Model Question Paper-II with effect from 2022 (CBCS Scheme)

USN | | | | | | | | | | |

Second Semester B.E Degree Examination
Mathematics-II for CIVIL ENGINEERING STREAM -BMATC201

TIME: 03 Hours **Max. Marks: 100**

Note:
1. Answer any **FIVE** full questions, choosing at least **ONE** 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.01	a	Evaluate $\int_0^a \int_0^{\sqrt{a^2-x^2}} \int_0^{\sqrt{a^2-x^2-y^2}} \frac{1}{\sqrt{a^2-x^2-y^2-z^2}}\, dz\, dy\, dx$	**7**	L3	**CO1**
	b	Evaluate $\int_0^{4a} \int_{\frac{x^2}{4a}}^{2\sqrt{ax}} xy\, dydx$ by changing the order of integration	**7**	L3	**CO1**
	c	Define beta and gamma functions. Show that $\gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$	**6**	L2	**CO1**
		OR			
Q.02	a	Evaluate $\int_0^a \int_y^a \left(\frac{x^2}{(x^2+y^2)^{3/2}}\right) dxdy$ by changing into polar coordinates	**7**	L3	**CO1**
	b	Using double integration find the area enclosed between the parabola $y = x^2$ and the line $y = x$	**7**	L3	**CO1**
	c	Write a modern mathematical program to evaluate the integral $\int_0^3 \int_0^{3-x} \int_0^{3-x-y} (xyz)\, dz\, dy\, dx$	**6**	L3	**CO5**
		Module-2			
Q. 03	a	If $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$ show that $(i)\nabla.\vec{r} = 3 \;\; (ii)\nabla \times \vec{r} = \vec{0} \;\; and \;\; (iii)\nabla r^n = nr^{n-2}\vec{r}$	**7**	L2	**CO2**
	b	If $\vec{F} = \nabla(xy^3z^2)$ find $div\, \vec{F}$ and $curl\, \vec{F}$ at the point $(1, -1, 1)$.	**7**	L2	**CO2**
	c	Define an irrotational vector. Find the constants a, b and c such that $\vec{A} = (axy - z^3) + (bx^2 + z)j + (bxz^2 + cy)k$ is irrotational.	**6**	L2	**CO2**
		OR			
Q.04	a	Evaluate $\int (5xy - 6x^2)dx + (2y - 4x)dy$, over the curve $y = x^3$ in the xy-plane from the point (1, 1) to (2, 8)	**7**	L2	**CO2**
	b	Use Stoke's theorem to evaluate $\int_C \vec{F} \cdot d\vec{r}$, where $\vec{F} = (x^2 + y^2)\hat{\imath} - 2xy\hat{\jmath}$ and C is bounded by $x = \pm a,\; y = b$	**7**	L3	**CO2**

	c	Write a modern mathematical tool program to evaluate $\oint_c [(xy+y^2)dx + x^2dy]$, where c is the closed curve bounded by $y = x$ and $y = x^2$ by using Green's theorem.	**6**	L3	**CO5**
		Module-3			
Q. 05	a	Form the partial differential equation by eliminating the arbitrary function from the relation $lx + my + nz = f(x^2+y^2+z^2)$	**7**	L2	**CO3**
	b	Solve $\frac{\partial^2 z}{\partial x^2} = xy$, subject to the conditions $\frac{\partial z}{\partial x} = \log(1+y)$, when $x = 1$ and $z = 0$, when $x = 0$.	**7**	L3	**CO3**
	c	With usual notations derive a one-dimensional heat equation	**6**	L2	**CO3**
		OR			
Q. 06	a	Form the partial differential equation by eliminating the arbitrary constants from $(x-a)^2 + (y-b)^2 + z^2 = 4$	**7**	L2	**CO3**
	b	Solve $\frac{\partial^2 z}{\partial y^2} = z$, given that when $y = 0, z = e^x and\ \frac{\partial z}{\partial y} = e^{-x}$	**7**	L3	**CO3**
	c	Solve $x^2(y-z)p + y^2(z-x)q = z^2(x-y)$	**6**	L3	**CO3**
		Module-4			
Q. 07	a	By Newton's-Raphson method find the root of $x \sin x + \cos x = 0$ which is near to $x = \pi$	**7**	L3	**CO4**
	b	Using Lagrange's interpolation formula, fit a polynomial which passes through the points $(-1, 0)$, $(1, 2)$, $(2, 9)$ and $(3, 8)$ and hence estimate the value of y when $x = 2.2$	**7**	L3	**CO4**
	c	Evaluate $\int_4^{5.2} \log x\, dx$ using Simpson's (3/8)th rule by taking 7 ordinates	**6**	L3	**CO4**
		OR			
Q. 08	a	Find an approximate value of the root of the equation $xe^x = 3$, using the method of false position, carry out four iterations.	**7**	L3	**CO4**
	b	The population of a town is given by the following table: Year: 1951, 1961, 1971, 1981, 1991 Population: 19.6, 39.65, 58.81, 72.21, 94.61 Using Newton's forward and backward interpolation formula, calculate the increase in population between the years 1955 and 1985.	**7**	L3	**CO4**
	c	Evaluate $\int_0^{0.3} (1-8x^3)^{\frac{1}{2}} dx$ by using Simpson's $\left(\frac{1}{3}\right)^{rd}$ rule, by taking 3 equal intervals.	**6**	L3	**CO4**
		Module-5			
Q. 09	a	Use Taylor's series method to find $y(0.2)$ from $\frac{dy}{dx} = x^2y - 1$, with $y(0) = 1$	**7**	L3	**CO4**
	b	Using Runge-Kutta method of order 4, find y at x = 0.1, given that $\frac{dy}{dx} = 3e^x + 2y,\quad y(0) = 1$	**7**	L3	**CO4**

	c	Applying Milne's Predictor-Corrector method , find y(0.8), from $\frac{dy}{dx} = x^3 + y$, given that $y(0) = 2$, $y(0.2) = 2.073$, $y(0.4) = 2.452$, $y(0.6) = 3.023$	**6**	L3	**CO4**
OR					
Q. 10	a	Solve by Using Modified Euler's method, $y' = \log_{10}(x + y)$, $y(0) = 2$ at $x = 0.2$ and $x = 0.4$	**7**	L3	**CO4**
	b	Find the value of y(0.5) using the Runge-Kutta method of fourth order, for the given equation $(x + y)\frac{dy}{dx} = 1$; $y(0.4) = 1$	**7**	L3	**CO4**
	c	Write a modern mathematical tool program to solve $y' + 4y = x^2$ with initial conditions y(0) =1 using Taylor's series method at x = 0.1, 0.2	**6**	L3	**CO5**

Bloom's Taxonomy Levels	**Lower-order thinking skills**		
	Remembering (knowledge): L_1	Understanding (Comprehension): L_2	Applying (Application): L_3
	Higher-order thinking skills		
	Analyzing (Analysis): L_4	Valuating (Evaluation): L_5	Creating (Synthesis): L_6

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Note:
1. Answer any **FIVE** full questions, choosing at least **ONE** question from each **module**.
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3. M: Marks, L: Bloom's level, C: Course outcomes.

		Module -1	**M**	**L**	**C**
Q.01	a	Evaluate $\int_0^1 \int_{y^2}^1 \int_0^{1-x} x\, dz\, dx\, dy$	**7**	L3	**CO1**
	b	Evaluate $\int_0^a \int_y^a \frac{x}{x^2+y^2} dxdy$ by changing the order of integration	**7**	L3	**CO1**
	c	Derive the relation $\beta(m,n) = \frac{\gamma(m)\,\gamma(n)}{\gamma(m+n)}$	**6**	L2	**CO1**
		OR			
Q.02	a	Evaluate $\int_0^1 \int_0^{\sqrt{1-y^2}} (x^2+y^2) dxdy$ by changing into polar coordinates	**7**	L3	**CO1**
	b	Using double integration find the area of a plate in the form of a quadrant of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$	**7**	L3	**CO1**
	c	Write a modern mathematical tool program to evaluate the double integral $\int_0^1 \int_0^x (x^2+y^2) dydx$	**6**	L3	**CO5**
		Module-2			
Q. 03	a	Find the directional derivative of $\varphi = x^2yz + 4xz^2$ at the point (1, -2, 1) in the direction of the vector $2\hat{\imath} - \hat{\jmath} - 2\hat{k}$	**7**	L2	**CO2**
	b	Evaluate $Curl(Curl\vec{F})$ and $div(curl\vec{F})$, If $\vec{F} = x^2y\,\hat{\imath} + y^2z\,\hat{\jmath} + z^2x\,\hat{k}$	**7**	L3	**CO2**
	c	Show that $\vec{F} = (y^2 - z^2 + 3yz - 2x)\,\hat{\imath} + (3xz + 2xy)\,\hat{\jmath} + (3xy - 2xz + 2z)\,\hat{k}$ is both solenoidal and irrotational	**6**	L2	**CO2**
		OR			
Q.04	a	Find the work done in moving a particle in the force field $\vec{F} = 3x^2\,\hat{\imath} + (2xz - y)\,\hat{\jmath} + z\,\hat{k}$ along the straight line from $(0,0,0)$ *to* $(2,1,3)$	**7**	L2	**CO2**
	b	Using Green's theorem, Evaluate $\oint[(3x - 8y^2)dx + (4y - 6xy)\,dy]$ over the boundary of the region $x = 0, y = 0, and\ x + y = 1$	**7**	L3	**CO2**
	c	Write a modern mathematical tool program to find the gradient of $\varphi = x^2y + 2xz - 4$	**6**	L3	**CO5**
		Module-3			
Q. 05	a	Form the partial differential equation from the relation $z = f(x + at) + g(x - at)$	**7**	L2	**CO3**

	b	Solve $\frac{\partial^2 z}{\partial x \partial y} = \sin x \sin y$ for which $\frac{\partial z}{\partial y} = -2\sin y$ when x = 0 and z = 0 when y is an odd multiple of $\frac{\pi}{2}$.	**7**	L3	**CO3**
	c	Solve $x(y^2 - z^2)p + y(z^2 - x^2)q - z(x^2 - y^2) = 0$	**6**	L3	**CO3**
		OR			
Q. 06	a	Form the partial differential equation from $f(x + y + z,\ x^2 + y^2 + z^2) = 0$	**7**	L2	**CO3**
	b	Solve $\frac{\partial^2 z}{\partial x^2} + \frac{\partial z}{\partial x} - 4z = 0$, given that when x = 0, z = 1 and $\frac{\partial z}{\partial x} = y$	**7**	L3	**CO3**
	c	With usual notations, derive one-dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$	**6**	L2	**CO3**
		Module-4			
Q. 07	a	Find a real root of $x^3 - 9x + 1 = 0\ in\ (2, 3)$ by the Regula-Falsi method in four iterations.	**7**	L3	**CO4**
	b	Using Newton's forward interpolation find y at x = 5 from the data x: 4, 6, 8, 10 y: 1, 3, 8, 16	**7**	L3	**CO4**
	c	Evaluate $\int_0^{\frac{\pi}{2}} \sqrt{\sin\theta}\, d\theta$ by taking 7 ordinates using Simpson's $\left(\frac{1}{3}\right)^{rd}$ rule	**6**	L3	**CO4**
		OR			
Q. 08	a	Find the real root of the equation $\cos x = xe^x$, which is nearer to $x = 0.5$ by the Newton-Raphson method, correct to four decimal places.	**7**	L3	**CO4**
	b	Determine $f(x)$ as a polynomial in x for the data given below by using Newton's divided difference formula x: 2, 4, 5, 6, 8, 10 $f(x)$: 10, 96, 196, 350, 868, 1746	**7**	L3	**CO4**
	c	Evaluate $\int_{0.2}^{1.4} (\sin x - \log x + e^x)\, dx$ by taking seven ordinates, using Simpson's $\left(\frac{3}{8}\right)^{th}$ rule.	**6**	L3	**CO4**
		Module-5			
Q. 09	a	Find an approximate value of y when $x = 0.1$, if $\frac{dy}{dx} = x - y^2$ and $y = 1$ at $x = 0$ using Taylor's series method.	**7**	L3	**CO4**
	b	Given $\frac{dy}{dx} = \frac{y-x}{y+x}$ with the initial condition $y = 1$ when $x = 0$. Find approximately y for $x = 0.1$ by Modified Euler's method. Carry out three modifications.	**7**	L3	**CO4**

	c	Given $\frac{dy}{dx} = xy + y^2, y(0) = 1, y(0.1) = 1.1169,\ y(0.2) = 1.2773,$ $y(0.3) = 1.5049,$ compute $y(0.4)$ using Milne's Predictor-Corrector method.	**6**	L3	**CO4**
OR					
Q. 10	a	Using modified Euler's formula, compute $y(1.1)$ correct to three decimal places given that $\frac{dy}{dx} + \frac{y}{x} = \frac{1}{x^2}$ and $y = 1$ at $x = 1$.	**7**	L3	**CO4**
	b	Using the Runge-Kutta method of fourth order solve $\frac{dy}{dx} = \frac{y^2-x^2}{y^2+x^2}$ with $y(0) = 1$ at $x = 0.2$	**7**	L3	**CO4**
	c	Write a modern mathematical tool program to solve $\frac{dy}{dx} = 2x + y,\ y(1) = 2$ by the Runge-Kutta 4^{th} order method.	**6**	L3	**CO5**

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