

First Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026

Mathematics – I for Civil Engineering Stream

Time: 3 hrs.

Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.

2. VTU Formula Hand Book is permitted.

3. M : Marks , L: Bloom's level , C: Course outcomes.

Module – 1			M	L	C
Q.1	a.	With usual notations, prove that $\tan \phi = r \frac{d\theta}{dr}$	06	L2	CO1
	b.	Show that the curves $r = a(1 + \cos \theta)$ and $r = a(1 - \cos \theta)$ cut each other orthogonally.	07	L2	CO1
	c.	Show that the radius of curvature at any point of the cycloid $x = a(\theta + \sin \theta)$ $y = a(1 - \cos \theta)$ is $4a \cos\left(\frac{\theta}{2}\right)$.	07	L3	CO1
OR					
Q.2	a.	Derive an expression for the radius of curvature in the Cartesian form as : $\rho = \frac{(1 + y_1^2)^{3/2}}{y_2}$	08	L2	CO1
	b.	Find the pedal equation of the curve $r^n = a^n \cos n\theta$	07	L2	CO1
	c.	Using modern mathematical tool, write a program/code to plot the curve $r = 2 \cos 2\theta $	05	L3	CO5
Module – 2					
Q.3	a.	Expand $\log(1 + \cos x)$ by Maclaurin's series upto the term containing x^4 .	06	L2	CO2
	b.	If $u = f(2x - 3y, 3y - 4z, 4z + 2x)$, show that $6 \frac{\partial u}{\partial x} + 4 \frac{\partial u}{\partial y} + 3 \frac{\partial u}{\partial z} = 0$	07	L2	CO2
	c.	Find the extreme values of $f(x, y) = x^3 + y^3 - 3x - 12y + 20$	07	L3	CO2
OR					
Q.4	a.	If $z = e^{ax+by} f(ax-by)$, prove that $b \frac{\partial z}{\partial x} + a \frac{\partial z}{\partial y} = 2abz$	08	L2	CO2
	b.	If $u = x + 3y^2 - z^3$, $v = 4x^2yz$, $w = 2z^2 - xy$ find $\frac{\partial(u, v, w)}{\partial(x, y, z)}$ at $(1, -1, 0)$	07	L2	CO2
	c.	Using modern mathematical tool, write a program to evaluate $\lim_{x \rightarrow \infty} \left(1 + \frac{1}{x}\right)^x$	05	L3	CO1

Module – 3

Q.5	a.	Solve $\frac{dy}{dx} + \frac{y}{x} = x^2 y^6$	06	L2	CO3
	b.	Find the orthogonal trajectories of the family of curves $r^n = a^n \cos n\theta$, where 'a' is a parameter.	07	L3	CO3
	c.	Solve, $xyp^2 - (x^2 + y^2)p + xy = 0$.	07	L2	CO3

OR

Q.6	a.	Solve $(4xy + 3y^2 - x)dx + x(x + 2y)dy = 0$	06	L2	CO3
	b.	If the temperature of the air is 30°C and a metal ball cools from 100°C to 70°C in 15 minutes, find how long will it take for the metal ball to reach the temperature of 40°C?	07	L3	CO3
	c.	Find the general solution of $xp^2 + xp - yp + 1 - y = 0$ by Clairaut's equation. Also find the singular solution.	07	L2	CO3

Module – 4

Q.7	a.	Solve $(4D^4 - 4D^3 - 23D^2 + 12D + 36)y = 0$	06	L2	CO3
	b.	Solve $y'' + 3y' + 2y = 12x^2$	07	L2	CO3
	c.	Solve $(2x+1)^2 \frac{d^2y}{dx^2} - 2(2x+1) \frac{dy}{dx} - 12y = 3(2x+1)$	07	L2	CO3

OR

Q.8	a.	Solve $\frac{d^2y}{dx^2} - 4y = \cosh(2x-1) + 3^x$	06	L2	CO3
	b.	Solve by the method of variation of parameters $(D^2 + 4)y = \tan 2x$.	07	L2	CO3
	c.	Solve $x^2 \frac{d^2y}{dx^2} - 4x \frac{dy}{dx} + 6y = \cos(2 \log x)$	07	L2	CO3

Module – 5

Q.9	a.	Find the rank of the matrix $\begin{bmatrix} 4 & 0 & 2 & 1 \\ 2 & 1 & 3 & 4 \\ 2 & 3 & 4 & 7 \\ 2 & 3 & 1 & 4 \end{bmatrix}$	06	L2	CO4
	b.	Solve the system of equations by Gauss – Jordan method $2x + 5y + 7z = 52$; $2x + y - z = 0$; $x + y + z = 9$	07	L3	CO4
	c.	Using Rayleigh's power method, find the dominant eigen value and the corresponding eigen vector of $\begin{bmatrix} 2 & 0 & 1 \\ 0 & 2 & 0 \\ 1 & 0 & 2 \end{bmatrix}$ by taking $[1 \ 0 \ 0]^T$ as the initial eigen vector. [Carry out 6 iterations].	07	L3	CO4

OR

Q.10	a.	Solve the system of equations by Gauss – Elimination Method $x + y + z = 9$, $x - 2y - 3z = 8$, $2x + y - z = 3$	07	L2	CO4
	b.	Solve the system of equations $2x - 3y + 20z = 25$; $20x + y - 2z = 17$, $3x + 20y - z = -18$, using Gauss – Seidel method, taking (0, 0, 0) as an initial approximation. [Carry out 3 iterations].	08	L3	CO4
	c.	Using modern mathematical tool, write a program/code to test the consistency of the equations $x + 2y - z = 1$, $2x + y + 4z = 2$, $3x + 3y + 4z = 1$	05	L3	CO5