Basavarajeswari Group of Institutions

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

USN | | | | | | | | | | | **Course Code** | 2 | 2 | M | A | T | M | 2 | 1 |

Second Semester B.E. Degree Summer Semester Examinations, September/October 2025

MATHEMATICS-II FOR MECHANICAL ENGINEERING STREAM

Duration: 3 hrs **Max. Marks: 100**

Note: ***1. Answer any* FIVE *full questions, choosing* ONE *full question from each module.***
2. Use of Mathematics Formula Handbook is permitted.
3. Missing data, if any, may be suitably assumed.

Q. No		Question	Marks	(RBTL:CO:PI)
		Module-1		
1.	**a.**	Find the directional derivatives of $\phi = x^2yz + 4xz^2$ at $(1,-2,-1)$ along the vector $2i - j - 2k$.	**06**	**(2:1:1.2.1)**
	b.	If $\vec{F} = (3x^2y - z)i + (xz^3 + y^4)j - 2x^3z^2k$, find $\text{grad}(\text{div}\vec{F})$ at $(2,-1,0)$.	**07**	**(2:1:1.2.1)**
	c.	Show that $\vec{F} = (y+z)i + (z+x)j + (x+y)k$ is irrotational and hence find a scalar function ϕ such that $\vec{F} = \nabla\phi$.	**07**	**(2:1:1.2.1)**
		(OR)		
2.	**a.**	Evaluate $\int_c (3x^2 - 8y^2)\,dx + (4y - 6xy)\,dy$, by Green's theorem in a plane, where C is the boundary of the region enclosed by $y = \sqrt{x}$ and $y = x^2$.	**06**	**(2:1:1.2.1)**
	b.	Find the total work done by the force represented by $\vec{F} = 3xyi - yj + 2zxk$ in moving a particle round the circle $x^2 + y^2 = 4$.	**07**	**(2:1:1.2.1)**
	c.	Evaluate $\int_c \vec{F}.d\vec{r}$ where $\vec{F} = (x^2 + y^2)i - 2xyj$ by Stoke's theorem taken round the rectangle bounded by $x = 0,\ x = a,\ y = 0,\ y = b$.	**07**	**(2:1:1.2.1)**
		Module-2		
3.	**a.**	Solve $\frac{d^3y}{dx^3} - 2\frac{d^2y}{dx^2} + 4\frac{dy}{dx} - 8y = 0$	**06**	**(2:2:1.2.1)**
	b.	Solve $(D^2 + 5D + 6)y = e^x$	**07**	**(2:2:1.2.1)**
	c.	Solve $y'' - 4y' + 13y = \sin 2x$	**07**	**(2:2:1.2.1)**
		(OR)		
4.	**a.**	Solve $(D^2 - 4D + 3)y = \sin 3x \cos 2x$.	**06**	**(2:2:1.2.1)**
	b.	Solve $x^2y'' + xy' + 9y = 3x^2 + \sin(3\log x)$	**07**	**(2:2:1.2.1)**
	c.	Solve $(1+x)^2\frac{d^2y}{dx^2} + (1+x)\frac{dy}{dx} + y = \sin 2[\log(1+x)]$.	**07**	**(2:2:1.2.1)**

Note: (**RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI - Performance Indicator)**

Module-3

			Marks	(RBTL:CO:PI)
5.	**a.**	Form the Partial differential equation by eliminating the arbitrary constants from $(x-a)^2+(y-b)^2+z^2=c^2$.	**06**	**(2:3:1.2.1)**
	b.	Solve $\frac{\partial^2 z}{\partial x\partial y}=\sin x\sin y,$ given that $\frac{\partial z}{\partial y}=-2\sin y$ when $x=0$ and $z=0$ when y is an odd multiple of $\frac{\pi}{2}$.	**07**	**(2:3:1.2.1)**
	c.	Solve $\frac{\partial^2 z}{\partial y^2}=z,$ given that when $y=0,\ z=e^x$ and $\frac{\partial z}{\partial y}=e^{-x}$.	**07**	**(2:3:1.2.1)**

(OR)

6.	**a.**	Form the PDE eliminating the arbitrary function from $z=y^2+2f\left[\frac{1}{x}+\log y\right]$	**06**	**(2:3:1.2.1)**
	b.	Solve $x\frac{\partial z}{\partial x}+y\frac{\partial z}{\partial x}=z.$	**07**	**(2:3:1.2.1)**
	c.	Derive one-dimensional wave equation in the standard form.	**07**	**(2:3:1.2.1)**

Module-4

7. a. Use Newton-Raphson method to find the real root of the equation $x\sin x+\cos x=0$ near $x=\pi.$ Carry out three iterations. **06** **(2:4:1.2.1)**

b. Use Newton's forward interpolation formula to find $f(38)$ **07** **(2:4:1.2.1)**

x	**40**	**50**	**60**	**70**	**80**	**90**
$f(x)$	**184**	**204**	**226**	**250**	**276**	**304**

c. From the following table find the number of students who have obtained (i) less than 45 marks (ii) between 40 and 45 marks by using appropriate interpolation formula. **07** **(2:4:1.2.1)**

Marks	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**
No. of students	**31**	**42**	**51**	**35**	**31**

(OR)

8. a. Using Newton's divided difference formula to find $f(4)$ given **06** **(2:4:1.2.1)**

x	**0**	**2**	**3**	**6**
$f(x)$	**-4**	**2**	**14**	**158**

b. Use Lagrange's interpolation formula to find $f(4)$ given **07** **(2:4:1.2.1)**

x	**0**	**1**	**2**	**5**
$f(x)$	**2**	**3**	**12**	**147**

c. Evaluate $\int_0^1 \frac{dx}{1+x}$ taking seven ordinates by applying Simpson's 3/8th rule. Hence deduce the value of $\log_e 2$. **07** **(2:4:1.2.1)**

Note: (**RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI - Performance Indicator)**

Module-5

9.	**a.**	Use Taylor's series method to find y at x = 0.1 considering terms up to the third degree given that $\frac{dy}{dx}-2y=3e^{x}$, y(0)=0	**06**	**(2:5:1.2.1)**
	b.	Using Modified Euler's method find y(0.1) correct to four decimal places solving the equation $\frac{dy}{dx}=x-y^{2}$, y(0)=1 taking h= 0.1	**07**	**(2:5:1.2.1)**
	c.	Given $\frac{dy}{dx}=3x+\frac{y}{2}$, $y(0)=1$, compute y(0.2) by taking h=0.2 using Runge-Kutta method of fourth order	**07**	**(2:5:1.2.1)**

(OR)

10.	**a.**	Use Taylor's series method to find y at x=0.1 considering terms up to 3rd degree given that $\frac{dy}{dx}=x^{2}+y^{2}$ and y (0) =1.	**06**	**(2:5:1.2.1)**
	b.	Using modified Euler's method to find y(0.1) correct to four decimal places solving the equation $\frac{dy}{dx}=x-y^{2}$, y(0)=1 taking h=0.1	**07**	**(2:5:1.2.1)**
	c.	Given $\frac{dy}{dx}=3x+\frac{y}{2}$, y(0)=1, compute y(0.2) by taking h=0.2 using Range-Kutta method of fourth order.	**07**	**(2:5:1.2.1)**

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Note: (**RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI - Performance Indicator)**