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	✓	✓		✓