A   Reg. No. : ☐☐☐☐☐☐☐☐☐☐☐☐

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Question Paper Code: U2M06

B.E./B.Tech. DEGREE EXAMINATION, NOV 2025

Second Semester

Civil Engineering

21UMA206- DIFFERENTIAL EQUATIONS, COMPLEX ANALYSIS & TRANSFORM TECHNIQUES

(Regulations 2021)

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Duration: Three hours   Maximum: 100 Marks

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Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

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1. The solution of $(D^3 + D^2 - D - 1)y = 0$ is _____   CO1-App

    (a) $Ae^x + Bxe^x + Cx^2e^x$ (b) $(Ax + B)e^x + C\ e^{-x}$

    (c) $e^{-x} + (\cos 2x + i \sin 2x)$ (d) $(Ax + B)e^{-x} + C\ e^x$

2. The particular solution of $y'' + 4y' + 4y = 0$ is _____   CO1-App

    (a) xe^{-2x} (b) xe^{2x} (c) x^2e^{2x} (d) 0

3. If $\varphi = x^2 + y^2 - z - 10$ then $|\nabla\ \varphi|$ at (1, 1, 1) is _____   CO2-App

    (a) $2(\bar{i} + \bar{j} + \bar{k})$ (b) $2\bar{i} + 2\bar{j} - \bar{k}$ (c) 3   (d) 9

4. If φ is a vector point function then Curl $(grad\varphi)$ =   CO2-App

    (a) 1   (b) 0   (c) 2   (d) None of the above

5. The PDE obtained from z = (x+a)(y+b) is __.   CO3- App

    (a) 3z = px + qy   (b) py - qx = 0   (c) z = pq   (d) px+qy = 0

6. The PDE of all planes having equal intercepts on the X axis and Y axis is   CO3- App
    _____

    (a) p = q   (b) p + q = 0   (c) pq = 1   (d) p(q + 1) = q

7. Simple pole is a pole of order _____   CO6-U

    (a) 1   (a) 2   (a) 3   (a) 4

8. The poles of z cot z is _____   CO6-U

     (a) 0   (b) $\pm n\pi$ (c) 1   (d) π

9. L (sin h at) = _____   CO6-R

     (a) $\dfrac{s}{s^2 - a^2}$ (b) $\dfrac{a}{s^2 - a^2}$ (c) $\dfrac{s}{s^2 + a^2}$ (d) $\dfrac{a}{s^2 + a^2}$

10. $L^{-1}\left(\dfrac{1}{(s+2)^3}\right) = $ _____   CO6-R

     (a) $t\, e^{2t}$ (b) $t^2\, e^{-2t}$ (c) $\dfrac{e^{-2t}\, t^2}{2!}$ (d) $\dfrac{e^{-t}\, t^3}{3!}$

PART – B (5 x 2= 10Marks)

11. Calculate the particular Integral of $(D^2 + 4D + 4)y = e^{2x}$ CO1-App

12. Compute the unit normal vector to the surface $x^2 + y^2 + z^2 = 1$ at (1, 1, 1).   CO2-App

13. Compute the complete integral of $p - q = k$ CO3-App

14. State Cauchy's residue theorem.   CO6-U

15. Find $L[t \sin at]$ CO5-App

PART – C (5 x 16= 80Marks)

16. (a)   (i) Using method of variation of parameters solve $(D^2 + 4)y = \sec 2x$.   CO1-App   (8)

         (ii) A colony of bacteria is growing exponentially. At time t=0 it has 10 bacteria in it, and at time t=4 it has 2000. At what time will it have 100,000 bacteria?   CO1- App   (8)

<p style="text-align:center">Or</p>

    (b)   (i) At the start of an experiment, there are 200 bacteria. If the bacteria follow an exponential growth pattern with rate k = 0.05. What will be the population after 8 hours? How long will it take for the population to double?   CO1- App   (8)

         (ii) Using method of variation of parameters solve $(D^2 + a^2)y = \tan ax$.   CO1- App   (8)

17. (a)   Verify Gauss Divergence theorem for $\vec{F} = x^2\vec{i} + y^2\vec{j} + z^2\vec{k}$ where S is the surface of the cuboid formed by the planes $x = 0, x = a, y = 0, y = b, z = 0 \ \& \ z = c$.   CO2-App   (16)

<p style="text-align:center">Or</p>

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(b) (i) Using Green's theorem, Evaluate $\int_C (3x^2 - 8y^2)\,dx +$ CO2 -App   (8)
$(4y - 6xy)dy$ where C is the boundary of the region defined by
X = 0, Y = 0, X + Y = 1 in the XY plane.

(ii) Prove that $\bar{F} = (x^2 + xy^2)\bar{\imath} + (y^2 + x^2y)\bar{\jmath}$ is irrotational   CO2 -App   (8)
vector and compute the Scalar potential such that $\bar{F} = \nabla\emptyset$.

18. (a) (i) Solve $\left(D^2 - 6DD' + 5D'^2 \right) z = e^{x+y} + \sin(2x + y)$ CO3-App   (8)

(ii) Solve $(y - z)p + (z - x)q = (x - y)$ CO3-App   (8)

Or

(b) (i) Solve $p^2 + q^2 = x^2 + y^2$ CO3-App   (8)

(ii) Form a PDE by eliminating arbitrary functions from   CO3-App   (8)
$z = px + qy + p^2 - q^2$

19. (a) (i) Evaluate using Cauchy's Integral formula for   CO4-App   (8)

$f(z) = \int_C \dfrac{z + 1}{(z - 1)(z - 3)}\,dz$, where 'C' : $|z| = 2$.

(ii) Expand $\dfrac{z - 1}{(z + 2)(z + 3)}$ as Laurent's series valid in the region   CO4-App   (8)

$2 < |z| < 3$

Or

(b) Using contour integration, to compute the value of $\displaystyle\int_0^{2\pi} \dfrac{d\theta}{13 + 5\cos\theta}$ CO4-App   (16)

20. (a) Solve the differential equation $y'' - 3y' - 4y = 2e^{-t}$, $y(0) = 1$ &   CO5-App   (16)
$y'(0) = 1$ by using Lapace transform method.

Or

(b) (i) Using the periodic function, Compute the Laplace transform of   CO5-App   (8)

$f(t) = f(t) = \begin{cases} k, & 0 \le t \le a \\ -k, & a \le t \le 2a \end{cases}$

(ii) Using Convolution Theorem, Compute $L^{-1}\left[\dfrac{1}{(s^2 + a^2)(s^2 + b^2)} \right]$ CO5-App   (8)

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