CBCS SCHEME

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BMATC101

First Semester B.E./B.Tech. Degree Examination, June/July 2023
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. M : Marks , L: Bloom's level , C: Course outcomes.
3. VTU formula handbook is permitted.

		Module – 1	M	L	C
Q.1	a.	Find the angle between radius vector and the tangent for the polar curve $r = ae^{\theta\cot\alpha}$, where α is a constant.	6	L2	CO1
	b.	Find the angle of intersection between $r = a\theta$ and $r = a/\theta$.	7	L2	CO1
	c.	Show that the radius of curvature of the curve $y = 4\,\text{Sin}\,x - \text{Sin}\,2x$ at $x = \pi/2$ is $5\sqrt{5}/4$.	7	L3	CO1
		OR			
Q.2	a.	Prove that the curves $r = a(1 + \text{Cos}\,\theta)$ and $r = b(1 - \text{Cos}\,\theta)$ intersect orthogonally.	7	L2	CO1
	b.	Show that the pedal equation for $r^2 = a^2\,\text{Sec}\,2\theta$ is $pr = a^2$.	8	L2	CO1
	c.	Using Modern mathematical tool with program / code to plot the curve $r = 2\lvert\text{Cos}2\theta\rvert$.	5	L3	CO5
		Module – 2			
Q.3	a.	Obtain Maclaurin's series for the function log(1+x) upto 4th degree terms.	6	L2	CO2
	b.	Prove that $\lim\limits_{x\to 1} x^{1/(1-x)} = 1/e$.	7	L3	CO2
	c.	Show that $f(x, y) = xy(a - x - y)$ $a > 0$ is maximum at the point $(a/3, a/3)$.	7	L2	CO2
		OR			
Q.4	a.	Prove that $\text{Sin}\,x + \text{Cos}\,x = 1 + x - \frac{x^2}{2} - \frac{x^3}{6} + \frac{x^4}{24} + ...$ by using Maclaurin's series.	7	L2	CO2
	b.	If $u = f(x-y, y-z, z-x)$, show that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = 0$.	8	L2	CO2
	c.	Using Modern mathematical tool, write a program to show that $U_{xx} + U_{yy} = 0$, given $U = e^x(x\,\text{Cos}\,y - y\,\text{Sin}\,y)$.	5	L3	CO5

		Module – 3			
Q.5	**a.**	Solve $(x^2 + y^2 + x)dx + xy\,dy = 0$.	**6**	**L2**	**CO3**
	b.	Find the Orthogonal trajectories of the family of curves $x^{2/3} + y^{2/3} = a^{2/3}$, where a is the parameter.	**7**	**L2**	**CO3**
	c.	Reduce the equation $y = 2px - y^2p^3$ to the Clairaut's form by substituting $X = 2x$, $Y = y^2$ and solve.	**7**	**L3**	**CO3**
		OR			
Q.6	**a.**	Solve $(xy^2 - e^{1/x^3})\,dx - x^2y\,dy = 0$.	**6**	**L2**	**CO3**
	b.	Solve the Bernoulli differential equation $\frac{dy}{dx} - \frac{y}{(1+x)} = \frac{-y^2}{(1+x)}$.	**7**	**L2**	**CO3**
	c.	Use Newton's law of cooling to solve the following : A bottle of water at room temperature of 72ºF is kept in a refrigerator where the temperature is 44ºF. After half an hour water cooled to 61ºF. i) What is the temperature of the water in another half an hour? ii) How long will it take to cool to 50ºF?	**7**	**L3**	**CO3**
		Module – 4			
Q.7	**a.**	Solve $(D^2 - 2D + 1)y = x + 2$.	**6**	**L2**	**CO3**
	b.	Solve using method of variation of parameters $(D^2 + a^2)y = \tan ax$.	**7**	**L2**	**CO3**
	c.	Solve $x^2y'' - 2xy' - 4y = x^4$.	**7**	**L2**	**CO3**
		OR			
Q.8	**a.**	Solve $(D^4 + 2D^3 - 5D^2 - 6D)y = 0$.	**6**	**L2**	**CO3**
	b.	Solve $(D^2 + 16)y = e^{-4x}$.	**7**	**L2**	**CO3**
	c.	Solve $(2x+1)^2 \frac{d^2y}{dx^2} - 2(2x+1)\frac{dy}{dx} - 12y = 3(2x+1)$.	**7**	**L2**	**CO3**
		Module – 5			
Q.9	**a.**	Find the rank of the matrix $\begin{pmatrix} 11 & 12 & 13 & 14 \\ 12 & 13 & 14 & 15 \\ 13 & 14 & 15 & 16 \\ 14 & 15 & 16 & 17 \end{pmatrix}$.	**6**	**L1**	**CO4**
	b.	Solve using Gaussian Elimination method : $3x + y + 2z = 3$ $2x - 3y - z = -3$ $x + 2y + z = 4$.	**7**	**L2**	**CO4**

	c.	Use Rayleigh's power method to find the largest eigen value and the corresponding eigen vector of the matrix A = $\begin{pmatrix} 2 & 0 & 1 \\ 0 & 2 & 0 \\ 1 & 0 & 2 \end{pmatrix}$. Take initial vector to be $\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$ perform 6 iteration.	**7**	**L3**	**CO4**
		OR			
Q.10	**a.**	Test the following system for consistency and solve $x + 2y + 3z = 1$ $2x + 3y + 8z = 2$ $x + y + z = 3.$	**7**	**L2**	**CO4**
	b.	Solve the following system by Gauss – Seidel method with trial solution $x = y = z = 0.$ $10x + y + z = 12$ $x + 10y + z = 12$ $x + y + 10z = 12.$	**6**	**L3**	**CO4**
	c.	Using modern mathematical tool, write a program/code to find the largest eigen value of A = $\begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$ by Power method.	**7**	**L3**	**CO5**

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