University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT212				
Course Title	Vector Calculus				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
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		**Vector Valued Functions**	**9**
	1	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)	
	2	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)	
	Chapter 12: Sections 12.1, 12.2 of Text [1]		

Module	Unit	Contents	Hrs
II	**Tangents and Curvature**		**9**
	3	Unit Tangent, Normal and Binormal vectors (introduction only) Normal and Tangential Components of Acceleration Curvature, radius of curvature,	
	Chapter 12: Section 12.4, 12.5 of Text [1]		
III	**Vector Differentiation**		**9**
	4	Vector fields (Definition), inverse square fields, Gradient fields, Conservative Fields and potential functions, Divergence and Curl, the ∇ operator	
	Chapter 15: Section 15.1 of Text[1]		
IV	**Vector Integration**		**9**
	5	Line integrals, Integrating a vector field along a curve - Exercise Set 15.2- problems 15-30, 33-36, 41-46, Independence of Path; Conservative Vector Fields	
	6	Chapter 15: Section 15.2, 15.3 of Text[1]	
V	**Suggestions for teacher designed module**		**9**
	For internal assessment examinations only.		
	7	Arc length parametrization Motion along a curve Green's Theorem Surface integrals evaluating surface integrals, Flux, evaluation of flux integrals The divergence theorem (without proof) using the divergence theorem to find flux. Stoke's theorem (all without proof) Relationships between Green's theorem and Stoke's theorem	
	These topics can be found in Chapter 12 Sections 12.3, 12.6, Chapter 15 Sections 15.4 to 15.8		

Practical sessions and examinations – 30 hours

All the topics mentioned above can be used for practical sessions using SageMath software. Some useful resources for solving these problems using the SageMath software are given against each problem/type of problem.

1. Defining parametric curves
2. Computing limits of vector valued functions
3. Computing dot products
4. Computing cross product
5. Differentiating dot and cross products
6. Computing unit tangent vector

7. Computing normal vector
8. Computing curvature
9. Sketching vector fields
10. Computing gradient, divergence, curl

Textbook

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

Resources for practical sessions

1. Sagemath documentation – Introductory Sage Tutorial https://doc.sagemath.org/html/en/prep/Intro-Tutorial.html
2. 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
3. Sagemath documentation – Symbolic variableshttps://doc.sagemath.org/html/en/reference/calculus/sage/calculus/var.html
4. Tuan A. Le, Hieu D. Nguyen, SageMath Advice for calculus https://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf
5. Sagemath documentation – Sage Quickstart for Multivariable Calculus https://doc.sagemath.org/html/en/prep/Quickstarts/Multivariable-Calculus.html
6. 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
7. P. Zimmermann *et al*, Computational Mathematics with SageMath, https://www.sagemath.org/sagebook/english.html
8. Gregory V. Bard, Sage for Undergraduates http://www.people.vcu.edu/~clarson/bard-sage-for-undergraduates-2014.pdf
9. SageMath documentation – 3D Graphics https://doc.sagemath.org/html/en/reference/plot3d/index.html

References

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

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

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

e-resources

1. https://www.sagemath.org/help.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	Understanding of Vector-Valued Functions and Parametric Curves	PSO 1	U	F, C	L	
CO 2	Ability to Parametrize Curves and Calculate Arc Length	PSO1, PSO2, PSO3, PSO4, PO1, PO2	R, U, E, Ap, An	P, C, F	L	
CO 3	Application of Line and Surface Integrals	PSO2, PSO3, PO1, PO2	U, Ap, E	P, F, C	L	
CO 4	Analyze and solve complex problems involving vector-valued functions and parametric curves in three-dimensional space.	PSO1, PSO2, PSO3, PSO4, PSO6, PO1, PO2, PO3	U, Ap, An, E, C	P, M	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	✓	✓		✓