 8.4. 8.5, 8.6, 8.7, 8.9 of text [1])	

Module	Unit	Contents	Hrs
III	**Index numbers**		**9**
	3	Definition, types of index numbers, methods of construction of price index numbers, Laspeyer's price index number (Chapter 6 :Sections: 6.1, 6.3, 6.4, 6.5, 6.6, 6.8, 6.16, 6.17 (Unit II) of Text [1]	
IV	**Time Series**		**9**
	4	Definition of Time Series, Components of Time Series, Analysis of Time Series, Measurement of Trend- Free hand Method (Chapter 7: Sections: 7.1, 7.2, 7.4 (Unit II) of Text [1])	
V	**Teacher designed module - suggested topics**		**9**
	For internal assessment examinations only.		
	5	Paasche's price index number Fisher ideal index number Advantages and limitations of index numbers Measurement of Trend – Semi Average Method Method of Least Squares.	
	These topics can be found on Chapters 6 and 7 of Text [1]		

Textbook

1. B M Agarwal, Business Mathematics and Statistics, Vikas Publishing House, New Delhi, 2009.

References

1. Alpha C Chiang, Kevin Wainwright, Fundamental methods of Mathematical Economics, 4th Edition, Mc-Graw Hill, 2005.

2. Qazi Zameeruddin, et al., Business Mathematics, Vikas Publishing House, New Delhi, 2009.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define Index Numbers and find index numbers from a given data using various methods.	PSO1, PO1, 2, 3, 4, 5, 6, 7	U, E	L	C	
CO 2	Define Time Series, components of Time Series and related concepts.	PSO1, PO1, 2, 3, 4, 5, 6, 7	U	L	C	
CO 3	Solve problems related to simple and compound interest using varying periods of compounding.	PSO2, PO1, 2, 3, 4, 5, 6, 7	Ap, E	L	P	
CO 4	Use mathematical tools to analyse time series and measure trend	PSO2, PO1, 2, 3, 4, 5, 6, 7	E, Ap, An	L	P	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	1	2	1	2	3	1	2	1	2	1	-
CO2	3	2	2	1	2	1	2	1	1	3	1	1	1	-
CO3	2	3	2	2	1	1	2	3	1	1	1	2	-	-
CO4	1	3	2	1	1	1	2	3	1	1	1	2	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2MDCMAT102				
Course Title	Basic Operations Research				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic mathematical operations				
Course Summary	This course covers the fundamentals of Operations Research including the historical background, mathematical formulation, graphical solution methods. It delves into the Transportation Problem and Assignment Problem, exploring various methods for obtaining initial basic feasible solutions and introducing algorithms for solving the Assignment Problem and travelling salesman problem.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Introduction to Operations Research**		**9**
	1	The History of Operations Research	
	2	Methodology of Operations Research	
	3	Applications of Operations Research	
	(Chapter 1: Section 1.2, 1.9, 1.13 of Text [1].)		
II	**Linear Programming**		**9**
	4	Structure of linear programming model	
	5	Mathematical model of an LPP	
	6	Graphical solution of LP problem	

Module	Unit	Contents	Hrs
	(Chapter 2: Sections 2.2, 2.6,2.8.1, Chapter 3: sections 3.2, 3.3 (Examples 3, 5, 3.6, 3.7, 3.11) of Text [1].)		
III	**Transportation Problem**		**9**
	7	Mathematical model of transportation problem	
	8	Initial feasible solution to Transportation Problem	
	(Chapter 9: Section 9.2, 9.4.1, 9.4.2, 9.4.3 of Text [1].)		
IV	**Assignment Problem**		**9**
	9	Mathematical model of Assignment problem	
	10	Hungarian Method for solving Assignment problem	
	(Chapter10: Section 10.2, 10.3.1, 10.4 of Text [1].)		
V	**Suggestions for the teacher designed module**		**9**
	For internal assessment examinations only		
	11	Special Cases in Linear Programming The Optimal Solution by MODI method Traveling Salesman Problem	
	These topics can be found on Chapters 3, 9 and 10 of Text [1]		

Textbook

1. J. K. Sharma, Operations Research - Theory and Applications, Sixth Edition, 2016.

References

1. Goel B.S and Mittal S.K “Operations Research” Pragati Prakashan, Meerut ,1973.
2. Hardly G, “Linear Programming” Addison Wesley, Reading. Mass, 1962.
3. Kapoor V.K, “Operations Research” Sultan chand and sons, New Delhi 1985.
4. Nita H.Shah, Ravi M.Gor, Hardik Soni, “Operations Research”, Prentice Hall of India, New Delhi, 2007.
5. Ravindran A, Don.T. Phillips, James.J.Solberg, “Operations research-Principles and Practice”, Second edition, John Wiley and Sons, 2000.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand and apply the concept of mathematical modelling	PSO2, PSO3, PO2	R,U, Ap	F,P	L	
CO 2	Apply the techniques of LPP to solve problems	PSO3, PO2	Ap , E	P	L	
CO 3	Recognize and formulate a transportation problem	PSO2, PSO3, PO2	R, U	F	L	
CO 4	Solve a travelling salesman problem.	PSO3	Ap, E	P	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	3	2	-	-	-	-	2	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	3	-	-	-	-	-	-
CO3	-	3	3	-	-	-	-	2	-	-	-	-	-	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

University of Kerala

Discipline	Mathematics				
Course Code	UK2MDCMAT103				
Course Title	Introduction to Modular Arithmetic and Cryptography				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	3	3			3
Pre-requisites	Basic properties of integers, divisibility, gcd Linear Diophantine equations, Unique factorization				
Course Summary	This is a short introduction to Cryptography using congruences.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Modular Arithmetic**	**9**
	1	Definition of congruence relation, Modular exponentiation, Divisibility tests, linear congruences, (Chapter 5: Sections 5.1, 5.2, 5.3, 5.4 of Text[1])	
II		**Three Classical Theorems**	**9**
	2	The Chinese remainder theorem, Fermat's theorem, Euler's theorem (Chapter 5: Sections 5.5, Chapter 6: Section 6.1, 6.2 of Text[1])	
III		**Introduction to Cryptography**	**9**
	3	Shift and affine cipher, Vigenere ciphers, transposition ciphers (Chapter 7: Sections 7.1, 7.2, 7.3, 7.4 of Text[1])	

Module	Unit	Contents	Hrs
IV	**RSA and applications**		**9**
	4	RSA, stream ciphers (Chapter 7: Sections 7.5, 7.6 of Text[1])	
V	**Suggestions for the teacher designed module**		**9**
	For internal assessment examinations only.		
	5	Wilson's theorem, Block ciphers, Secret sharing	
	These topics can be found on Chapters 6 and 7 of Text [1]		

Textbook

1. James S.Kraft, Lawrence C. Washington. Elementary Number Theory, CRC Press, 2015.

References

1. James S.Kraft, Lawrence C. Washington, An Introduction to Number Theory with Cryptography, CRC Press, 2014.
2. G A Jones, J M Jones, Elementary Number Theory, Springer, 1998.
3. Thomas Koshy, Elementary Number Theory with Applications, 2^{nd} Edition, Academic Press, 2007.

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Assignment (As)
CO 1	Describe the basic concept of Modular arithmetic	PSO1, PSO2	R	F,C	L	
CO 2	Apply congruence to solve various problems.	PSO3	U,Ap	P	L	
CO 3	Analyse the properties of integers using congruences via three milestone theorems	PSO3, PSO4	U,An	C	L	
CO 4	Apply congruence to cryptography	PSO3	R,U,An	C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	1	2	-	-	-	-	-	-	-	-	-	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4		✓		✓