K. K. Wagh Institute of Engineering Education & Research, Nashik

(An Autonomous Institute From A.Y. 2022-23)

WINTER-2025	
Exam Seat No.:	
Academic Year:2025-2026	Semester:III/IV
Class:SY	Program:B.Tech
Branch Code:MEC/ROB	Pattern:2023
Name of Course:Applied Mathematics	Course Code:2300201D
Max. Marks:60	Duration:2.30 Hrs.

Instructions: Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 3 pages.
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome of the Question/sub-question.
6. Use of non-programmable scientific calculator is allowed.

Marks CO

Question No. 1

1 a) Solve the following differential equation using Laplace transforms: (6) CO4

$y'' - 3y' + 2y = 0, \quad y(0) = 2, y'(0) = 6.$

Question No. 2

2 a) Solve by using Method of variation of parameters: (6) CO2

$\frac{d^2y}{dx^2} + 4y = sec2x.$

Question No. 3

3 a) A body weighing 4 N is hung from a spring stretching the spring by 30 cm. When the equilibrium is reached, the weight is stuck so as to give it a downward velocity of 60 cm/sec. (8) CO4

i) Set up the associated differential equation and conditions describing motion.

ii) Find the displacement and velocity of body after time 't' seconds

iii)Find the amplitude, period and frequency of motion.

OR

3 b) A body of mass 1 Kg is hung from a spring stretching the spring by 245 cm. A damping force equal to 4 Nm/s is applied to the body. If the body is pulled down to 300 cm below equilibrium position and released, then (8) CO4

i) Set up the corresponding differential equation and the conditions describing motion.

ii) Find the displacement and velocity of the body at time 't' seconds.

3 c) Solve the differential equation $\frac{\partial u}{\partial t} = a^2 \frac{\partial^2 u}{\partial x^2}$ subject to following conditions: (8) CO4

$i)\ \ u(x, \infty)\ \ is\ \ finite.$ $ii)\ \ u(0,t) = 0,\ \ \forall t.$

$iii)\ \ u(l,\mathrm{t}) = 0,\ \ \forall t.$
$iv)\ \ \mathrm{u}(\mathrm{x},0) = 100\mathrm{x}$ in $0 \le \mathrm{x} \le \mathrm{l}.$

OR

3 d) A flexible string of length π is tightly stretched between $x = 0\ \ and\ \ x = \pi$ on x-axis, its ends being fixed at these points. When set into vibrations, the displacement u(x,t) from x-axis at any point t is $\frac{\partial^2 u}{\partial t^2} = 9\frac{\partial^2 u}{\partial x^2}$. (8) CO4

Find the solution of the equation which satisfies

$i)\, u(0,t) = 0, \forall t.$ $ii)\, u(\pi,\mathrm{t}) = 0, \forall \mathrm{t}.$

iii) $\left(\frac{\partial \mathrm{u}}{\partial \mathrm{t}}\right) = 0$ at $\mathrm{t} = 0.$
iv) $\mathrm{u}(\mathrm{x},0) = 0.2\ \ \sin\mathrm{x} + 0.02\sin 4\mathrm{x},\ \ 0 \le \mathrm{x} \le \pi.$

Question No. 4

4 a) A robotic gripper has force sensors on both sides.The force measured(in N) during the gripping are given in the following table. Calculate the Karl Pearson correlation coefficient between left force and right force applied for gripping by a gripper. (6) CO4

Left Force(N)	10	12	14	16	18	20	22	24
Right Force(N)	11	13	13	17	18	19	23	25

OR

4 b) A hybrid actuator system compares the hydraulic pressure readings with pneumatic pressure readings(both in bar). The readings are as follows. (6) CO4

Hydraulic pressure(bar)	2	3	4	5	6	7
Pneumatic pressure(bar)	2.1	3	4.1	5.7	6.1	6.8

Find the regression line of y on x. Also estimate y when x=5.5

4 c) Calculate the first four moments about the mean of the given distribution. Also find $\beta_1\ \ and\ \ \beta_2$. (5) CO3

x	2	2.5	3	3.5	4	4.5	5
f	5	38	65	92	70	40	10

OR

4 d) Two automation motors X and Y are tested for battery life(in hours) under identical operating conditions. The battery life for 8 test runs is recorded as under: (5) CO3

Motor X	5.2	5.8	5.1	5.2	5.7	5.6	5.8	6
Motor Y	4.8	5.6	5.2	5.1	4.9	5.3	5.2	5

Decide which motor has longer battery life on average and which motor is more consistent under battery performance.

4 e) The time taken by a robot to assemble a part is normally distributed with a mean of 79 sec and standard deviation of 5 sec. How many parts out of 200 parts, (5) CO3

1. Assemble between 75 sec to 82 sec.
2. Take less than 89 sec to assemble.

OR

4 f) On an average a box containing 10 articles is likely to have 2 defectives. If we consider a consignment of 100 boxes, how many of them are expected to have three or more defectives? (5) CO3

Question No. 5

5 a) Find the work done in moving a particle under the force field given by (6) CO4

$\vec{F} = \left(3x\right)\vec{i} + 2xz\vec{j} + \left(z\right)\vec{k}$ along the curve $x = 2t^2, \quad y = t \quad and \quad z = 4t^2$ from t=0 to t=1.

OR

5 b) Evaluate $\int_C \vec{F}.\overrightarrow{dr}$ using Stoke's theorem for $\vec{F} = xy^2\vec{i} + y\vec{j} + z^2x\vec{k}$ for the surface of the rectangular lamina bounded by x=0, y=0, x=2, y=3, z=0. (6) CO4

5 c) Show that the vector field $\vec{F} = \left(2x + 3z\right)\vec{i} + \left(2y + z\right)\vec{j} + \left(3x + y\right)\vec{k}$ is irrotational. Also find the scalar potential function ϕ such that $\vec{F} = \nabla\phi$. (5) CO2

OR

5 d) Show that the vector field $\vec{F} = \left(3y^2\cos x + 3z^2\right)\vec{i} + \left(6y\sin x\right)\vec{j} + \left(6xz\right)\vec{k}$ is irrotational. Also find the scalar potential function ϕ such that $\vec{F} = \nabla\phi$. (5) CO2

5 e) Find the directional derivative of $\phi = xy^2z^2 + 3yz$ at the point P(1,-3,-1) along the line PQ where P ≡ (1,-3,-1) and Q ≡ (2,1,-1). (5) CO2

OR

5 f) For the function $\phi = 2e^y\vec{i} + z\sin x\vec{j} + z^3\vec{k}$ (5) CO2

1) Find divergence of ϕ at (2,0,1).

2) Find the curl of ϕ at (2,0,1).

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