Program Outcomes		
PO1	**Engineering knowledge**	An ability to apply knowledge of mathematics (including probability, statistics and discrete mathematics), science, and engineering for solving Engineering problems and modeling
PO2	**Problem analysis**	An ability to design, simulate and conduct experiments, as well as to analyze and interpret data including hardware and software components
PO3	**Design / development of solutions**	An ability to design a complex system or process to meet desired specifications and needs
PO4	**Conduct investigations of complex problems**	An ability to identify, formulate, comprehend, analyze, design synthesis of the information to solve complex engineering problems and provide valid conclusions.
PO5	**Modern tool usage**	An ability to use the techniques, skills and modern engineering tools necessary for engineering practice
PO6	**The engineer and society**	An understanding of professional, health, safety, legal, cultural and social responsibilities
PO7	**Environment and sustainability**	The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and demonstrate the knowledge need for sustainable development.
PO8	**Ethics**	Apply ethical principles, responsibility and norms of the engineering practice
PO9	**Individual and team work**	An ability to function on multi-disciplinary teams.
PO10	**Communication**	An ability to communicate and present effectively
PO11	**Project management and finance**	An ability to use the modern engineering tools, techniques, skills and management principles to do work as a member and leader in a team, to manage projects in multi-disciplinary environments
PO12	**Life-long learning**	A recognition of the need for, and an ability to engage in, to resolve contemporary issues and acquire lifelong learning

PROGRAM SPECIFIC OUTCOMES (PSOs):

The graduates of the department will attain:

PSO1	The ability to analyze, design and implement application specific complex engineering problems by applying the knowledge of basic sciences, engineering mathematics and engineering fundamentals.
PSO2	The ability to adapt for rapid changes in tools and technology with an understanding of societal and ecological issues relevant to professional engineering practice through life-long learning.
PSO3	Excellent adaptability to function in multi-disciplinary work environment, good interpersonal skills as a leader in a team in appreciation of professional ethics and societal responsibilities.

Course No: MA 102	**Course Title :** Higher Calculus
Semester: II	**L T P C** : 2 1 0 3
Degree : B.Tech	**Branch:** Civil Engineering, Computer Science Engineering, Electrical and Electronics Engineering, Electrical and Communication Engineering, Data Science &Artificial Engineering, Mechanical Engineering, Mechatronics
COURSE AREA/DOMAIN: MATHEMATICS	**Lab(if any):NIL**

Prerequisite: Differentiation and Integration of single variable

Instructor In charge: Dr. Rakesh Reddy T

Instructors: Dr. S. Mohan Reddy, Dr.K.Ramesh, Dr.T.Divya

Course Objectives:

- To enable the students to study vector and scalar valued functions
- To learn system of partial derivatives and Tangent planes
- To enable the ways of solving Multiple integrals
- To learn vector differentiation and integration
- To get the exposure to Engineering applications of Green's, Stoke's and Guass Theroems

Text Book T	Thomas G.B. Thomas Calculus, Pearson Education, 14th ed., 2018.
Reference book(s)	
R1	Erwin Kreyszig , Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons , 2012.
R2	Salas S. L., Einar Hille and Garret J. Etgen, Calculus (One and Several variables), John Wiley, 8th Edition, 1999.

Lecture-wise plan (Syllabus):

Lecture Nos.	Learning Objective	Topics to be covered	Reference (Chapter/Sec./Page Nos. of Text/Ref. Books)
1	Use calculus to study the paths, velocities, and accelerations of moving bodies	Limits, Continuity and Differentiability of vector functions	T1: 13.1
2	To study the applications of derivative and motion in space	Velocity & Unit tangent vector	T1: 13.3
3-4	To understand the frame of mutually orthogonal unit vectors	Normal vectors, Curvature, Torsion and the binormal	T1: 13.4,13.5
5-6	To understand the frame of mutually orthogonal unit vectors	Tangential & normal components of velocity and acceleration	**T**: 13.5
7-8	To study the functions of more than one independent variable, the way to graph them	Functions of several variables, Limits and continuity in higher dimensions	**T**: 14.1,14.2

9-10	To calculate partial derivatives and find the linearization using differentiability	Partial derivatives, differentials,	**T**: 14.3,
11-14	To find the derivative of a composite function	Chain rule for derivative, linearization, Tangent planes, Error for Linear approximation.	**T:** 14.4, 14.6
15-16	To understand the idea of directional derivatives and the equations of tangent planes and normal lines	Directions derivatives, Gradient	**T**: 14.5
17-19	Approximation of f(x, y),To find extreme values of functions of several variable	Taylor's formula for two variables Maxima, Minima with application	**T:**: 14.9,14.7
20-22	To integrate a continuous function of two or three variables over abounded region in xy-plane	Double integrals, Polar coordinates,	**T:**15.1-15.4
23-27	To find the volume of three dimensional shapes using triple integrals	Triple integrals in rectangular, cylindrical and spherical coordinates (moments, masses and centroids)	**T:**15.5-15.7
28	To evaluate multiple integrals by substitution	Substitutions in multiple integrals, Jacobian	**T:**15.8
29-32	To calculate the work done by variable forces along paths in space and rates at which fluids flow along curves and cross boundaries	Line integrals of scalar and vector fields , Path Independence, Potential functions & Conservative fields,	**T**:16.1-16.3
33-43	To describe the relationship between the way an incompressible fluid flows across the boundary of a plane region and the way it moves inside the region	Green's theorem, Surface area and surface integrals and Curl, Stokes theorem Divergence ,Gauss theorem (theorems without proofs).	**T:**16.4-16.8

COURSE OUTCOMES:

COURSE OUTCOME	EXPLANATION
CO1	Able to learn basic concepts of Vector calculus
CO2	Able to perform basic operations of several variable functions
CO3	Able to find tangent planes, Maxima and Minima of multi variable functions
CO4	Able to learn multiple integrals
CO5	Able to learn differentiation of vector valued functions
CO6	Able to learn vector integration

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**2**	**1**								
CO2	**3**	**3**	**2**	**1**								
CO3	**3**	**3**	**2**	**1**								
CO4	**3**	**3**	**2**	**1**								
CO5	**3**	**3**	**2**	**1**								
CO6	**3**	**3**	**2**	**1**								

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

SNO	DESCRIPTION	PROPOSED ACTIONS
1	Lagrange's Multipliers	Assignment
2	Some more applications on Multiple integrals	Assignment
3	Some more applications on Vector integrations	Assignment

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

S.No.	ADVANCED TOPICS
1	Partial derivatives with constrained variables
2	Quadratic surfaces
3	Unified Theory
4	Applications to Probability

WEB SOURCE REFERENCES:

S.No.	Web links
1	https://swayam.gov.in
2	https://nptel.ac.in

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

√ BOARD	√ STUD. ASSIGNMENT	√ WEB RESOURCES
STUD. SEMINARS	√ ICT ENABLED CLASSES	√ LCD

ASSESSMENT METHODOLOGIES-DIRECT:

√ TESTS/COMPRE. EXAMS	√ ASSIGNMENT	MINI/MAJOR PROJECTS
STUD. SEMINARS	STUD. LAB PRACTICES	STUD. VIVA

ASSESSMENT METHODOLOGIES-INDIRECT:

√ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	√ STUDENT FEEDBACK ON FACULTY (TWICE)
ASSESSMENT OF MINI/MAJOR PROJECTS	OTHERS

Justification for CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	Able to apply Mathematics knowledge for solving Engineering problems and modeling	An ability to analyze and interpret data including software and hardware	Able to design a complex system or process to meet desired specifications and needs	An ability to identify, formulate and solve complex engineering problems and provide valid conclusions								
CO2	Able to apply Mathematics knowledge for solving Engineering problems and modeling	An ability to analyze and interpret data including software and hardware	Able to design a complex system or process to meet desired specifications and needs	An ability to identify, formulate and solve complex engineering problems and provide valid conclusions								
CO3	Able to apply Mathematics knowledge for solving Engineering problems and modeling	An ability to analyze and interpret data including software and hardware	Able to design a complex system or process to meet desired specifications and needs	An ability to identify, formulate and solve complex engineering problems and provide valid conclusions								
CO4	Able to apply Mathematics knowledge for solving Engineering problems and modeling	An ability to analyze and interpret data including software and hardware	Able to design a complex system or process to meet desired specifications and needs	An ability to identify, formulate and solve complex engineering problems and provide valid conclusions								
CO5	Able to apply Mathematics knowledge for solving Engineering problems and modeling	An ability to analyze and interpret data including software and hardware	Able to design a complex system or process to meet desired specifications and needs	An ability to identify, formulate and solve complex engineering problems and provide valid conclusions								
CO6	Able to apply Mathematics knowledge for solving Engineering problems and modeling	An ability to analyze and interpret data including software and hardware	Able to design a complex system or process to meet desired specifications and needs	An ability to identify, formulate and solve complex engineering problems and provide valid conclusions								