A Tutorials Manual for

Mathematics-II (BE02R00011)

B.E. Semester-II (All Branches)

Institute logo

Directorate of Technical Education, Gandhinagar, Gujarat

Mathematics II (BE02R00011)

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Certificate

This is to certify that Mr./Ms. ________________________________ ________ Enrollment No. ________________of B.E. 2nd - Semester, Branch ________________________________Engineering of this Institute (GTU Code:) has satisfactorily completed the Tutorial work for the subject **Mathematics-II (BE02R00011)** for the academic year 2025-26.

Place: __________

Date: __________

Name &Sign of Faculty member **Head of the Department**

Preface

Main objectives of assignment work of any subject are for pleasing to the eye on required skills as well as creating ability amongst students to solve real time problem by developing relevant competencies in psychomotor domain. By keeping in view, GTU has designed competency focused outcome-based curriculum for engineering degree programs where sufficient time given to Assignment or Tutorial work. It shows importance of enhancement of skills amongst the students, and it pays attention to utilize every second of time allotted for Assignment or Tutorial work amongst students, faculty members to achieve relevant outcomes by solving the Assignment or Tutorial rather than having simply study type classroom learning. It is must for effective implementation of competency focused outcome-based curriculum that every Assignment or Tutorial work is keenly designed to serve as a tool to develop and enhance relevant competency required by the various branch of engineering among every student. These psychomotor skills are exceedingly difficult to develop through traditional chalk and board content delivery method in the classroom. Accordingly, this lab manual is designed to focus on the program and Course Outcome defined relevant program, rather than old practice of conducting Assignment or Tutorial to prove concept and theory.

By using this Assignment or Tutorial manual students can go through the relevant theory and numerical in advance which creates an interest and students can have basic practice prior to exam. This in turn enhances pre-determined outcomes amongst students. Each Assignment or Tutorial in this manual begins with understanding, utility, modeling, analytic and creativity other relevant skills, course outcomes as well as practical outcomes (objectives).
This Assignment or Tutorial also provides guidelines to faculty members to facilitate student centric Assignment or Tutorial activities through each Assignment or Tutorial by arranging and managing necessary resources in order that the students follow the procedures with required skill to achieve the outcomes. It also gives an idea that how students will be assessed by process of continuous evaluation system.

Mathematics-II(BE02000011)

Mathematics-II(BE02R00011)			
CO-PO Matrices			
Table			
Sr. No.	COs	Statement	
1	1	Perform various matrix operations effectively, use matrices for solving system of linear equations and compute the eigen values and eigen vectors of a square matrix.	20%
2	2	Classify first order ordinary differential equations and apply the suitable methods to solve them.	15%
3	3	Classify higher order ordinary differential equations and apply the suitable methods to solve them. Derive the general solution of the ordinary differential equations using power series.	25%
4	4	Determine the analyticity of complex functions and examine the characteristics of analytic function.	20%
5	5	Apply Cauchy's Integral Formula and Cauchy's Residue theorem. Compute Taylor's and Laurent's series. Identify and analyze the singularities of complex function.	20%

Table CO – PO Matrix

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	
CO1												
CO2												
CO3												
CO4												
CO5												

Instructions for Students

1. Students are expected to carefully listen to all the theory classes delivered by the faculty members and understand the COs, content of the course, teaching and examination scheme, skill set to be developed etc.
2. Students shall organize the work in the group and make record of all work.
3. Students shall develop maintenance skill as expected by course.
4. Student shall attempt to develop related hand-on skills and build confidence.
5. Student shall develop the habits of evolving more ideas, innovations, skills etc. apart from those included in scope of manual.
6. Student shall refer book and resources.
7. Student should develop a habit of submitting the Assignment or Tutorial work as per the schedule and she/he should be well prepared for the same.

Mathematics-II(BE02000011)

Index

Name of the student : ____

Enrollment Number :____

Sr. No.	Tutorial	Page No.	Sign	Remarks
1	Tutorial no: 01			
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Course Outcomes	Topics
1	**Module 1: Matrices:** Linear Independence; Row Echelon form (REF)and Reduced Row Echelon form(RREF) of a Matrix, Rank of a Matrix using REF/RREF; Inverse of a matrix using Gauss-Jordan method; Solution of System of linear equations by elementary row operations; Symmetric, skew-symmetric and orthogonal matrices; Eigen values and eigenvectors; Diagonalization of matrices; Inverse of a Matrix by Cayley-Hamilton Theorem.
2	**Module 2: First order ordinary differential equations:** Exact differential equations, Integrating factors for non-Exact differential equations, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.
3	**Module 3: Ordinary differential equations of higher orders:** Higher order linear differential equations with constant and variable coefficients, Euler-Cauchy equations, solution by variation of parameters, method of undetermined coefficients; Classification of Ordinary and Singular points, Power series solutions for ordinary points.
4	**Module 4: Complex Variables (Differentiation):** Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; analyticity of elementary functions (exponential, trigonometric, logarithm) and their properties.
5	**Module 5: Complex Variables (Integration):** Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy residue theorem (without proof), Rouche's theorem.

B. T. Level: R: Remembering, U: Understanding, A: Applying, N: Analyzing ,E: Evaluating, C: Creating

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Date:	
Assignment No: 01	
Topic:	Linear Algebra (Matrices)
Sub Topics:	Elementary row operations in a matrix, Row echelon and reduced row echelon form, Rank by row echelon form, Inverse by Gauss- Jordan method, Solution of system of linear equation by Gauss Elimination method
Relevant CO:	1
Objectives:	1. find Row echelon and reduced row echelon form 2. inverse of matrix using elementary row operations 3. solution of system of linear equations using Gauss Elimination method

Sr. No.	Question	CO	PI	B.T. level
1	**Find** row echelon and reduced row echelon form of the matrix $\begin{bmatrix} 1 & 5 & 4 \\ 0 & 3 & 2 \\ 2 & 13 & 10 \end{bmatrix}$	1	1.1.1	U
2	**Find** the rank of the given matrices by reducing it into row echelon form (i) $\begin{bmatrix} 1 & 5 & 3 & -2 \\ 2 & 0 & 4 & 1 \\ 4 & 8 & 9 & -1 \end{bmatrix}$ (ii) $\begin{bmatrix} 0 & 6 & 7 \\ -5 & 4 & 2 \\ 1 & -2 & 0 \end{bmatrix}$	1	1.1.1	U
3	**Find** inverse of the following matrices by Gauss Jordan method (i) $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 5 & 3 \\ 1 & 0 & 8 \end{bmatrix}$ (ii) $\begin{bmatrix} 2 & 6 & 6 \\ 2 & 7 & 6 \\ 2 & 7 & 7 \end{bmatrix}$	1	1.1.1	U
4	**Discuss** the consistency of system of linear equations using concept of rank of matrix	1	1.1.1	R
5	**Examine** consistency of following equations **using** Gauss elimination method and **find** its solution if it exists (1) $x + y + 2z = 9$, $2x + 4y - 3z = 1$, $3x + 6y - 5z = 0$ (2) $x + 2y + z = 8$, $2x + 3y + z = 13$, $x + y = 5$	1	2.1.1	U, A
6	**Solve** the system of linear equations using Gauss elimination method $x - 2y + z = 4$ $3x + 5y + z = 6$ $6x - y + 4z = 2$	1	2.1.1	U, A

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Date:	
Assignment No: 02	
Topic:	Linear Algebra (Matrices)
Sub Topics:	Solution of system of linear equation by Gauss Jordan method, Eigen values and Eigen vectors
Relevant CO:	1
Objectives:	1. solve linear system using Gass Jordan method 2. find eigen values and eigen vectors of matrix

Sr. No.	Question	CO	PI	B.T. level
1	**Solve** the following linear system using Gauss-Jordan method $x+2y-z=-1$, $3x+8y+2z=28$, $4x+9y-z=14$, $x+y+z=6$, $x+2y+3z=14$, $2x+4y+7z=30$	1	2.1.1	U, A
2	**Investigate** for what values of a and b the following system of linear equations have (1) No solution (2) Infinite solutions (3) Unique solution $x+y+z=6$ $x+2y+3z=10$ $x+2y+az=b$	1	1.1.1	U, A
3	**Apply** Gauss elimination as well as Gauss Jordan elimination methods to find solution of following system of linear equation. **Examine** both methods by comparing steps of methods. $x+y+z=6$ $x+2y+3z=14$ $2x+4y+7z=30$	1	2.1.1	A
4	**Find** eigen values of A, A^{-1}, A^T and A^2 where $A=\begin{bmatrix}1 & 2\\ 0 & 4\end{bmatrix}$	1	1.1.1	U
5	**Find** the eigenvalues and corresponding eigen vectors of the following matrices (i) $A=\begin{bmatrix}4 & 0 & 1\\ -2 & 1 & 0\\ -2 & 0 & 1\end{bmatrix}$ (ii) $A=\begin{bmatrix}1 & 2 & 2\\ 0 & 2 & 1\\ -1 & 2 & 2\end{bmatrix}$	1	1.1.1	U
6	**Find** $\det(A)$ given that A has $P(\lambda)$ as its characteristic polynomial $\lambda^3-2\lambda^2+\lambda+5$	1	1.1.1	U

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Date:	
Assignment No: 03	
Topic:	Linear Algebra (Matrices)
Sub Topics:	Caley-Hamilton theorem, Diagonalization of a matrix
Relevant CO:	1
Objectives:	1. Inverse of matrix by Caley-Hamilton theorem 2. Diagonalization of a matrix

Sr. No.	Question	CO	PI	B.T. level
1	**State** Caley -Hamilton theorem. Verify Caley Hamilton theorem for following matrix and hence **find** A^{-1}, A^3. Where, $A = \begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$. Also express $A^4 - 7A^3 + 11A^2 - A - 10I$ as a linear polynomial in A.	1	1.1.1	U,A
2	**Find** A^{-1} using Caley-Hamilton theorem ; (i) $A = \begin{bmatrix} 1 & -1 \\ 2 & 3 \end{bmatrix}$ (ii) $A = \begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$	1	1.1.1	U,A
3	**Find** A^3 without matrix multiplication if $$A = \begin{bmatrix} 1 & 0 & 1 \\ 1 & -1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$	1	1.1.1	U,A
4	**Show** that the following matrix is not diagonalizable $$A = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 2 & 0 \\ -3 & 5 & 2 \end{bmatrix}$$	1	1.1.1	U,A
5	**Diagonalize** given matrix and hence **find** A^{13} $$A = \begin{bmatrix} 0 & 0 & -2 \\ 1 & 2 & 1 \\ 1 & 0 & 3 \end{bmatrix}$$	1	1.1.1	U,A
6	**Determine** a diagonal matrix orthogonally similar to the real symmetric matrix $A = \begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$	1	1.1.1	U,A

B. T. Level: R: Remembering, U: Understanding, A: Applying, N: Analyzing ,E: Evaluating, C: Creating

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Date:	
Assignment No: 04	
Topic:	First Order Ordinary Differential Equations
Sub Topics:	Exact, Non-exact differential equations
Relevant CO:	2
Objectives:	1. Solve exact diff. equations. 2. find Integrating factor and solve

Sr. No.	Question	CO	PI	B.T. level
1	**Define** an ordinary differential equation. Explain concept of order and degree of ordinary differential equation with example.	2	1.1.1	R
2	**Explain** Exact Differential Equation. Write necessary and sufficient condition for that.	2	1.1.1	R
3	**Find** the solution of $y\,e^x\,dx + (2y + e^x)\,dy = 0\,,\; y(0) = -1.$	2	1.1.1 2.1.1	U
4	**Solve** $\frac{dy}{dx} + \frac{y\cos x + \sin y + y}{\sin x + x\cos y + x} = 0$	2	1.1.1 2.1.1	U
5	**Solve** $x^2y\,dx - (x^3 + xy^2)\,dy = 0$	2	1.1.1 2.1.1	U
6	**Solve** $(x^2y^2 + 2)y\,dx + (2 - x^2y^2)x\,dy = 0$	2	1.1.1 2.1.1	U
7	**Solve** $(xy^3 + y)\,dx + 2(x^2y^2 + x + y^4)\,dy = 0$	2	1.1.1 2.1.1	U

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Date:	
Assignment No: 05	
Topic:	First Order Ordinary Differential Equations
Sub Topics:	Linear differential equations, Bernoulli’s equation, higher degree differential equations
Relevant CO:	2
Objectives:	1. Solve Linear differential equations 2. Solve Non-Linear differential equations 3. Differential equations solvable for p, solvable for x, solvable y 4. Clairaut’s equation.

Sr. No.	**Question**	**CO**	**PI**	**B.T. level**
1	**Define** Leibnitz’s linear differential equation and Bernoulli’s differential equation .	2	1.1.1	R
2	**Solve** $(1+y^2)\frac{dx}{dy} = tan^{-1}y - x$	2	1.1.1 2.1.1	R, U
3	**Solve** $\frac{dx}{dy} + (cot\,y)x = \frac{1}{cos\,y}$	2	1.1.1 2.1.1	R, U
4	**Solve** $y(y-x)\,dx + x^2\,dy = 0$ where $y(1) = 4$	2	1.1.1 2.1.1	R, U
5	**Solve** $\frac{dy}{dx} + \frac{1}{x} = \frac{e^y}{x^2}$	2	1.1.1 2.1.1	R, U
6	**Solve** $r\cos\theta - \sin\theta\frac{dr}{d\theta} = r^2$ given that $r\left(\frac{\pi}{2}\right) = 1$	2	1.1.1 2.1.1	R, U
7	**Solve** $(1+x)\frac{dy}{dx} - \tan y = (1+x)^2 e^x \sec y$	2	1.1.1 2.1.1	R, U
8	**Solve** $\left(\frac{dy}{dx}\right)^2 + \frac{dy}{dx} = e^y$	2	1.1.1 2.1.1	R, U
9	**Solve** $p = \tan\left(x - \frac{p}{1+p^2}\right)$	2	1.1.1 2.1.1	R, U
10	**Solve** Clairaut’s Equation y = px + f(p)	2	1.1.1 2.1.1	R, U

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Date:	
Assignment No: 06	
Topic:	Ordinary differential equations of higher orders
Sub Topics:	Homogeneous Linear ODEs of Higher Order, Homogeneous Linear ODEs with Constant Coefficients
Relevant CO:	3
Objectives:	1. Solve Homogeneous Linear ODEs with Constant Coefficients

Sr. No.	Question	CO	PI	B.T. level
1	**Explain** Homogeneous Linear ODEs with Constant Coefficients.	3	1.1.1	R
2	**Solve** the following: (i) $y'' - 9y = 0, y(0) = 2, y'(0) = -1.$ (ii) $\frac{d^4y}{dx^4} + \frac{dy}{dx} - 2y = 0$ (iii) $(D-2)(D^2+D+1)^2y = 0$ where $D = \frac{d}{dt}$. (iv) $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0$ (v) $3x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} - y = 0$	3	1.1.1 2.1.1	R,U
Solve the following:				
3	$y'' - 3y' + 2y = 0$	3	1.1.1 2.1.1	R,U
4	$y'' + 4y = 0$	3	1.1.1 2.1.1	R,U
5	$y'' + y' - 6y = 0$	3	1.1.1 2.1.1	R,U
6	$y'' + 2y'' - 35y = 0$	3	1.1.1 2.1.1	R,U

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Date:	
Assignment No: 07	
Topic:	Ordinary differential equations of higher orders
Sub Topics:	Non-Homogeneous Linear ODEs of Higher Order , Method of Undetermined Coefficients, Variation of parameter
Relevant CO:	3
Objectives:	1. Solve using Method of Undetermined Coefficients 2. Solve using Variation of parameter method

Sr. No.	Question	CO	PI	B.T. level
1	**Apply** method of undetermined coefficients to **find** the solution of following differential equations (i) $y'' - 3y' + 2y = e^{3x}$ (ii) $y'' + 4y = \sin 3x$ (iii) $y'' + y' - 6y = -6x^3 + 3x^2 + 6x$ (iv) $y'' + 2y'' - 35y = 12e^{5x} + 37\sin 5x$	3	1.1.1 2.1.1	U,A
2	**Solve** the following differential equation by Method of Variation Parameter: (i) $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = e^x \log x$ (ii) $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = e^x \tan x$ (iii) $(D^2 + 1)y = \frac{1}{1+sinx}$. (iv) $\frac{d^2y}{dx^2} + y = sinx$. (v) $\frac{d^2y}{dx^2} + a^2y = secax$,	3	1.1.1 2.1.1	U,A

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Date:	
Assignment No: 08	
Topic:	Ordinary differential equations of higher orders
Sub Topics:	Euler–Cauchy, Series Solution
Relevant CO:	3
Objectives:	1. Solve Euler-Cauchy differential equation 2. Series Solution

Sr. No.	Question	CO	PI	B.T. level
1	**Explain** Euler-Cauchy differential equation.	3	1.1.1	R
2	**Solve** $x^2y'' - 3xy' + 4y = 0, y(0) = 1, y'(1) = 3$	3	1.1.1 2.1.1	R, U
3	**Solve** $x^2y'' - 2xy' + 2y = x^3 cosx$		1.1.1 2.1.1	R, U
4	**Solve** $x^2y'' - 4xy' + 6y = 21x^{-4}$	3	1.1.1 2.1.1	R, U
5	**Find** a power series solution of the following differential equation near the ordinary point $x = 0$ $y'' + y = 0$	3	1.1.1 2.1.1	R, U
6	**Find** the power series solution of the equation $(x^2 + 1)y'' + xy' - xy = 0$, about an ordinary point.	3	1.1.1 2.1.1	R, U
7	**Find** a power series solution of the following differential equation near the ordinary point $x = 0$ $y'' + xy = 0$	3	1.1.1 2.1.1	R, U

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Date:	
Assignment No: 09	
Topic:	Complex Variables (Differentiation)
Sub Topics:	Limit, Continuity, Diffrentiability, Analytic function, C-R Equations
Relevant CO:	4
Objectives:	1. Find Limit of Complex function 2. Continuity of Complex function 3. Derivative of Complex function 4. Analyticity of Complex function

Sr. No.	Question	CO	PI	B.T. level
1	**Evaluate** the Limit if it exists (i) $\lim_{z\to 0}\frac{z}{\lvert z\rvert}$ (ii) $\lim_{z\to i}\frac{z-i}{z^2+1}$	4	1.1.1	R,U
2	**Discuss** the continuity of the function **(i)** $f(z)=\begin{cases}\frac{Re(z^2)}{\lvert z\rvert}, & z\neq 0\\ 0, & z=0\end{cases}$ **(ii)** $f(z)=\begin{cases}\frac{\bar{z}}{z}, & z\neq 0\\ 0, & z=0\end{cases}$	4	1.1.1	R,U
3	**Show** that $f(z)=\bar{z}$ is nowhere differentiable.	4	2.1.1	R,U
4	**Show** that $f(z)=\lvert z\rvert^2$ is differentiable only at the point $z=0$.	4	2.1.1	R,U
5	**Determine** C-R equations in polar form.	4	2.1.1	R,U
6	**Define** analytic function. **State** necessary condition for the function $f(z)$ to be analytic. **State** sufficient condition for the function $f(z)$ to be analytic.	4	2.1.1	R,U
7	**Verify** that the function $f(z)=z^2$ satisfies CR equations and determine the derivative $f'(z)$.	4	2.4.1	R,U
8	**Show** that the function $f(z)=e^z$ is entire function.	4	2.1.1	R,U

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Date:	
Assignment No: 10	
Topic:	Complex Variables (Differentiation)
Sub Topics:	Trigonometric, hyperbolic, Exponential and Logarithmic functions.
Relevant CO:	4
Objectives:	Use properties of Trigonometric, hyperbolic, Exponential and Logarithmic functions.

Sr. No.	Question	CO	PI	B.T. level
1	**Find** the real and imaginary part of (i) $f(z) = \sin z$ (ii) $f(z) = \cosh z$.	4	1.1.1	R, U
2	**Solve** : $\sin z = 6$.	4	2.1.1	R, U
3	**Show** that $\lvert \sin z\rvert^2 = \sin^2 x + \sinh^2 y$	4	2.1.1	R, U
4	**Show** that $\mathrm{Log}(i^3) \neq 3\,\mathrm{Log}(i)$,	4	2.1.1	R, U
5	**Solve** : $e^z = -2$.	4	2.1.1	R, U
6	**Solve**: $\mathrm{Log}\, z = 4 - 3i$.	4	2.1.1	R, U

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Date:	
Assignment No: 11	
Topic:	Complex Variables (Differentiation)
Sub Topics:	Analytic function, C-R Equations, Harmonic function
Relevant CO:	4
Objectives:	1. Check analyticity of Complex functions 2. Find harmonic conjugates and analytic functions

Sr. No.	Question	CO	PI	B.T. level
1	Using C-R equations, **check** whether the following functions are analytic or not at any point. (i) $f(z) = z^3$ (ii) $f(z) = z\|z\|$ (iii) $f(z) = \sin z$ (iv) $f(z) = \frac{1}{z}\ ; z \neq 0$ (v) $f(z) = e^x(\cos y + i \sin y)$	4	2.1.1 2.4.1	R,U
2	**Define** a harmonic function. Check whether the following functions are Harmonic or not . If harmonic, **find** its harmonic conjugate. (i) $u = x^2 - y^2 - y$ (ii) $u = e^x cos\ y$ **(iii)** $u = x^2 - y^2 + \frac{x}{x^2+y^2}$	4	2.1.1	R,U
3	**Determine** Analytic function whose imaginary part is $e^x(x\ cos\ y - y\ sin\ y)$	4	2.4.1	R,U
4	**Determine** Analytic function whose real part is $u = x^4 - 6x^2y^2 + y^4$ Also **find** corresponding function *v*.	4	2.1.1	R,U

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Date:	
Assignment No: 12	
Topic:	Complex Variables (Integration)
Sub Topics:	Line Integrals, Cauchy-Goursat theorem
Relevant CO:	5
Objectives:	Evaluate contour integrals

Sr. No.	Question	CO	PI	B.T. level
1	**Evaluate** $\int_C z^2\,dz$ where C is the line joining the points (0,0) and (4,2).	5	2.1.1, 2.4.1	R,U
2	**Evaluate** $\int_C (x^2 + ixy)dz$ from points (1,1) to (2,4) along the curve $x = t, y = t^2$.	5	2.1.1, 2.4.1	R,U
3	**Evaluate** $\int_C Re(z^2)\,dz$ where C is the boundary of the square with vertices $0,\ i, 1+i, 1$ in the clockwise direction.	5	2.1.1, 2.4.1	R,U
4	**Evaluate** $\oint_C \frac{e^{-z}}{z+1}dz;\ C\ is\ \lvert z\rvert = \frac{1}{2}$	5	2.1.1, 2.4.1	R,U
5	**State** Cauchy's Integral Theorem. **Evaluate** $\oint_C e^{z^2}\,dz$, where C is any closed contour. Justify your Answer.	5	2.1.1, 2.4.1	R,U
6	**Evaluate** $\oint_C \frac{Z-1}{(Z+1)^2(Z-2)}dz$, where C is the circle $\lvert z-i\rvert = 2$	5	2.1.1, 2.4.1	R,U
7	**Evaluate** $\oint_C \frac{1}{(Z^3-1)^2}dz$, where C is the circle $\lvert z-1\rvert = 1$	5	2.1.1, 2.4.1	R,U
8	**Evaluate** $\oint_C \frac{2Z+6}{(Z^2+4)}dz$, where C is the circle $\lvert z-i\rvert = 2$	5	2.1.1, 2.4.1	R,U

B. T. Level: R: Remembering, U: Understanding, A: Applying, N: Analyzing ,E: Evaluating, C: Creating

PI*https://www.aicte-india.org/sites/default/files/ExaminationReforms.pdf

Date:	
Assignment No: 13	
Topic:	Complex Variables (Integration)
Sub Topics:	Cauchy integral formula, Power series, Taylor and Maclaurin series
Relevant CO:	5
Objectives:	Evaluate complex integration, Obtain Taylor and Maclaurin series

Sr. No.	Question	CO	PI	B.T. level
1	**State** Cauchy's integral formula. Hence **evaluate** $\oint_C \frac{z^2}{(z-1)(z-2)}\, dz;\ C\ is\ \lvert z\rvert = 3$	5	2.1.1, 2.4.1	R
2	**Evaluate** $\oint_C \frac{z^2}{(z-3i)^2}\, dz;\ C\ is\ \lvert z\rvert = 5$	5	2.1.1, 2.4.1	R
3	**Evaluate** $\oint_C \frac{1}{(Z^3-1)^2} dz$, where C is the circle $\lvert z-1\rvert = 1$	5	2.1.1, 2.4.1	R
4	**Evaluate** $\oint_C \frac{2Z+6}{(Z^2+4)} dz$, where C is the circle $\lvert z-i\rvert = 2$	5	2.1.1, 2.4.1	R
5	**Find** the Maclaurin series (Taylor series about $z=0$) of $f(z) = \frac{1}{1+z^2}$. Find the radius of convergence.	5	2.1.1, 2.4.1	R
6	**Find** the Maclaurin series (Taylor series about $z=0$) of $f(z) = \frac{1}{z+3i}$. Find the radius of convergence.	5	2.1.1, 2.4.1	R
7	**Find** the Taylor series of $f(z) = \frac{1}{z}$ with centre 2. Find the radius of convergence.	5	2.1.1, 2.4.1	R
8	**Find** the Taylor series of $f(z) = sin\, z$ with centre $\pi/2$. Find the radius of convergence.	5	2.1.1, 2.4.1	R

B. T. Level: R: Remembering, U: Understanding, A: Applying, N: Analyzing ,E: Evaluating, C: Creating

PI*https://www.aicte-india.org/sites/default/files/ExaminationReforms.pdf

Date:	
Assignment No: 14	
Topic:	Complex Variables (Integration)
Sub Topics:	Singularities, Laurent series, Residues, Cauchy residue theorem.
Relevant CO:	5
Objectives:	Find Laurent series, Evaluate complex integration by Cauchy residue theorem.

Sr. No.	Question	CO	PI	B.T. level
1	**Define**: Singular point, Isolated singular point, Residue	5	2.1.1	R
2	**Explain** types of isolated singular points.	5	2.1.1	R
3	**Determine** and classify all singularities of following functions **1.** $f(z) = \frac{\sin z}{z}$ **2.** $f(z) = \frac{z^3}{(z-1)^3(z-3)^2}$	5	2.1.1	R,U
4	**Find** the Laurent series of $\frac{1}{(z^2-3z+2)}$ for region $(i)\ 0 < \lvert z\rvert < 1 \quad (ii) 1 < \lvert z\rvert < 2 \quad (iii) \lvert z\rvert > 2$	5	2.1.1, 2.4.1	R,U
5	**Find** the Laurent series of $\frac{7z-2}{(z+1)z(z-2)}$, $\quad 1 < \lvert z+1\rvert < 3$	5	2.1.1, 2.4.1	R,U
6	**Find** the residues at singular points. $f(z) = \frac{z^2}{(z-1)^2(z+2)}$	5	2.1.1, 2.4.1	R,U
7	**Find** the residues at singular points. $f(z) = \frac{1}{(z+1)^4}$	5	2.1.1, 2.4.1	R,U
8	**Evaluate** using Cauchy residue theorem $\int_C \frac{dz}{z^3(z+4)}$, where $C: (a)\ \lvert z\rvert = 2 \quad (b)\ \lvert z+2\rvert = 3$	5	2.1.1, 2.4.1	R,U

B. T. Level: R: Remembering, U: Understanding, A: Applying, N: Analyzing ,E: Evaluating, C: Creating

PI*https://www.aicte-india.org/sites/default/files/ExaminationReforms.pdf

Activity–2: Quiz Participation

- Quiz–1: Matrices and Systems of Linear Equations
- Quiz–2: Ordinary Differential Equations
- Quiz–3: CR Equations and Analytic Functions
- Quiz–4: Residue Theorem

Activity–3: AI-Based Content Development

- Application of ODEs
- Application of Complex Analysis

Continuous Evaluation: Class Tests

GOVERNMENT ENGINEERING COLLEGE, BHUJ

General Department

CLASS TEST MANUAL

MATHEMATICS–II (BE02R00011)

B.E. Semester–II (All Branches)

Academic Year: 2025–26

The present class tests are the sample formats for the Class tests which are going to be conducted throughout the semester. It provides guideline for the students to prepare for the tests.

Contents

GOVERNMENT ENGINEERING COLLEGE BHUJ

General Department

B.E. Second Semester (All Branches)

Subject: Mathematics–II (BE02R00011)

Class Test–01 (CO–1: Matrices)

Date: ______________

Time: 1 Hour **Marks: 15**

(a) Reduce the matrix to RREF and find its rank:

$$\begin{bmatrix} 2 & 4 & 6 \\ 1 & 3 & 5 \\ 3 & 7 & 11 \end{bmatrix}$$

[4]

(b) Investigate for what values of k the system has no solution, infinite solutions or unique solution:

$$\begin{aligned} x + y + z &= 2 \\ 2x + 3y + 4z &= 5 \\ x + 2y + kz &= 3 \end{aligned}$$

[4]

(c) Find eigenvalues and eigenvectors of:

$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & 2 & 1 \\ 0 & 1 & 2 \end{bmatrix}$$

[7]

CO–RBT–Marks Mapping

Question	CO	RBT Level	Marks
Q1(a)	CO1	U	4
Q1(b)	CO1	U	4
Q1(c)	CO1	A	7

GOVERNMENT ENGINEERING COLLEGE BHUJ

General Department

B.E. Second Semester (All Branches)

Subject: Mathematics–II (BE02R00011)

Class Test–02 (CO–2: First Order ODE)

Date: ______________

Time: 1 Hour **Marks: 15**

(a) Define exact differential equation and integrating factor. [3]

(b) Solve: $(2xy + y^2)\,dx + (x^2 + 2xy)\,dy = 0$ [5]

(c) Solve: $\frac{dy}{dx} + y = xy^2$ [7]

CO–RBT–Marks Mapping

Question	CO	RBT	Marks
Q1(a)	CO2	R	3
Q1(b)	CO2	U	5
Q1(c)	CO2	A	7

GOVERNMENT ENGINEERING COLLEGE BHUJ

General Department

B.E. Second Semester (All Branches)

Subject: Mathematics–II (BE02R00011)

Class Test–03 (CO–3:Higher Order ODE)

Date: ______________

Time: 1 Hour **Marks: 15**

(a) Solve: $y'' - 6y' + 9y = 0$ [4]

(b) Apply method of undetermined coefficients to solve the the ODE:
$(D^2 + 4)y = 10 \sin 2x$ [5]

(c) Apply method of variation of parameters to solve the the ODE:
$y'' + y = \sec x$ (VOP) [6]

CO–RBT–Marks Mapping

Question	CO	RBT	Marks
Q(a)	CO3	U	4
Q(b)	CO3	A	5
Q(c)	CO3	A	6

GOVERNMENT ENGINEERING COLLEGE BHUJ

General Department

B.E. Second Semester (All Branches)

Subject: Mathematics–II (BE02R00011)

Class Test–04 (CO–4:Complex Differentiation)

Date: ______________

Time: 1 Hour **Marks: 15**

(a) State C–R equations in (i) polar form, (ii) Cartesian form, (iii) Complex form. [3]

(b) Check analyticity of $f(z) = x^2 - y^2 + 2ixy$ [5]

(c) Find analytic function $f(z) = u + iv$ whose real part is $u = x^3 - 3xy^2$ [7]

CO–RBT–Marks Mapping

Question	CO	RBT	Marks
Q(a)	CO4	R	3
Q(b)	CO4	U	5
Q(c)	CO4	A	7

GOVERNMENT ENGINEERING COLLEGE BHUJ

General Department

B.E. Second Semester (All Branches)

Subject: Mathematics–II (BE02R00011)

Class Test–05 (CO–5:Complex Integration)

Date: ______________

Time: 1 Hour **Marks: 15**

(a) Evaluate $\oint \frac{z+1}{z(z-2)}dz$, where $C : |z| = 2$ [4]

(b) Find the Laurrent series expansion of $\frac{1}{(z-1)(z+2)}$ for (i)$|z| < 1$, (ii) $1 < |z| < 2$. [5]

(c) Evaluate the residues of the function $f(z) = \frac{sinz}{z(z-2)}$. [6]

CO–RBT–Marks Mapping

Question	CO	RBT	Marks
Q(a)	CO5	U	4
Q(b)	CO5	U	5
Q(c)	CO5	A	6

GOVERNMENT ENGINEERING COLLEGE BHUJ

General Department

B.E. Second Semester (All Branches)

Subject: Mathematics–II (BE02R00011)

Class Test–01 (CO–1: Matrices)

Date: ______________

Time: 1 Hour Marks: 15

Difficulty Classification

Class Test	Easy	Moderate	Hard
CT–01	Q(a)	Q(b)	Q(c)
CT–02	Q(a)	Q(b)	Q(c)
CT–03	Q(a)	Q(b)	Q(c)
CT–04	Q(a)	Q(b)	Q(c)
CT–05	Q(a)	Q(b)	Q(c)

— END OF CLASS TEST MANUAL —

MID Examination: Previous Papers-Sample

Bachelor of Engineering – Semester I/II Examination

MID–SEMESTER EXAMINATION

Academic Year: 2025–26

Subject Code: **BE02R00011**	Time: **1 Hour 15 Minutes**
Subject Name: **Mathematics–II**	Total Marks: **30**

Instructions:

1. Attempt **ALL** questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple non-programmable calculator is permitted.

Q.1

(a) Define Row Echelon Form (REF) and Reduced Row Echelon Form (RREF) of a matrix. Give one example of each. **[3](CO1 – R)**

(b) Solve the following system of linear equations using Gauss–Jordan method:
$x + 2y + z = 4; 2x + 5y + 3z = 11; 3x + 6y + 4z = 15$ **[4](CO1 – U)**

(c) Investigate for what values of λ the system has (i) no solution, (ii) infinite solutions, (iii) unique solution: $x + y + z = 3; 2x + 3y + \lambda z = 7; x + 2y + 2z = 5$ **[5](CO1 – A)**

Q.1. OR

(a) State Cayley–Hamilton Theorem. **[3](CO1 – R)**

(b) Find the inverse of the matrix using Gauss–Jordan method: $A = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 3 & 2 \\ 1 & 1 & 1 \end{bmatrix}$ **[4](CO1 – U)**

(c) Find the eigenvalues and eigenvectors of: $A = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$ **[5](CO1 – A)**

Q.2

(a) Explain Exact Differential Equation.
State the necessary and sufficient condition for exactness. **[3](CO2 – R)**

(b) Solve the differential equation: $(3x^2y + y^2)\, dx + (x^3 + 2xy)\, dy = 0$ **[3](CO2 – U)**

(c) Solve the linear differential equation: $\frac{dy}{dx} + y = e^x$ **[3](CO2 – U)**

Q.2. OR

(a) Define order and degree of a differential equation.
Find the order and degree of: $\left(1+\frac{dy}{dx}\right)^{3/2}=\frac{d^3y}{dx^3}$ **[3](CO2 – R)**

(b) Test for exactness and solve: $(2xy+y^2)\,dx+x^2\,dy=0$ **[3](CO2 – U)**

(c) Solve the Bernoulli equation: $\frac{dy}{dx}-y=xy^2$ **[3](CO2 – U)**

Q.3

(a) Define analytic function. State sufficient condition for analyticity. **[3](CO4 – R)**

(b) Find the harmonic conjugate of the function:$u=x^2-y^2$ **[3](CO4 – U)**

(c) Show that the function $f(z)=x^2-y^2+2ixy$ is analytic and find its derivative. **[3](CO4 – U)**

Q.3. OR

(a) Define a harmonic function. Verify whether $u=x^3-3xy^2$ is harmonic. **[3](CO4 – R)**

(b) Find the analytic function $f(z)=u+iv$ whose real part is: $u=x^2-y^2$ **[3](CO4 – U)**

(c) If $f(z)$ is analytic and $|f(z)|$ is constant, show that $f(z)$ is constant. **[3](CO4 – U)**

***** ALL THE BEST *****

End Semester Examination

Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - 1/2 EXAMINATION - WINTER 2025

Subject Code: BE02000011 **Date: 23-12-2025**

Subject Name: Mathematics – 2

Time: 02:30 PM TO 05:30 PM **Total Marks: 70**

Instructions

1. Attempt all questions.

2. Make suitable assumptions wherever necessary.

3. Figures to the right indicate full marks.

4. Simple and non-programmable scientific calculators are allowed.

			Marks
Q.1	**(a)**	Check whether the function $e^{\bar{z}}$ analytic or not at any point ?	**03**
	(b)	Solve $xlogx\dfrac{dy}{dx} + y = 2logx$	**04**
	(c)	Diagonalize the matrix $A = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$	**07**
Q.2	**(a)**	State Cauchy integral formula and Evaluate $\oint_C \dfrac{dz}{z(z+3)}$ Where C is the circle $\lvert z\rvert = 1$	**03**
	(b)	Solve $y'' - 4y = 0, y(0) = 2, y'(0) = -1$	**04**
	(c)	(i) Evaluate $\oint_C (x - y + ix^2)dz$ Where C is a straight line from z=0 to z = 1+i. (2) If $sin(\alpha + i\beta) = x + iy$ then prove that $x^2sech^2\beta + y^2cosech^2\beta = 1$	**07**
		OR	
	(c)	(i) Evaluate $\oint_C \dfrac{e^z}{(z-1)^4}dz$ where C is the circle $\lvert z\rvert = 3$ (ii) Using CR equations show that $z\lvert z\rvert$ is no where analytic.	**07**
Q.3	**(a)**	Solve $\dfrac{dy}{dx} + 2xy = xe^{-x^2}$	**03**
	(b)	Find the rank of the matrix $A = \begin{bmatrix} 1 & -1 & 2 & -3 \\ 4 & 1 & 0 & 2 \\ 0 & 3 & 1 & 4 \\ 0 & 1 & 0 & 2 \end{bmatrix}$	**04**

(c) Check whether $u = x^2 - y^2 - y$ is harmonic or not. If so find the harmonic conjugate v of u. **07**

OR

(a) Test for exactness and solve (tany+x) dx+ (xsec^{2}y-3y) dy=0 **03**

(b) Solve the following linear system by Gauss elimination method. **04**
$x + 2y - z = 2, x - y + z = 4, 2x + y - z = 5$

(c) Define Harmonic function. Check whether $u = x^3 - 3xy^2$ is Harmonic or not if so construct the analytic function f(z) = u + iv **07**

Q.4 (a) Solve $\left(xy^2 - x\right) dx = \left(y + x^2 y\right) dy$ **03**

(b) Find inverse of the matrix $A = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$ by Cayley Hamilton theorem. **04**

(c) State Cauchy residue theorem and Evaluate $\oint_C \frac{z^3 - z^2 + z - 1}{z^3 + 4z} dz,$ Where C is $(a)\ |z| = 1, (b)\ |z| = 3$ **07**

OR

(a) Solve $x\frac{dy}{dx} + \frac{y^2}{x} = y$ **03**

(b) Find the inverse of the matrix $A = \begin{bmatrix} 0 & 1 & 2 \\ 1 & 2 & 3 \\ 3 & 1 & 1 \end{bmatrix}$ using Gauss Jordan method. **04**

(c) Expand $f(z) = \frac{1}{(z+1)(z-2)}$ in Laurent's series in the region $(1)\ |z| < 1\ (2)\ 1 < |z| < 2\ (3)\ |z| > 2$ **07**

Q.5 (a) Solve $\left(x^2 + y^2 + x\right) dx + xydy = 0$ **03**

(b) Solve $y'' - 2y' + y = 4\frac{e^x}{x^2}$ **04**

(c) Solve $y'' - 6y' + 9y = \frac{e^{3x}}{x^2}$ by the method of variation of Parameters. **07**

OR

(a) Solve $y = 3x + logp$ **03**

(b) Solve $y'' + y' - 6y = 6x + 3x^2 - 6x^3$ by undetermined coefficient method **04**

(c) Find the power series solution of $y'' + x^2 y = 0$ about x = 0. **07**

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Enrolment No./Seat No_______________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–I&II EXAMINATION – SUMMER 2025

Subject Code:BE02000011 **Date:18-06-2025**

Subject Name:Mathematics – 2

Time:10:30 AM TO 01:30 PM **Total Marks:70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Prove that $f(z) = \frac{1}{z}$ is not differentiable at $z = 0$, by definition.	**03**
	(b)	Solve $\frac{dx}{dy} + \frac{x}{y} = x^3$.	**04**
	(c)	Check the whether the given matrix $A = \begin{bmatrix} -1 & 4 & -2 \\ -3 & 4 & 0 \\ -3 & 1 & 3 \end{bmatrix}$ is diagonalizable? If so, then find matrix P such that $P^{-1}AP = D$.	**07**
Q.2	**(a)**	State Rouche's Theorem. Evaluate $\int_C e^z dz$ if C is the circle $\|z\| = 99$.	**03**
	(b)	Solve $y'' + 4y' + 4y = 0, y(0) = 1, y'(0) = 1$.	**04**
	(c)	(1) Evaluate $\int_C \frac{3z^2+z}{z^2-1} dz$ where C is the circle $\|z - 1\| = 1$.	**03**
		(2) Define entire function. Prove that e^z is analytic at everywhere.	**04**
		OR	
	(c)	(1) Evaluate $\int_C Re(z)dz$ from $1 + i$ to $3 + 2i$ along the straight line $2y = x + 1$.	**03**
		(2) Find real part and imaginary part of the following functions (i) $\sin z$ (ii) $\ln z$.	**04**
Q.3	**(a)**	Solve $\frac{dy}{dx} + 2y \tan x = \sin x, y(0) = 2$.	**03**
	(b)	Solve the following linear system by Gauss elimination method: $x - 2y + 3z = -2, \quad -x + y - 2z = 3, \quad 2x - y + 3z = -7$.	**04**
	(c)	Define Harmonic function. Check whether $v = 3x^2y - y^3$ is harmonic or not. If so, construct the analytic function $f(z) = u + iv$.	**07**
		OR	
Q.3	**(a)**	Test for exactness and solve $2xydx + x^2dy = 0$.	**03**
	(b)	Find the rank of the matrix $A = \begin{bmatrix} 1 & 2 & -1 & 0 \\ -1 & 3 & 0 & -4 \\ 2 & 1 & 3 & -2 \\ 1 & 1 & 1 & -1 \end{bmatrix}$.	**04**
	(c)	Check whether $u = 3x - 2xy$ is harmonic or not. If so, find the harmonic conjugate v of u.	**07**

Q.4	**(a)**	Solve $x^2ydx - (x^3 + xy^2)dy = 0$.	**03**
	(b)	Find the inverse of the matrix $A = \begin{bmatrix} 1 & 3 & 3 \\ 1 & 4 & 3 \\ 1 & 3 & 4 \end{bmatrix}$ using Gauss Jordan method.	**04**
	(c)	Find all the Taylor's and Laurent series of $f(z) = \frac{-2z+3}{z^2-3z+2}$ with center 0.	**07**

OR

Q.4	**(a)**	Solve $xe^x(dx - dy) + e^x dx + ye^y dy = 0$.	**03**
	(b)	Find inverse of the matrix $A = \begin{bmatrix} 2 & -1 & 2 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$ by Cayley-Hamilton theorem.	**04**
	(c)	State Cauchy Residue theorem. Evaluate $\int_C \frac{z^2}{(z-1)^2(z+2)} dz$ where C is the circle $\|z\| = 3$ using Cauchy Residue theorem.	**07**
Q.5	**(a)**	Solve $x^2p^2 + 3xyp + 2y^2 = 0$.	**03**
	(b)	Solve $xy'' + y' = \frac{12 \log x}{x}$.	**04**
	(c)	Solve $y'' - 2y' + y = xe^x \sin x$ by using the method of variation of parameter.	**07**

OR

Q.5	**(a)**	Solve $\left(x\frac{dy}{dx} - y\right)\left(1 - \frac{dy}{dx}\right) = \frac{dy}{dx}$.	**03**
	(b)	Solve $y'' + 2y' + 4y = 2x^2 + 3e^{-x}$ by undetermined coefficient method.	**04**
	(c)	Find the power series solution of $y'' + xy' + x^2y = 0$ about $x = 0$.	**07**

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