A Tutorials Manual for

Mathematics-II
(3110015)

B.E. Semester-II (All Branches)

Directorate of Technical Education,
Gandhinagar, Gujarat

Mathematics II (3110015)

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Certificate

This is to certify that Mr./Ms. ______________________________________ _________ Enrollment No. __________________of B.E. 2^{nd} - Semester, Branch _______________________________________Engineering of this Institute (GTU Code: 013) has satisfactorily completed the Tutorial work for the subject **Mathematics-II (3110015)** for the academic year 2023-24.

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(3110015)			
CO-PO Matrices			
Table			
Sr. No.	**COs**	**Statement**	
1	1	**Solve problems related to gradient, curl and divergence and use them to identify vector fields. Compute line integrals by the appropriate methods and use them to determine work, flow, circulation and flux. Describe double integrals as line integrals as an application of Green's theorem.**	20%
2	2	**Compute Laplace and inverse Laplace transforms of the various functions using its properties and apply them to solve ordinary differential equations. Compute Fourier integrals.**	20%
3	3	**Classify first order ordinary differential equations and apply the suitable methods to solve them.**	14%
4	4	**Classify higher order ordinary differential equations and apply the suitable methods to solve them.**	26%
5	5	**Derive the general solution of the ordinary differential equations using power series and Frobenius methods. Determine the properties of Bessel's functions and Legendre's polynomials.**	20%

Table CO – PO Matrix

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	--	--	--	--	--	--	--	--	--	--
CO2	3	3	--	--	--	--	--	--	--	--	--	--
CO3	3	3	--	--	--	--	--	--	--	--	--	--
CO4	3	3	--	--	--	--	--	--	--	--	--	--
CO5	2	2	--	--	--	--	--	--	--	--	--	--

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.

Index

Name of the student : ____

Enrollment Number :____

Sr. No.	Tutorial	Page No.	Sign	Remarks
1	Tutorial no: 01			
2	Tutorial no: 02			
3	Tutorial no: 03			
4	Tutorial no: 04			
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Course Outcomes	**Topics**
3110015.1	Vector Calculus: Parametrization of curves, Arc length of curve in space, Line Integrals, Vector fields and applications as Work, Circulation and Flux, Path independence, potential function, piecewise smooth, connected domain, simply connected domain, fundamental theorem of line integrals, Conservative fields, component test for conservative fields, exact differential forms, Div, Curl, Green's theorem in the plane (without proof).
3110015.2	Laplace Transform and inverse Laplace transform, Linearity, First Shifting Theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit Step Function (Heaviside Function), Second Shifting Theorem (t-Shifting), Laplace transform of periodic functions, Short Impulses, Dirac's Delta Function, Convolution, Integral Equations, Differentiation and Integration of Transforms, ODEs with Variable Coefficients, Systems of ODEs. Fourier Integral, Fourier Cosine Integral and Fourier Sine Integral.
3110015.3	First order ordinary differential equations, Exact, 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.
3110015.4	Ordinary differential equations of higher orders, Homogeneous Linear ODEs of Higher Order, Homogeneous Linear ODEs with Constant Coefficients, Euler–Cauchy Equations, Existence and Uniqueness of Solutions, Linear Dependence and Independence of Solutions, Wronskian, Nonhomogeneous ODEs, Method of Undetermined Coefficients, Solution by Variation of Parameters.
3110015.5	Series Solutions of ODEs, Special Functions, Power Series Method, Legendre's Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions of the first kind and their properties.

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

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Sr. No.	# Tutorial-1 Fourier Integral (Fourier Integral, Fourier Cosine Integral and Fourier Sine Integral.)	CO	PI	Level as per Bloom's taxonomy
1.	Define the Fourier integral of a function.	CO2	1.1.1	R
2.	Express the function $f(x) = \begin{cases} 3, & \|x\| < 3 \\ 0, & \|x\| > 3 \end{cases}$ as Fourier integral representation.	CO2	1.1.1	U
3.	Express the function $f(x) = \begin{cases} 1 - x^2, & \|x\| < 1 \\ 0, & \|x\| > 1 \end{cases}$ as Fourier integral representation.	CO2	1.1.1	A
4.	Express the function $f(x) = \begin{cases} \frac{\pi}{2}, & 0 < x < \pi \\ 0, & x > \pi \end{cases}$ as Fourier sine integral representation.	CO2	1.1.1	A
5.	Find the Fourier cosine integral representation of $f(x) = e^{-x} \cos x$.	CO2	1.1.1	U
6.	Using the Fourier integral representation, show that $$\int_0^\infty \frac{\cos \omega x + \omega \sin \omega x}{1 + \omega^2} d\omega = \begin{cases} 0, & x < 0 \\ \frac{\pi}{2}, & x = 0 \\ \pi e^{-x}, & x > 0 \end{cases}$$	CO2	1.1.1	A
8.	Find the Fourier cosine & sine integrals of $f(x) = e^{-kx}; \quad x > 0, k > 0$. Hence show that $$\int_0^\infty \frac{\cos wx}{k^2 + w^2} d\omega = \frac{\pi}{2k} e^{-kx} \ (x > 0, k > 0)$$	CO2	1.1.1	A

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Sr. No.	**Tutorial-2 First Order Differential Equation** (First order ordinary differential equations, linear and Bernoulli's equations.)	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	Explain following terms using illustrations. 1. Particular solution. 2. General solution. 3. Singular solution. 4. Initial value problem. 5. Boundary value problem. 6. Existence of solution of the problem. 7. Linear and non-linear differential equation. 8. Homogeneous and non-homogeneous differential equation.	CO3	1.1.1	U
2	Find the order and degree of (1) $\left[1+\frac{dy}{dx}\right]^{3/2}=\frac{d^3y}{dx^3}$. (2) $\frac{d^2y}{dx^2}+\sqrt{1+\frac{dy}{dx}}=0.$	CO3	1.1.1	U
2.	Solve: $xy(1+y)dy-(1-x^2)(1-y)dx=0.$	CO3	1.1.1	U
3.	Discuss the solution of $(2x+y+1)dx+(4x+2y-1)dy=0$	CO3	1.1.1	U
4.	Explain the solution of $\frac{dy}{dx}+\frac{y}{x}\log y=\frac{y}{x^2}(\log y)^2.$	CO3	1.1.1	U
5.	Solve: $(y\sin xy+xy^2\cos xy)dx+(x\sin xy+x^2y\cos xy)dy=0.$	CO3	1.1.1	U
6.	Discuss the solution of $\left(xy^2-e^{\frac{1}{x^3}}\right)dx-x^2ydy=0.$	CO3	1.1.1	U
8.	Derive the solution of $\sqrt{1+x^2+y^2+x^2y^2}+xy\frac{dy}{dx}=0.$	CO3	1.1.1	U
9.	Derive the solution of $(x+y-1)dx+(2x+2y-3)dy=0.$	CO3	1.1.1	U
10.	Discuss the solution of $\frac{dy}{dx}-\frac{tany}{tanx}=(1+x)e^x secy.$	CO3	1.1.1	U

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Sr. No.	**Tutorial-3 Laplace Transforms** (Laplace Transform and inverse Laplace transform, Linearity, First Shifting Theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit Step Function (Heaviside Function), Second Shifting Theorem (t-Shifting), Laplace transform of periodic functions, Short Impulses, Dirac's Delta Function, Convolution, Integral Equations, Differentiation and Integration of Transforms.)	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	Define the Laplace transform.	CO2	1.1.1	R
2.	By using the definition of Laplace transform show that (i) $L\{\sin at\} = \frac{a}{s^2+a^2}$. (ii) $L\{t^n\} = \frac{n!}{s^{n+1}}$. (iii) $L\{\cosh at\} = \frac{s}{s^2-a^2}$.	CO2	1.1.1	U
3.	Apply the property of Laplace transform to find the following. (i) $L(\cos 4t \sin t)$. (ii) $L(t^3 \cosh t)$. (iii) $L(t\, e^{4t} \cos 2t)$. (iv) $L(f(t))$,where, $f(t) = \begin{cases} \frac{t}{k}, & 0 < t < k \\ 1, & t > k \end{cases}$	CO2	1.1.1	A
4.	Apply the property of Laplace transform to find the following. (i) $(sin^2 t)$.(ii) $L(\sinh 2t + t^3 + 5)$.(iii) $L(e^{-3t}\{t^2 + \cos t\})$. (iv)$L(t^2 e^{-4t})$.(v) $L\left(\frac{1-e^{3t}}{t}\right)$.(vi)$L(t^2 \cos 3t)$. (vii)$L\left(\int_0^t \left(\frac{1-e^x}{x}\right) dx\right)$.	CO2	1.1.1	U
5.	Compute inverse Laplace transform of the following function (i) $\frac{2s-3}{(s-2)^3}$.(ii) $\frac{s+1}{s^3-6s^2+11s-6}$.(iii) $\frac{s+1}{s^2+s+1}$.(iv) $\frac{s}{s^4+4}$. (v) $\frac{s-3}{s^2-6s+13}$	CO2	1.1.1	A
6.	State the second shifting theorem	CO2	1.1.1	R
8.	Apply appropriate theorem or formula to find inverse Laplace transform of following functions. (i) $\frac{(s+3)\,e^{-s}}{s^2+1}$. (ii) $\frac{e^{-4s}}{(s+2)^3}$.(iii) $\frac{e^{-\pi s}}{s^2+4s+5}$.(iv) $\log\left(\frac{1}{s}\right)$.(v) $\log\sqrt{\frac{s(s+1)}{s^2+4}}$.	CO2	1.1.1	A
9.	Compute inverse Laplace transform of the following function (i) $\frac{3s^3-5s^2+6}{s^4}$. (ii) $\frac{s+5}{s^2+6s+10}$. (iii) $\frac{3s-4}{(s^2-9s+20)}$. (iv)$\frac{5s+3}{(s-1)(s^2+2s+5)}$. (v) $\frac{2s^2-4}{(s^3-4s^2+s+6)}$. (vi) $\frac{2s^2-1}{(s^2+1)(s^2+4)}$.	CO2	1.1.1	U
10.	State the convolution theorem for the Laplace transforms.	CO2	1.1.1	R
11.	Using Convolution theorem evaluates the following: (i) $L^{-1}\left(\frac{1}{s^2(s^2+4)}\right)$ (ii) $L^{-1}\left(\frac{s}{(s^2+1)(s^2+4)}\right)$	CO2	1.1.1	A
12.	Use the convolution theorem to evaluate inverse Laplace transform of following functions (i) $\frac{1}{s(s^2+9)}$.(ii) $\frac{s}{(s^2+1)^2}$. (iii) $\frac{s^2}{(s^2+a^2)(s^2+b^2)}$.	CO2	1.1.1	A
13.	Define Convolution of two function.	CO2	1.1.1	R
14.	Evaluate the following (i) $1 * \sin at$.(ii) $\cos at * \cos at$.(iii) $cosat * \ sinat$.	CO2	1.1.1	U

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Sr. No.	**Tutorial-4 First Order Differential Equation** (Exact equations,Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.)	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	Write the condition of exact differential equation.	CO3	1.1.1	R
2.	Solve: $xe^x(dx - dy) + e^x dx + ye^y dy = 0$.	CO3	1.1.1	U
3.	Solve : $\frac{dy}{dx} = \frac{x}{y}$.		1.1.1	
4.	Solve :$P^2 + 2pycotx = y^2$ Ans: $y(1 \pm cosx) = C$	CO3	1.1.1	U
5.	Solve :$y = 2px + p^n$	CO3	1.1.1	U
6.	Solve :$(Px - y)(Py + x) = a^2P$.	CO3	1.1.1	U
8.	Solve :$xP^2 - yP - y = 0$.	CO3	1.1.1	U
9.	Solve :$e^{4x}(p - 1) + e^{2y}p^2 = 0$.	CO3	1.1.1	U
10.	Solve :$\frac{dy}{dx} - \frac{dx}{dy} = \frac{x}{y} - \frac{y}{x}$.	CO3	1.1.1	U
11.	Solve: $y - 2px = tan^{-1}(xp^2)$.	CO3	1.1.1	. U.
12.	Solve: $y = 2px + y^2p^3$.	CO3	1.1.1	U
13.	Solve: $x^2\left(\frac{dy}{dx}\right)^2 + xy\frac{dy}{dx} - 6y^2 = 0$.	CO3	1.1.1	U
14.	Solve :$y = xy' - (y')^2$.	CO3	1.1.1	U

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Sr. No.	# Tutorial-5 Laplace Transforms (ODEs with Variable Coefficients, Systems of ODEs.)	CO	PI	Level as per Bloom's taxonomy
1.	Use Laplace Transform to solve the following ordinary differential equations (i) $y' + 6y = e^{4t};\ y(0) = 2.$ (ii)$y'' + 2y' - 3y = 6e^{-2t};\ y(0) = 1, y'(0) = -14.$ (iii) $y'' + y = \sin 2t;\ y(0) = 2, y'(0) = 1.$	CO2	1.1.1	A
2.	Express the following function in the terms of unit step function and hence find the Laplace transform $f(t) = \begin{cases} t, & 0 < t < 2 \\ t^2, & t > 2 \end{cases}.$	CO2	1.1.1	U
3.	Using Laplace Transform, solve the integral equation $y(t) = 1 - \int_0^t (t - x)y(x)dx.$	CO2	1.1.1	A
4.	Use Laplace Transform to solve following ordinary differential equations: (i)$y'' - 4y = 24\cos 2t;\ y(0) = 3, y'(0) = 4.$ (ii)$y'' + 2y' + 5y = e^{-t}\sin t;\ y(0) = 0, y'(0) = 1.$ (iii)$y'' - y' - 2y = 20\sin 2t; y(0) = -1, y'(0) = 2$	CO2	1.1.1	A
5.	Use Laplace Transform to solve simultaneous equations $x'(t) - 2x + 3y = 0, y'(t) + 2x - y = 0, x(0) = 8, y(0) = 3.$	CO2	1.1.1	A
6.	Evaluate the following (i) $L^{-1}\left[e^{-3(t-3)}u(t-3)\right]$. (ii)$L^{-1}[t^2u(t-2)]$. (ii)$L^{-1}[u(t-\pi)cos(t-\pi)]$.	CO2	1.1.1	U
8.	Apply appropriate theorem or formula to find inverse Laplace transform of following functions. (i)$\frac{s\,e^{-s}}{s^2+9}$. (ii) $\frac{s\,e^{-3s}+e^{-2s}}{s^2+25}$. (iii) $\log\left(\frac{s+5}{s+2}\right)$. (iv) $\log\left(\frac{s^2+16}{s^2}\right)$.	CO2	1.1.1	A

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Sr. No.	**Tutorial -6 Higher Order Differential Equation** (Ordinary differential equations of higher orders, Homogeneous Linear ODEs of Higher Order, Homogeneous Linear ODEs with Constant Coefficients, Euler–Cauchy Equations, Existence and Uniqueness of Solutions, Linear Dependence and Independence of Solutions, Wronskian.)	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	Explain following terms with examples. 1. Homogeneous Linear ODEs with Constant Coefficients. 2. Euler–Cauchy Equations. 3. Linear Dependence and Independence of Solutions. 4. Wronskian.	CO 4	1.1.1	R
2.	Solve the following: (i) $y'' - 9y = 0, y(0) = 2, y'(0) = -1.$ (ii) $\frac{d^4x}{dt^4} + 4x = 0$ (iii) $\frac{d^4y}{dx^4} + \frac{dy}{dx} - 2y = 0$ (iv) $y'' + 2y' + 4y = 0, y(0) = 1, y'(0) = 1.$ (v) $(D-2)(D^2 + D + 1)^2 y = 0$ where $D = \frac{d}{dt}$. (vi) $y'' + 4y' + 4y = 0, y(0) = 1, y'(0) = 1$ (vii) $y'' - 4y' + 4y = 0 \; with \; y(0) = 3, y'(0) = 1$ (viii) $y''' - 6y'' + 11y' - 6y = 0$ (ix) $x^2 \frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0$ (x) $3x^2 \frac{d^2y}{dx^2} - x\frac{dy}{dx} - y = 0$	CO 4	1.1.1	U
3.	Find the particular integral of the following: (i) $\frac{d^5y}{dx^5} - 3\frac{d^4y}{dx^4} + y = e^x$ (ii) $\frac{d^2y}{dx^2} + 6\frac{dy}{dx} + 9y = 50e^x \cos x$ (iii) $(D^4 - 1)y = x^3$	CO4	1.1.1	U

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Sr. No.	**Tutorial- 7 Higher Order Differential Equation** (Method of Undetermined Coefficients.)	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	Find the solution of following differential equation using Undetermined Coefficient method. (i) $(D^3+1)y=\cos(2x-1)$ (ii) $\frac{d^3y}{dx^3}+4\frac{dy}{dx}=\sin 2x$ (iii) $\frac{d^2y}{dx^2}+\frac{dy}{dx}=x^2+2x+4$ (iv) $(D^2-2D+4)y=e^x\cos x$ (v) $(D-2)^2=8(e^{2x}+\sin 2x+x^2)$ (vi) $\frac{d^4y}{dx^4}+5\frac{d^3y}{dx^3}+6\frac{d^2y}{dx^2}-4\frac{dy}{dx}-8y=e^{-2x}+2e^{-x}+3e^x-3$ (vii) $(D^2+1)y=cosxcos2x$ (viii) $(D^2+16)y=x^4+e^{3x}+cos2x$ (ix) $\frac{d^2y}{dx^2}-2\frac{dy}{dx}+y=x^2e^{3x}$	CO 4	1.1.1	A

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Sr. No.	**Tutorial- 8 Higher Order Differential Equation** (Nonhomogeneous ODEs , Solution by Variation of Parameters.)	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	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) $\frac{d^2y}{dx^2} + a^2y = secax$,	CO 4	1.1.1	A
2.	Solve the following: (i) $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = \frac{x^3}{1+x^2}$ (ii) $(2x+3)^2\frac{d^2y}{dx^2} - (2x+3)\frac{dy}{dx} - 12y = 6x.$ (iii) $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} + y = \log x \sin(\log x)$ (iv) $(1+x)^2\frac{d^2y}{dx^2} + (1+x)\frac{dy}{dx} + y = 4\cos(\log(1+x)$	CO 4	1.1.1	A

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Sr. No.	**Tutorial - 9 Vector Calculus** (Parametrization of curves, Arc length of curve in space, Lin Integrals, Vector fields and applications as Work, Circulation and Flux)	CO	PI	Level as per Bloom's taxonomy
1.	Write parametric equations for (1) Circle (2) Parabola (3) Ellipse (4) Straight line (5) Circular Helix.	CO 1	1.1.1	R
2.	Find parametric equation for (1) $y^2 = 4x$ (2)$y = (x-3)^2$ (3) Circle with centre (1,2) & radius 2 (4) Straight line joining Points (1,2) & (2,4).	CO 1	1.1.1	U
3.	Find the arc length of the cure $\bar{r}(t) = 5t\hat{\imath} + 4sin3t\,\hat{\jmath} + 4cos3t\,\hat{k}$for $0 \le t \le \pi$.	CO 1	2.1.3	U
4.	Find the arc length of the cure $\bar{r}(t) = t^2\hat{\imath} + t^3\hat{\jmath}$ between (1, 1) to (4,8).	CO 1	2.1.3	U
5.	Let the vector field be $\bar{F} = x^2\hat{\imath} - xy\hat{\jmath}$, Find its line integral from the origin O to the point P(1,1), (1) Along the straight-line OP. **(2)** Along Parabola $y^2 = x$.	CO 1	1.1.1	U
6.	Define : 1. Vector fields 2. Work Done 3. Circulation4. Flux.		1.1.1	
7.	Find the work done by the force field $\bar{F} = (3x^2 - 3x)\hat{\imath} + 3x\hat{\jmath} + \hat{k}$ along the straight line $t\hat{\imath} + t\hat{\jmath} + t\hat{\jmath}, 0 \le t \le 1$.	CO 1	2.1.3	A
8.	Find the circulation around the circler(t) $=$ cos t i $+$ sin t j of the velocity field F = (x-y) i+ x j .	CO 1	2.1.3	A
9.	Find the circulation of F =2x i+ 2z j + 2y k around the closed path given by following curves $\mathrm{C1}:\ \mathrm{r(t)} = \cos t\, \mathrm{i} + \sin t\, \mathrm{j} + t\, \mathrm{k}, 0 \le t \le \frac{\pi}{2}$ $\mathrm{C2}:\ \mathrm{r(t)} = \mathrm{j} + \frac{\pi}{2}(1-\mathrm{t})\mathrm{k}, 0 \le t \le 1$ $\mathrm{C3}:\ \mathrm{r(t)} = t\,\mathrm{i} + (1-\mathrm{t})\,\mathrm{j}, 0 \le t \le 1$	CO 1	2.1.3	A
10.	Compute the flux of F = (x - y) i + yj across the unit circle in the XY-plane.	CO 1	2.1.3	A
11.	Find the work done when a force $\bar{F} = (x^2 - y^2 + 2x)\hat{\imath} - (2xy + y)\hat{\jmath}$ moves a particle in the xy plane from (0,0) to (1,1) along the parabola $y^2 = x$. Is the work done different when the path is the straight line $y = x$?	CO 1	2.1.3	A

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

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Sr. No.	**Tutorial - 10 Vector Calculus** (Path independence, potential function, piecewise smooth, connected domain, simply connected domain, fundamental theorem of line integrals, Conservative fields, component test for conservative fields)	CO	PI	Level as per Bloom's taxonomy
1.	Define 1. Potential function. 2. Piecewise smooth curve 3. Connected domain. 4. Simply connected domain 5. Conservative fields. 6. Exact differential forms.	CO 1	1.1.1	R
2.	State fundamental theorem of line integrals.	CO 1	1.1.1	R
3.	Write Component test for conservative fields.	CO 1	1.1.1	R
4.	If $\bar{F} = (2xy + z^3)\hat{\imath} + (x^2)\hat{\jmath} + (3xz^2)\hat{k}$. Show that $\int \bar{F} \cdot \overline{dr}$ is independent of path of integration. Hence find the integral when C is any path joining (1,-2,1) and (3,1,4).	CO 1	1.1.1	A
5.	Let $\bar{F} = (x^2 - yz)\hat{\imath} + (y^2 - zx)\hat{\jmath} + (z^2 - xy)\hat{k}$. (i)If $\bar{F}$ is conservation, find its scalar potential ϕ. (ii)Find the work done in moving a particular under this force field from (1,1,0) to (2,0,1).	CO 1	2.1.3	A
6.	Find the work done in the moving particle in a force field $\bar{F} = 3xy\hat{\imath} - 5z\hat{\jmath} + 10x\hat{k}$ along the curve $x = t^2 + 1, y = 2t^2, z = t^3$ from $t = 0\ to\ t = 2$.	CO 1	2.1.3	U
7.	If $\bar{r} = xi + yj + zk$ then find $curl\ (r^n\bar{r})$.	CO 1	1.1.1	U
8.	If $\bar{V} = (ax^2y + yz)\hat{\imath} + (xy^2 - xz^2)\hat{\jmath} + (2xyz - 2x^2y^2)\hat{k}$ is solenoidal then find the value of constant a.	CO 1	1.1.1	U
9.	Prove that $\bar{F} = r^2\bar{r}$ is irrotational. Find its scalar function.	CO 1	1.1.1	U

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

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Sr. No.	**Tutorial - 11 Vector Calculus** (Div, Curl, Green's theorem in the plane (without proof).)	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	Show that $\bar{F} = (y^2 - Z^2 + 3yz - 2x)\hat{\imath} + (3xy + 2xy)\hat{\jmath} + (3xy - 2xz + 2z)\hat{k}$ is both solenoidal and irrotational.	CO 1	1.1.1	U
2.	State Green's theorem and use it to evaluate the integral $\int_C y^2 dx + x^2 dy$ where C is the triangle bounded by $x = 0, x + y = 1, y = 0$.	CO 1	1.1.1	A
3.	Verify Green's Theorem for $\bar{F} = (x - y)\hat{\imath} + x\hat{\jmath}$ where C : $x^2 + y^2 = 1$.	CO 1	1.1.1	A
4.	If $\bar{F} = 3xy\hat{\imath} - y^2\hat{\jmath}$, evaluate $\int_C \bar{F}\, d\bar{r}$ where C is the arc of parabola $y = 2x^2$ from (0,0) to (1,2).	CO 1	1.1.1	U
5.	Evaluate by Green's theorem $\int_C e^{-x}(siny\, dx + cosy\, dy)$ where C is the rectangle with vertices $(0,0)(\pi, 0), \left(\pi, \frac{\pi}{2}\right), \left(0, \frac{\pi}{2}\right)$.	CO 1	1.2.1	A

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Sr. No.	**Tutorial-12 Series Solution** **(**Series Solutions of ODEs, Special Functions, Power Series Method**)**	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	Classify the singularities of following differential equation (i) $3x^2y'' + 5xy' + (x+2)y = 0$ (ii) $(x^2-1)y'' + 5xy' + (x+2)y = 0$ (iii)$(x+1)^2y'' - 2xy' + (x+2)y = 0$ (iv)$y'' - y' + y = 0$ (v) $(x-2)y'' + 3xy' + 4xy = 0$ (vi)$(x-1)^2y'' - xy' + (x+1)y = 0$	CO5	1.1.1	U
2.	Apply the power series method to solve following differential equations: (i) $y'' - xy' + 2y = 0$, near $x = 0$ (ii) $(1-x^2)y'' + 2xy' - y = 0$, near $x = 0$ (iii) $(1+x^2)y'' + xy' - y = 0$, near $x = 0$ (iv) $xy' - y = 0$, near $x = 1$ (v) $(1+x^2)y'' - 9y = 0$, near $x = 0$ (vi) $y'' - xy' - (1+2x^2)y = 0$, near $x = 0$	CO5	1.1.1	A

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Sr. No.	# Tutorial-13 Series Solution (Frobenius Method)	CO	PI	Level as per Bloom's taxonomy
1.	Apply the Frobenious method to solve following differential equations: (i) $2xy'' + (1-2x)y' - y = 0$, (ii) $2x(1-x)y'' + (1-x)y' + 3y = 0$, (iii) $x^2y'' + 4xy' + (x^2+2)y = 0$ (iii) $xy'' + y' - y = 0$, (iv) $x(x-1)y'' - xy' + y = 0$, near $x = 0$	CO5	1.1.1	A

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Sr. No.	**Tutorial-14 Series Solution** (Legendre's Equation, Legendre Polynomials, Bessel's Equation, Bessel functions of the first kind and their properties.)	**CO**	**PI**	**Level as per Bloom's taxonomy**
1.	Express $f(x) = x^3 + 2x^2 - x - 3$ in the terms of Legendre's polynomial. Ans. $\frac{2}{5}P_3 + \frac{4}{3}P_2 - \frac{2}{5}P_1 - \frac{7}{3}P_0$	CO5	1.1.1	U
2.	Show that $\int_{-1}^{1} P_n(x)\, P_m(x) dx = \begin{cases} 0 & ; m \neq n \\ \frac{2}{2n+1} & ; m = n \end{cases}$	CO5	1.1.1	U
3.	Prove the following equalities (i) $\frac{d}{dx}\ (x^n J_n(x)) = x^n J_{n-1}(x)$ (ii) $J'_n(x) = \frac{1}{2}(J_{n-1}(x) - J_{n+1}(x))$ (iii) $xJ'_n(x) = xJ'_{n-1} - nJ_n(x)$.	CO5	1.1.1	A
4.	Write the Rodrigues' formula.	CO5	1.1.1	R
5.	Express $f(x) = x^5$ in the terms of Legendre's polynomial.	CO5	1.1.1	U
6.	Show that $nP_n(x) = xP'_n(x) - P'_{n-1}(x)$	CO5	1.1.1	A

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