BETHLAHEM INSTITUTE OF ENGINEERING
KARUNGAL

Department of Mechanical Engineering

2.6 COURSE PLAN **Date : 25/11/2022**

Name of the Staff **: Ms. G. RATHIKA**

Program **: B.E/ MECH**

Course Code &Title **: MA3151/ MATRICES AND CALCULUS**

Year / Semester **: I/ I**

No. of Credits **: 4**

1. Vision & Mission of the Program

VISION: -

To become a renowned centre of excellence in Mechanical Engineering to meet the demands in mechanical field with moral values and scientific research.

MISSION: -

- To dispense quality technical education in Mechanical Engineering for all sectors of the society.
- To inculcate various soft skills and professional skills to meet the global needs through student centric learning approach.
- To foster the qualified faculty members to be well informed about the latest Development in Mechanical Engineering.
- To establish a promising and favorable state-of-the-art environment for impressive Teaching.
- To encourage the individual and teamwork contribution through healthy interactions with stakeholders for the overall personality development of the mechanical students.
- To encourage the social responsibility of the mechanical engineers.

2. Program Educational Objectives (PEOs)

1. To enable our graduates will be successful in solving engineering problems associated with the lifestyle of mechanical systems.

2. To provide students to learn and advance their career through activities such as participation in professional organizations, attainment of professional certification and seeking higher education with strong fundamental concepts..

3. To prepare the students to critically analyze existing literature in an area of specialization and ethically develop innovate and research-oriented methodologies to solve the problems identified.

3. Program Outcomes (POs)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

4. Program Specific Outcomes (PSOs):-

- **PSO 1:** The ability to analyze, design and implement application specific systems for complex engineering problems and thermal domains like manufacturing technology, heat and mass transfer, energy, finite element analysis designs, robotics and automation by applying the knowledge of basic engineering mathematics and engineering fundamentals.

- **PSO 2:** Excellent compliance to function in multi-disciplinary environment and leadership skills with higher degree professionalism.

- **PSO 3:** The ability to adapt to sophistications in latest modeling software and recent technology in mechanical field with societal and ecological issues adhering to ethical engineering practice.

5. Course Outcomes (COs)

Students will be able

CO1: Understanding the different types of matrices, basic concept of factorization which will then be used to solve related matrix problems.

CO2: Applying the concepts of basic differentiation and limits, continuity functions.

CO3: Understanding the basic concepts differentiation and partial derivatives.

CO4: Analyze the key questions in the integral calculus by using basic integrals, trigonometric and logarithmic functions.

CO5: Applying the multiple integrals. Students can able to apply integrations to find area and volume of double and triple integrals.

6. Mapping of COs, POs& PSOs

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	3	2	2	1	1	-	-	1	3	1	-	1	2	1	-
CO 2	3	3	2	2	-	1	1	-	2	1	-	3	1	-	2
CO 3	3	2	1	2	2	-	-	2	2	1	1	1	3	-	-
CO 4	3	3	2	3	-	2	1	-	1	1	-	2	2	2	-
CO 5	3	2	3	2	1	-	-	1	2	-	-	3	2	-	2

High – 3, Medium – 2, Low - 1

JUSTIFICATION FOR CORRELATION

Sl. No	Related POs	Justification
CO1	PO1 PO2 PO3 PO4 PO5 PO8 PO9 PO10 PO12 PSO1 PSO2	1.Students have got some basic knowledge in Matrix 2.Students will able to do matrix problems by analyzing Cayley Hamilton theorem 3.Students have ideas about nature of matrix and design the quadratic forms of the matrix 4.Students will be able verify the given problems under Cayley-Hamilton theorem 5.Students will able to apply the appropriate techniques of matrix 8. Students will follow the ethical rules in Matrices 9.Students will do matrix problems by forming teams as well as individuals 10.To understand basic concept of Matrix in engineering field 12.Students understand life-long technical works using matrix 1. Students will apply the basic fundamentals of maths in Matrix 2. Students can do difficult problems in matrices using advanced engineering tools

CO2	PO1 PO2 PO3 PO4 PO6 PO7 PO9 PO10 PO12 PSO1 PSO3	1.Know some basic differentiation concepts and limit functions 2. Students will able to analyze the problems whether it is continuous or not 3.To design various graphical representation of continuous and discontinuous functions 4. Students will understand the applications of maxima and minima and it will provide a valid conclusions. 6. Students learn some graphical representation of problems 7. Do some typical problems using their effective presentations 9. By forming groups can do various problems 10. Make effective presentations by graphical representations 12.To understand some domain and range function using graph 1.Students will able to do high level problems by using various tests (first and second order differentiation) 2. To lead industrial environments by applying various differentiation techniques.
CO3	PO1 PO2 PO3 PO4 PO5 PO8 PO9 PO10 PO11 PO12 PSO1	1.Students will know about partial and total derivatives 2.Students will do various trigonometric function problems using Eulers and Extetion of Euler's theorem 3. Students will able to understand jacobians by designing two by two and three by three determinants 4. Students can do some complex problems 5.Students can use some modern tools of Partial differentiation techniques 8.Students will follow the ethics in partial differentiation 9. Students will do the problems individually and by forming groups 10.Students will analyze maxima and minima points of the given function 11.Learn Taylors series and Lagranges method using Partial differential 12Students can do typical problems in lifelong by using simple differentiation rules To apply basic fundamentals of differentiation process for various problems
CO4	PO1 PO2 PO3 PO4 PO6 PO7 PO9 PO10 PO12 PSO1 PSO2	1.Students will able to understand different techniques of integration by various methods 2.Students will analyse the complex problems by using A.P formulas 3. Students can design the problems by using integration techniques. 4.Can do problems by using reduction of odd and even formulas in trigonometric 6. .Apply reasoning knowledge in integrations 7. Demonstrate the problems by partial fraction methods 9. Students can do the problems by forming groups 10. Learn some instructions by convergent and divergent of integration 12. Lifelong process of mass and centre of momentum applications 1. Have basic fundamental ideas in integrations 3.To improve their performances by using applications of integral calculus

CO5	PO1 PO2 PO3 PO4 PO5 PO8 PO9 PO12 PSO1 PSO3	1. Students will learn some multiple integrals problems with limits 2. Students can analyze the problems using the boundary values 3. Students will design the integration problems by various graphs 4. Students will do some area problems of Cartesian and polar forms by using double integrals. 5. Students may use modern tools for finding area and volume of a given region 8. Should follow ethics of integrations 9. Students will able to do the problems in triple integrals 12. Lifelong useful for finding area and volume of a particular region and object 1. To apply basic limits in area and volume 3. To improve their performances by using applications of multiple integrals

JUSTIFICATION FOR CORRELATION

Sl. No	Related PSOs	Justification
CO 1	PSO1 PSO2	1. Ability to do some different problems 2. Students can do various typical problems by using matrix
CO 2	PSO1 PSO3	1. To give various ideas about differentiation problems by graphical representations 2. Ability to identify the continuous and discontinuous of the problems
CO 3	PSO1	1. To have some basic partial differentiation techniques
CO 4	PSO1 PSO2	1. To acquire the differentiation and integration techniques 2. Ability to do various integration problems by using simple techniques
CO 5	PSO1 PSO3	1. Ability to do some area and volume problems 2. To acquire the integration techniques

7. Pre-requisite

- Higher Secondary Mathematics (+1 & +2).

8. Course Description

Introduce the basic types of matrices, matrix addition, subtraction and multiplication which will then be used to solve related problems. Introduce and apply the concepts of basic differentiation, understand the basic concepts in integration. Examine the key questions in Functions of several variables. Give an integrated approach to differential calculus and integral calculus, and provide a firm basis for further reading and study in the subject.

9. Course Objectives

On completion of this course the student will understand how to

Apply the matrix algebra methods for solving practical problems, and able to use different calculus ideas in several functions of variables.

To know how to apply different methods of integration in solving difficult problems.

To understand by solving multiple integral ideas in solving areas, volumes and other practical problems.

10. Lesson Plan

Lecture No.	Topic(s) to be covered	Text / Ref. Book	Teaching Method (CTL, ICT, NPTEL, FL, IV, Inplant Training etc.)	Testing Method (Group Discussion, MCQ, Tutorial, Seminar,Written / Oral Test)	Course Outcome (COs)	No. of Hours	Cummulative Hours
Unit – 1 MATRICES							
1	Eigenvalues and Eigenvectors of a real matrix	T1,R3	CTL	Oral, written Test, Tutorial	CO1	2	2
2	Characteristic equation	T1	CTL		CO1	1	3
3	Properties of Eigenvalues and Eigenvectors	T1	CTL,PPT		CO1	2	5
4	Cayley – Hamilton theorem	T1	CTL		CO1	1	6
5	Diagonalization of matrices by orthogonal transformations	T1	CTL		CO1	1	7
6	Reduction of a quadratic form to canonical form by orthogonal transformation	T1	CTL		CO1	2	9
7	Nature of quadratic forms	R3	PPT		CO1	1	10
8	Applications : Stretching of an elastic membrane	R3	CTL		CO1	1	11
9	Tutorial	T1	CTL		CO1	1	12

	Lecture No.	Topic(s) to be covered	Text / Ref. Book	Teaching Method (BB, PPT, NPTEL, Video Lect. IV, Inplant Training etc.)	Testing Method (Group Discussion, MCQ, Tutorial, Seminar,Written / Oral Test)	Course Outcome (COs)	No. of Hours	Cummulative Hours
	Unit - II DIFFERENTIAL CALCULUS							
	1	Representation of Functions	T3, R4	CTL	Oral and Written test, Tutorial	CO2	1	13
	2	Limit of a function, Continuity	T1,R7	CTL		CO2	2	15
	3	Derivatives	T1	CTL		CO2	1	16
	4	Differentiation rules (sum, product, quotient, chain rules)	T2, R4	PPT		CO2	2	18
	5	Implicit differentiation	T1	CTL		CO2	1	19
	6	Logarithmic differentiation	T3, R1	CTL		CO2	2	21
	7	Applications: Maxima and Minima of functions of one variable.	T1	CTL		CO2	2	23

	8	Tutorial	T1	CTL		CO2	1	24

	Lecture No.	Topic(s) to be covered	Text / Ref. Book	Teaching Method (BB, PPT, NPTEL, Video Lect. IV, Inplant Training etc.)	Testing Method (Group Discussion, MCQ, Tutorial, Seminar, Written / Oral Test)	Course Outcome (COs)	No. of Hours	Cummulative Hours
Unit – III FUNCTIONS OF SEVERAL VARIABLES								
	1	Partial differentiation	T2, R5	CTL	Oral, Written Test and Tutorial	CO3	1	25
	2	Homogeneous functions and Euler's theorem	T2	CTL		CO3	2	27
	3	Total derivative	T2	CTL		CO3	1	28
	4	Change of variables	T2	CTL		CO3	1	29
	5	Jacobians	T2	CTL,PPT		CO3	1	30
	6	Partial differentiation of implicit functions	T2	CTL		CO3	1	31
	7	Taylor's series for functions of two variables	T2, R6	CTL		CO3	2	33
	8	Applications: Maxima and Minima of functions of two variables and Lagrange's method of undetermined multipliers.	T1, R2	CTL,PPT		CO3	2	35
	9	Tutorial	T2	CTL		CO3	1	36

Lecture No.	Topic(s) to be covered	Text / Ref. Book	Teaching Method (BB, PPT, NPTEL, Video Lect. IV, Inplant Training etc.)	Testing Method (Group Discussion, MCQ, Tutorial, Seminar, Written / Oral Test)	Course Outcome (COs)	No. of Hours	Cummulative Hours
Unit – IV INTEGRAL CALCULUS							
1	Definite and Indefinite integrals	T3, R1	CTL	Written Test and Tutorial	CO4	1	37
2	Substitution rule	T2	CTL		CO4	1	38
3	Techniques of Integration : Integration by parts, Trigonometric integrals	T2	CTL		CO4	2	40
4	Trigonometric substitutions	T2	CTL		CO4	1	41
5	Integration of rational functions by partial fraction	T3, R4	PPT		CO4	2	43
6	Integration of irrational functions	R7	CTL		CO4	1	44

7	Improper integrals	T3	CTL		CO4	1	45
8	Applications : Hydrostatic force and pressure, moments and Centre's of mass	T2	CTL		CO4	2	47
9	Tutorial	T2	CTL		CO4	1	48

Lecture No.	Topic(s) to be covered	Text / Ref. Book	Teaching Method (BB, PPT, NPTEL, Video Lect. IV, Inplant Training etc.)	Testing Method (Group Discussion, MCQ, Tutorial, Seminar, Written / Oral Test)	Course Outcome (COs)	No. of Hours	Cummulative Hours
Unit – V MULTIPLE INTEGRALS							
1	Double integrals	T2	CTL	Written Test and Tutorial	CO5	1	49
2	Change of order of integration	T2,R5	CTL		CO5	2	51
3	Double integrals in polar coordinates	T2	PPT		CO5	1	52
4	Area enclosed by plane curves	T2,R6	CTL		CO5	2	54
5	Triple integrals	T2	CTL		CO5	1	55
6	Volume of solids	T2,R5	CTL		CO5	1	56
7	Change of variables in double and triple integrals	T2	CTL		CO5	2	58
8	Applications : Moments and Centre's of mass, moment of inertia	R5	CTL		CO5	1	59
9	Tutorial	T2	CTL		CO5	1	60

[CTL-Chalk and Talk, FL- Flipped Class, EL- Experiential Learning, RL- Research based Learning]

11. List of Text Books by AU:

T1. Kreyszig.E, "Advanced Engineering Mathematics", John Willey and Sons, 10th Edition, New Delhi, 2016.
T2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition,2018.
T3. James Stewart, "Calculus : Ealry Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.
[For Units I & II – Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 – 7.4 and 7.8].

12. Reference Books by AU:

R1. Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10th Edition, 2016.
R2. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
R3. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.

R4. Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009
R5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt.Ltd, New Delhi, 2016.
R6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
R7. Thomas. G.B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.

13. Other Related books Available in our library:

O1. Dr.G.Balaji "Matrices and Calculus", Balaji Publications, Chennai.
O2. Dr. V. Chandrashkar "Matrices and Calculus", Vishnu prints Media.
O3. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics"
O4. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi
O5. Dr. J John "Matrices and Calculus", Jaison Publications.

13. Web Resources

Unit	Topic	Web Link
I	Matrices basics	https://personalpages.manchester.ac.uk/staff/ctdodson/matrices.pdf
II	Differentiation Rules	https://www.sydney.edu.au/content/dam/students/documents/mathematics-learning-centre/introduction-to-differential-calculus.pdf
III	Taylors series, Maxima and Minima	https://egyankosh.ac.in/bitstream/123456789/17969/1/Unit-8.pdf
IV	Definite integrals	https://www.mathcentre.ac.uk/resources/Engineering%20maths%20first%20aid%20kit/latexsource%20and%20diagrams/8_9.pdf
V	Change of order of integration	https://nitkkr.ac.in/docs/5-Multiple%20Integrals%20and%20their%20Applications.pdf

14. Video Resources

Sl. No	University	Website	Video Link
V1	IIT Kanpur	www.nptelvideos.com	https://www.nptelvideos.com/lecture.php?id=13592
V2	IISc Bangalore	www.nptelvideos.com	https://www.nptelvideos.com/lecture.php?id=13485

15. Assignments

Sl.No.	COs	Topic
1	CO1	Eigenvalues and Eigenvectors, Cayley-Hamilton theorem
		Reduction of a Q.F into a C.F by orthogonal transformation
2	CO2	Continuity
		Maxima and Minima of functions of one variable
3	CO3	Taylor's series for functions of two variables
		Maxima and Minima of functions of two variables and Lagrange's method of undetermined multipliers.
4	CO4	Integration of rational functions by partial fraction
		Moments and Centre's of Mass
5	CO5	Change of order of integration
		Moments and Centre's of mass, moment of inertia

16. Content beyond Syllabus

Details of Content Beyond the syllabus for attaining COs/POs/PSOs:

Sl. No	Gap Identified	Contents/Activity to bridge the gap	Method of Implementation (Seminar / Guest Lecture/IV/ Workshop etc.)	No. of Period	Mapping to COs	Mapping to POs	Mapping to PSOs
1	Applications of Hydrostatic force and pressure	A detailed concepts are studied	Seminar	2	CO4	PO2, PO12	PSO2
2	Centre of mass and Moment of inertia	A detailed concepts are studied	Seminar	2	CO5	PO2,PO7	PSO1

JUSTIFICATION FOR CORRELATION

Contents/Activity to bridge the gap	Related COs, POs & PSOs	Justification
Differential Calculus, Partial differentiation, Integral Calculus	CO2	Able to do Calculus of variations problems using differential calculus
	CO3	Able to do various partial differentiation problems
	CO4	Able to perform various integrations like single and multiple integrals using integral calculus
	PO5	Analyze various critical problems using differential and integral calculus
	PSO3	Can perform different fields in differentiation and integration of various variables using differential and integral calculus

17. Journals Link

Sl. No	Journal Name	Publisher	Link
1.	A New Solution to the Matrix Equation $X-A\overline{X}B=C$	Caiqin Song	https://doi.org/10.1155/2021/5795940
2.	On multiple integral transformations with the multivariable A-functions	Vinod Gill	https://ijmttjournal.org/2017/Volume-52/number-2/IJMTT-V52P519.pdf

18 . Assessment Methodology

Assessment	Topic	CO	Marks
IAT-1	Unit 1& Unit 2	CO1 CO2	50 50
IAT-2	Unit 3 & Unit 4	CO3 CO4	50 50
Model Test	Unit 1- Unit 5	CO1 CO2 CO3 CO4 CO5	20 20 20 20 20
Assignment	Unit 1- Unit 5	CO1 CO2 CO3	20 20 20

		CO4 CO5	20 20
Slip Test	Unit 5	CO5	50

Course In-charge **Verified by** **HoD** **Principal**

(ACADEMIC RESOURCE CELL MEMBER)