Mukesh Patel School of Technology Management and Engineering
Basic Sciences and Humanities Department

Course Policy

Program/Branch/Semester	**:**	B Tech & MBATech /Computers/ Sem IV
Academic Year	**:**	2022-23
Course Code & Name	**:**	Complex Variables and Transforms
Credit Details	**:**	L T P C 3 1 0 4
Course Coordinator Faculty	**:**	Dr. V. R. Lakshmi Gorty
Contact No. & Email	**:**	022-42334084
Office	**:**	Sixth Floor, VI C
Student's contact hours	**:**	Tuesday 12 noon to 1 pm
Other Course Faculty members teaching this course	**:**	**Course Faculty for Tutorial:** **Contact No. & Email:** **Office:** **Student's contact hours:**

Course Faculty for Laboratory: **NA** **Contact No. & Email:** **Office:** **Office Hours:**	**Course Faculty 1:** Dr. V. R. Lakshmi Gorty **Contact No. & Email:** 022-42334084 **Office:** Sixth Floor, VI C **Student's contact hours:** Tuesday 12 noon to 1 pm
Queries by Emails are encouraged.	

Course link	**:**	Portal Link : https://portal.svkm.ac.in/usermgmt/login

1 Introduction to the Course

1.1 Importance of the course

Complex Variables and Transforms is important because it is required to solve problems, to analyze mathematical relations and in using the laws of nature, which are mathematical expressions. Complex differentiation, complex integration, Laplace transform, Fourier series and Fourier transform are having wide applications in engineering. Study of these topics is useful in image processing, circuit theory, vibration analysis, finite element analysis and quantum mechanics.

1.2 Objective of the Course

This course teaches the students techniques in solving problems based on complex differentiation, integration, Laplace transform, Fourier series, Fourier transform and further directs them to think mathematically and apply these techniques to solve engineering problems.

1.3 Pre-requisite

- Fundamental knowledge of Derivatives, Integration

2 Course Outcomes (CO) and mapping with Program Outcomes(PO)

2.1 Course Outcomes

After successful completion of the course, a student will be able to-

1. Demonstrate understanding of the concepts of Complex variables, Laplace Transforms, Fourier series and Fourier Transforms
2. Solve problems based on complex variables, Laplace Transforms, Fourier series and Fourier Transforms
3. Apply the techniques of Complex variables, Laplace Transforms, Fourier series and Fourier Transforms to solve engineering problems

2.2 CO-PO Mapping

	PO 1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	2										
CO2	3	2										
CO3	3	2			2							

2- medium mapping 3- high mapping

Program Outcomes

1. Apply the knowledge of mathematics, science, engineering fundamentals for the solution of complex engineering problems in mechanical engineering domain.

2. Identify, formulate, research literature, and analyse complex mechanical engineering problems reaching substantiated conclusions using first principles of mathematics and mechanical engineering.

3. Design and develop solutions for complex mechanical engineering problems by considering public health and safety, and cultural, societal and environmental considerations.

4. Use research based knowledge including Design of experiments, analysis and interpretation of data to solve mechanical engineering related product problems.

5. Select, create and apply current techniques/ tools and resources in mechanical engineering challenges.

6. Apply reasoning using contextual knowledge on contemporary issues and the impact of professional practice.

7. Apply the broad education necessary to understand the impact of mechanical engineering solutions on environment and for sustainable development in society.

8. Apply ethical principles and commit to professional ethics, and norms and best practices of mechanical engineering.

9. Function effectively as an individual and a team member in multidisciplinary settings to provide solutions to problems.

10. Effectively communicate within the mechanical engineering community in particular and society in general.

11. Demonstrate knowledge and understanding of mechanical engineering sciences principles and apply these to one’s own work as a member and a leader to manage projects.

12. Engage in independent and lifelong learning to adapt technological changes in mechanical engineering field

3 Syllabus, Pre-class activity and References

3.1 Teaching and evaluation scheme

Teaching Scheme				Evaluation Scheme	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (50 Marks)**	**Theory (3 Hrs, 100 Marks)**
3	0	1	4	Marks Scaled to 50	Marks Scaled to 50

3.2 Syllabus

Unit	Description	Duration
1	Complex Variables : Differentiation Complex differentiation, Cauchy-Riemann equation, analytic functions, harmonic functions, harmonic conjugate, Elementary analytic functions (exponential, trigonometric, logarithmic functions), Conformal mappings: definition and problems, Mobius transformation and their properties.	**07**
2	Complex Variables : Integration Contour Integrals: definition and problems, Cauchy-Goursat theorem, Cauchy Integral formula, Zeros and singularities of analytic functions, Taylor's series, Laurent's series, Residues, Cauchy Residue theorem.	**08**
3	Laplace Transforms: Definition of Laplace Transform, Laplace Transform of 1, e^{at} , $\sin at$, $\cos at$, $\sinh at$, $\cosh at$, t^n , Properties of Laplace Transforms: Linearity property, First and second shifting theorems of Laplace Transform, Change of scale property, $L\{t^n f(t)\}$, $L\left\{\frac{f(t)}{t}\right\}$, $L\{f^n(t)\}$, $L\left\{\int_0^t f(u)\,du\right\}$, Evaluation of Inverse Laplace Transform by partial fraction, Convolution theorem, Laplace Transforms of Periodic functions, Unit step functions, Dirac delta functions. Applications: Evaluation of Integrals using Laplace Transforms, Solving initial and boundary value problems involving ordinary differential equations.	**11**
4	Fourier Series: Orthogonality and Orthonormality, Periodic function, Trigonometric Series, Dirichlet's conditions, Euler's formulae (Derivative of Fourier coefficients a_n , b_n is not expected), Fourier Series of Functions for the interval [α , α +2π] and [α, α + 2c], Functions having points of discontinuity, Even and odd functions, half range sine and cosine expansions, Complex form of Fourier Series. Applications: Applications to Wave equation, Heat equation and Laplacian equation.	**12**

5	Fourier Transforms: Fourier integral theorem, Fourier sine and cosine integral. Fourier Transform, Fourier Sine Transform, Fourier Cosine Transform, Properties of Fourier Transforms (Linearity property, Change of scale property, Shifting property), Inverse Fourier Transform, Inverse Fourier Sine Transform, Inverse Fourier Cosine Transform, Finite Fourier Transform. Applications: Solving differential equations using Fourier Transforms.	**07**
	Total hours	**45**

3.2 Pre-class activity

Outline for preliminary study to be done for each unit will be provided prior to commencement of each unit. Preliminary study material (video links, presentation, notes etc) will be made available on the student portal. Students are expected to go through this material before attending the upcoming session. It is expected that the students put in at least two hours of self-study for every one hour of classroom teaching. During the lecture session, more emphasis will be given on in-depth topics, practical applications and doubt solving.

3.3 References

Text Books:

1. B. V. Ramana (2017), "Higher Engineering Mathematics", McGraw Hill Education, 1st Edition.
2. T. Veerarajan, Engineering Mathematics, 3rd Edition, McGraw Hill Education, 2007.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley India, 2017.
2. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers, 2017.
3. James Ward Brown, Ruel V. Churchill, Complex Variables and Applications, 8th Edition, McGraw Hill Education", 2014.

Note: The latest edition of books should be referred.

4 Tutorial Plan

Sr. No.	Week No.#	Tutorial exercises / activity	Mapped CO
1	1	Finding analytic function whose real part, imaginary part or combination given	1,2
2	2	Problems based on conformal mapping	1,2
3	3	Problems based on Cauchy's integral theorem	1,2
4	4	Problems based on Laurent's series and Cauchy's Residue theorem	3

5	5	Problems on properties of Laplace transform	1,2
6	6	Problems on Laplace transform of special functions	1,2
7	7	Problems on Inverse Laplace transform	1,2
8	8	Application of Laplace transform	3
9	9	Orthogonal and orthonormal functions, Fourier series in $[0,2\pi]$	1,2
10	10	Fourier series of even, odd function	1,2
11	11	Application of Fourier series: Wave equation	3
12	12	Application of Fourier series: Heat equation	3
13	13	Fourier sine and cosine transform	1,2
14	14	Inverse Fourier transform	1,2
15	15	Application of Fourier transform	3

5 Assessment Policy

5.1 Component wise Continuous Evaluation Internal Continuous Assessment (ICA) and Term End Examination (TEE)

Assessment Component	**ICA (100 Marks) (Marks scaled to 50)**					**TEE (100 marks) (Marks scaled to 50)**
	Tutorial Performance	**Assignment**	**Presentation on application**	**Class Test1 and Class Test2**	**Class Participation**	
Weightage	10%	10%	5%	20%	5%	50%
Marks	20	20	10	20+20	10	100
Date/week of activity	Weekly	Week 7& 13	Week 15	Test 1: August 16-23, 2022 Test 2: October10-15, 2022	Week 3,Week 6,Week 8	November 16 to December 2, 2022

5.2 Assessment Policy for Internal Continuous Assessment (ICA)

Assessment of ICA comprises of the following components.

1. Class test 1 and 2 (20 Marks each)
Two class tests will be conducted as per the academic calendar each carrying 20 marks.

2. Tutorial performance evaluation (20 marks)
Continuous mode of assessment including self-assessment such as adaptive learning shall be encouraged through tutorial sessions. Each student shall be evaluated based on the rubrics (5.2.2). The student is expected to solve at least 50% of the questionnaire for the said tutorial session and submit the remaining completed solutions within the stipulated time period as allotted by the faculty. For example-If the tutorial sheet contains 10 questions, the students of the respective batch are required to solve at least 5 questions per hour. Discussion of the work amongst peers is allowed. However, each student is expected to submit self-written work.

Rubric for Tutorial assessment:

Assessment components	5	3	L
problem solving skills/techniques used	Used at least 20 % of the skills from previous learnings/ different techniques	Could not relate even 40% of the classwork	
process of solving/methodology	Followed steps	Concluding answers without explanation	
Completeness/complete number of questions in the sheet within the stipulated time-line	Complete	Incomplete	
Timely submission	Before/ on time		Late submission

3. Assignment (20 marks)

Students shall be assigned a problem from tutorial sheets of module 4 and 5. They are expected to search an image associated with the given problem. No two students should present the same image.

Students will be asked to create/construct/build four questions relating to the selected image. Further they are expected to use softwares (incorporated/ suggested during lectures or individual knowledge of any software) for graphical representation of the functions

used in the constructed questions. Also they should evaluate the questions with physical interpretation and conclusions.

Assessment will be based on the selection of image, construction of questions, graphical representation, solutions (in the form of variables created from the image), physical interpretation and timely submission. Students will be asked to submit the pdf file to the respective faculty on Teams/Portal.

4 questions for the assignment	4	3	2	1
Selection of image	Related to the given question and of proper size and resolution.		Not related to the given question.	
Construction of questions	All questions are designed in sync with the selected image.	Some of the questions are designed in sync with the selected image.	Very few questions are designed in sync with the selected image.	
Graphical presentation		Graphical presentation enhancing the understanding of concepts, ideas and relationships.	Irrelevant graphical representations.	
Solutions		Completed correctly.	Partially completed.	Incorrect.
Physical interpretation		Suitable interpretation.		Poor interpretation.
Timely submission		Submitted on time.	Not submitted on time.	

4. Presentation based on Real-life applications (10 marks)

Students shall be asked to choose a topic from the syllabus for presentation and prepare a PowerPoint presentation on the real-life problem/ application on the chosen topic. Time duration for the presentation will be a maximum of 5 minutes. Assessment shall be based on the rubrics.

Assessments components	3	2	1
Selection of topic			pertaining to syllabus

construction of a problem statement/reinforcing of concepts/ mathematical modeling			related to the selected topic
Understanding	appraise the topic with complete understanding	Relate the concepts used in presentation	List the presented content
Originality		Same problem statement should not be chosen by any other classmate	Same application but different example
Presentation skills	presenting with explanation and illustration	presenting with explanation/ illustration	read aloud

5. Class Participation (10 marks) - Students are supposed to maintain a CW notebook. Rubrics:

Understanding the formula and maintain a formula sheet	Solving the problems in the class	Applications understanding and solving capacity
3	3	4

5.3 Assessment Policy for Term End Examination (TEE)

A written examination of 100 marks for 3hrs duration will be conducted for the course as per the academic calendar.

6. Lesson Plan

Session No.	Topics	Mapped CO	Reference
1	Basics of complex numbers, analytic function and C-R equation	1,2	TB1, RB2
2	Finding analytic function when real part, imaginary part	1,2	TB1, RB2
3	Finding analytic function when combination of real and imaginary part is given	1,2	TB1, RB2

4	Harmonic function and properties	1,2	TB1, RB2
5	Mobius transformation and properties	1,2	TB1, RB2
6	Problems based on conformal mapping	1,2	TB1, RB2
7	Introduction to complex integration	1,2	TB1, RB2
8	Problems based on complex line integral	1,2,3	TB1, RB2
9	Cauchy's theorem and formula	1,2,3	TB1, RB2
10	Cauchy's integral formula and examples	1,2,3	TB1, RB2
11	Taylor's series and Laurent's series	1,2	TB1, RB3
12	Cauchy's Residue theorem and examples	1,2	TB1, RB3
13	Laplace transform of standard functions Properties of Laplace transform: Shifting and scaling	1,2	TB1, RB3
14	Class Test 1		
15	Properties of Laplace transform: Multiplication by t and division by t	1,2	TB1, RB3
16	Properties of Laplace transform: derivative and integration	1,2	TB1, RB3
17	Evaluation of infinite integrals using Laplace transform	1,2	TB1, RB3
18	Laplace transform of special functions: Periodic	1,2	TB1, RB3
19	Laplace transform of special functions: Heaviside and Dirac delta	1,2	TB1, RB3
20	Inverse Laplace transform of standard functions	1,2	TB1, RB3
21	Properties of Inverse Laplace transform	1,2	TB1, RB3
22	Inverse Laplace transform by partial fraction	1,2	TB1, RB3
23	Inverse Laplace transform by convolution	1,2	TB1, RB3
24	Inverse by Heaviside Unit step function	3	TB1, RB3
25	Applications of Laplace transform: Solving differential equations	3	TB1, RB3
26	Applications of Laplace transform examples	3	TB1, RB3
27	Class Test 2		
28	Orthogonal and orthonormal functions: Definitions, method to construct orthonormal set	1,2	TB1, RB3
29	Fourier series in [0,2pi]: formula and examples	1,2	TB1, RB3
30	Fourier series in [0,2pi]: formula and examples	1,2	TB1, RB3
31	Fourier series of odd and even functions: formula and examples	1,2	TB1, RB3
32	Fourier series of odd and even functions: formula and examples	1,2	TB1, RB3
33	Fourier series in general interval: formula and examples	1,2	TB1, RB3

35	Fourier series in general interval: formula and examples	1,2	TB1, RB3
36	Half range cosine and sine series: formula and examples, Parseval's Identity	1,2	TB1, RB3
37	Application of Fourier series to solve Wave equation	3	TB1, RB3
38	Application of Fourier series to solve one dimensional and two dimensional heat flow equation	3	TB1, RB3
39	Real life examples with periodic phenomena and application of Fourier series from https://www.sjsu.edu/me/docs/hsu-Ch5LTCh6FScondensed2018CompatibilityModel.pdf	3	TB1, RB3
40	Fourier sine transform , Fourier cosine transform	1,2	TB1, RB3
41	Properties of Fourier transform	1,2	TB1, RB3
42	Properties of Fourier transform	1,2	TB1, RB3
43	Inverse Fourier sine transform	1,2	TB1, RB3
44	Inverse Fourier cosine transform	1,2	TB1, RB3
45	Application of Fourier Transform	3	TB1, RB3

7. Teaching-learning methodology

Faculty will make a group of 2-3 students for any group based activity such as class participation, project, presentation etc. Lecture and tutorial session will be conducted as follows-

1. **Lectures:**
   - Outline for preliminary study to be done for each unit will be provided prior to commencement of each unit.
   - Deeper concepts and applications will be explained through Presentation and Video Lectures.
   - Numerical problems based on concept will be solved during the session on *smart board.*
2. **Tutorial:**
   - Tutorial problem set will be uploaded on student portal/Ms Teams at the beginning of each tutorial session.
   - Regular tutorial assessment and grading will be done. Students will be marked based on parameters like completion of tutorial, originality, interaction during the tutorials submission, punctuality and discipline

8. Active learning techniques

Active learning is a method of learning in which students are actively or experientially involved in the learning process. Following active learning techniques will be adopted for the course.

1. **Muddiest topic:** Faculty will find out the least understood point/topic in the session. This topic is then further explained to ensure that it is understood well.

2. **Wait Time:** Rather than choosing the student who will answer the question presented, this variation has the faculty WAITING before calling on someone to answer it.

3. **Blended Learning:** Students will be introduced to the topic at home while the in-depth topics, applications and numerical problems will be discussed by the faculty in the lecture session. Outline for preliminary study to be done for each unit will be provided prior to commencement of each unit. Preliminary study material (video links, presentation, notes etc) will be made available on the student portal.

4. Question-and Answer Technique

Questions are a simple yet effective way to promote interaction, and provide you with a sense of your students' comprehension. Questions can be used in any discipline. Develop your questions before class and decide when you are going to ask them. Questions can be asked at any time, but it is important to vary the timing to prevent repetition/boredom (e.g., do not routinely ask questions after every 5 slides). It is important to stimulate activity from the whole class and to acknowledge all answers, to support continued participation.

4. In-class Demonstrations

Interactive demonstrations can be used to demonstrate the application of a concept. Students should be involved in the demonstration, and be required to reflect and analyze the process. For example, you can have students predict the outcome of the demonstrations individually, and then have them discuss it in groups, or with the whole class. In-class demonstrations are valuable because they increase student understanding of concepts, while also increasing student enjoyment of the class.

5. Polling:

Having students vote anonymously on what they perceive as the best explanation/answer to a question, followed by opportunities to discuss their ideas with peers, and then to vote again leads to greater learning of the material. It is important to have students discuss why they think their explanation is the most accurate and also why the other explanations proposed are not accurate. It is also important that the teacher looks at the polling results and listens to the reasoning of the students in order to determine what further explanations and summary might need to be made in lecture.

6. **Remedial session:** Remedial session will be conducted as and when a student feels that topic clarity is required.
7. **Tutorial:**

   - Story-telling problems shall be sketched with engineering aspects.
   - Set of tutorial problems will be uploaded on the student portal/ Microsoft Teams at the beginning of each tutorial session as per their respective batches.
   - Students shall be solving problems during scheduled sessions.
   - During tutorial sessions the students can discuss and clarify their doubts with the faculty or amongst peers.

- Students are expected to upload the completed work on the student portal/Ms Teams as per the stipulated time mentioned by the respective faculty.
- Regular tutorial assessment based on parameters as per the rubrics (5.2.2).

9. Course Material

Following course material is uploaded on the student portal: (give student portal link)

- Course Policy
- Lecture Notes
- Lecture Videos
- Lecture Presentations
- Books / Reference Books / NPTEL video lectures link
- Assignments
- List of Program Outcomes

10. Course Outcome Attainment

Following means will be used to assess attainment of course learning outcomes.

- Use of formal evaluation components of continuous evaluation, assignments, laboratory work, semester end examination
- Informal feedback during course conduction
- Course exit survey

11. Academic Integrity Statement

Students are expected to carry out assigned work under Internal Continuous Assessment (ICA) independently. Copying in any form is not acceptable and will invite strict disciplinary action. Evaluation of corresponding component will be affected proportionately in such cases. Plagiarism detection software will be used to check plagiarism wherever applicable. Academic integrity is expected from students in all components of course assessment.