University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT208				
Course Title	Geometry, Multivariate and 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.Differentiation 2. Integration 3. Vectors				
Course Summary	This course enables the students to know the parametric and polar representation of curves, vector-valued functions, partial derivatives multiple integrals and vector fields				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Parametric and polar curves: Conic sections**	**9**
	1	Parametric equations: Tangent lines and arc length of parametric curves, Polar coordinates, Tangent lines, arc length and area of polar curves, Conic sections, Conic section in Polar coordinates.	
		Chapter 10: Section 10.1 ,10.2, 10.3, 10.4, 10.6 of Text [1]	
II		**Vector-valued functions**	**9**
	2	Introduction To Vector-Valued Functions, Calculus of Vector-Valued Functions, Arc Length (arc length from the vector view point only), Unit Tangent, Normal Vectors, Curvature.	
		Chapter 12: Section 12.1 to 12.5 of Text [1]	
III		**Partial derivatives**	**9**

44

Module	Unit	Contents	Hrs
	3	Functions of Two or More Variables, Limits and Continuity (Continuity at Boundary Points and Extensions of Three Variables may be omitted.)	
	4	Partial Derivatives, The Chain Rule (Estimating Partial Derivatives From Tabular Data, Partial Derivatives and Continuity, The Wave Equation may be omitted)	
		Chapter 13: Section 13.1, 13.2, 13.3, 13.5 of Text [1]	
IV		**Multiple integrals**	**9**
	5	Double Integrals, Double Integrals over Non-rectangular Regions (Chapter 14: Section 14.1, 14.2 of Text[1]	
	6	Double Integrals in Polar Coordinates (Chapter 14: Section 14.3 of Text[1])	
	7	Triple Integrals (Chapter 14: Section 14.5 of Text 1). Definition of Triple Integral, Properties of Triple Integrals, Evaluating Triple Integrals over Rectangular Boxes.	
		Chapter 14: Section 14.1, 14.2, 14.3, 14.5, 14.6, 14.7, Chapter 15: Section 15.1, 15.2, 15.3 of Text [1]	
V		**Suggestions for teacher designed module**	**9**
		For internal assessment examinations only.	
	8	Binomial vectors, curvature, motion along a curve Surface area, Parametric surface, Change of variables in multiple integrals, Jacobians Vector fields, line integrals, Independence of paths, Conservative vector fields	
		These topics can be found in Chapter 12 Section 12.4, 12.5, 12.5 Chapter 14 Sections 14.4, 14.7, Chapter 15 sections 15.1, 15.2, 15.3	

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 tangent lines

3. Finding arc lengths

4. Plotting conic sections

5. Computing unit tangent, normal vectors

6. Computing curvature

7. Sketch the graphs and level surfaces of two variable functions and (using 3 dimensional plot)

8. Evaluate the limit of two variable functions

9. Compute partial derivatives of two/three variable functoins and evaluate them at given points.

10. Evaluate double integrals in rectangular co-ordinates.

A record should be maintained with atleast 7 problems from the main topics/teacher designed topics. 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.

Resources for practical sessions

1. SageMath – documentation
   https://doc.sagemath.org/html/en/tutorial/introduction.html

2. Online SageMath server https://sagecell.sagemath.org/

3. Graphing Functions of two variables using Technology
   https://doc.sagemath.org/html/en/tutorial/tour_algebra.html

4. Maxima and Minima Of Functions Of Two Variables
   https://wiki.sagemath.org/interact/calculus#Root_Finding_Using_Bisection

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

6. Tutorial: Vector Calculus in Euclidean Spaces https://doc.sagemath.org/html/en/thematic_tutorials/vector_calculus.html

7. 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

Text books

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

References

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

46

Ref. 2 J Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited, 2008

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

e-resources

1. https://www.geogebra.org/m/AzVR5uU7

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	Understands basic concepts of parametric and polar curves, conic section and vector-valued function	PSO1, 2, PO1	R, U	F, C	L, T	
CO 2	Evaluate multiple Integrals	PSO2, PO3, 4	An, Ap	F	L, T	
CO 3	Develop a concrete idea Partial derivatives	PSO1, PO2, 3	U, An	C	L, T	
CO 4	Apply multiple integrals to solve problems	PSO3, PO2	Ap, E	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
CO1	2	1	-	-	-	-	3	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	1	3	-	-	-
CO3	2	-	-	-	-	-	-	2	2	-	-	-	-
CO4	-	-	2	-	-	-	-	3	-	-	-	-	-

47

(- -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	✓	✓		✓

48