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

1. H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons, 2012.
2. Dennis G. Zill, *Advanced Engineering Mathematics* 6th 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

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

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	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	✓	✓		✓