SUBJECT NAME : **Engineering Mathematics – II**

SUBJECT CODE : **MA2161**

MATERIAL NAME : **Part – A questions**

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Name of the Student: Branch:

Unit – I (Ordinary Differential Equations)

1. Solve the equation $\left(D^2-6D+13\right)y=0$.

2. Solve $\left(D^2-4\right)y=1$.

3. Find a particular integral of the differential equation $\left(D^2+6D+5\right)y=e^{-5x}$.

4. Find the particular integral of $\left(D^2-4\right)y=\cosh 2x$.

5. Find the particular integral of $\left(D^2-2D+1\right)y=\cosh x$.

6. Find the particular integral of $\left(D^2+4\right)y=\sin 2x$.

7. Find the particular integral of $\left(D^2+1\right)y=\sin x$.

8. Find the particular integral of $\left(D^2+2D+1\right)y=e^{-x}\cos x$.

9. Find the particular integral of $\left(D+1\right)^2 y=e^{-x}\cos x$.

10. Find the particular integral of $\left(D^2-2D+2\right)y=e^{x}\cos x$.

11. Find the particular integral of $\left(D-1\right)^2 y=e^{x}\sin x$.

12. Find the particular integral of $\left(D^2 - 4D + 4\right)y = x^2 e^{2x}$.

13. Solve the equation $x^2 y'' - xy' + y = 0$.

14. Solve $x^2 \dfrac{d^2 y}{dx^2} + 4x\dfrac{dy}{dx} + 2y = 0$.

15. Reduce the equation $\left(x^2 D^2 + xD + 1\right)y = \log x$ into an ordinary differential equation with constant coefficients.

16. Transform the differential equation $x^2 y'' - xy' + 2y = 0$ with constant coefficients.

17. Transform the equation $x^2 y'' + xy' = x$ into a linear differential equation with constant coefficients.

18. Convert $\left(3x^2 D^2 + 5xD + 7\right)y = 2/x\log x$ into an equation with constant coefficients.

19. Transform the differential equation $\left(x^2 D^2 + 4xD + 2\right)y = x + \dfrac{1}{x}$ to a differential equation with constant coefficients.

20. Transform the equation $(2x+3)^2 \dfrac{d^2 y}{dx^2} - 2(2x+3)\dfrac{dy}{dx} - 12y = 6x$ into a differential equation with constant coefficients.

Unit – II (Vector Calculus)

1. Find $\Delta\left(\Delta\bullet\left(\left(x^2 - yz\right)\vec{i} + \left(y^2 - xz\right)\vec{j} + \left(z^2 - xy\right)\vec{k}\right)\right)$ at the points $(1,-1,2)$.

2. Define solenoidal vector function. If $\vec{V} = \left(x + 3y\right)\vec{i} + \left(y - 2z\right)\vec{j} + \left(x + 2\lambda z\right)\vec{k}$ is solenoidal, find the value of λ.

3. Find the value of m so that the vector $\vec{F} = \left(x + 3y\right)\vec{i} + \left(y - 2z\right)\vec{j} + \left(x + mz\right)\vec{k}$ is solenoidal.

4. Find λ such that $\vec{F} = (3x - 2y + z)\vec{i} + (4x + \lambda y - z)\vec{j} + (x - y + 2z)\vec{k}$ is solenoidal.

5. Find the values of a, b, c so that the vector $\vec{F} = \left(x + y + az\right)\vec{i} + \left(bx + 2y - z\right)\vec{j} + \left(-x + cy + 2z\right)\vec{k}$ may be irrotational.

6. State the physical interpretation of the line integral $\int_A^B \vec{F} \cdot d\vec{r}$.

7. Find the directional derivative of $\phi(x, y, z) = xy^2 + yz^2$ at the point $(2,-1,1)$ in the direction of the vector $i + 2j + 3k$.

8. Find the directional derivative of $\phi = xyz$ at $(1,1,1)$ in the direction of $\vec{i} + \vec{j} + \vec{k}$.

9. Is the position vector $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ irrotational? Justify.

10. Prove that $\vec{F} = yz\vec{i} + zx\vec{j} + xy\vec{k}$ is irrotational.

11. Find grad (r^n) where $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ and $r = |\vec{r}|$.

12. Find the unit normal to the surface $x^2 + xy + z^2 = 4$ at $(1,-1,2)$.

13. Prove that $div\ \vec{r} = 3$ and $curl\ \vec{r} = 0$.

14. If $\vec{A}$ and $\vec{B}$ are irrotational, prove that $\vec{A} \times \vec{B}$ is solenoidal.

15. State Stoke's theorem.

16. State Green's theorem.

17. State Gauss divergence theorem.

18. Prove by Green's theorem that the area bounded by a simple closed C curve is $\frac{1}{2}\int_C (xdy - ydx)$.

19. Evaluate $\iiint_V \nabla.\vec{F}\ dV$ where $\vec{F} = x^2 i + y^2 j + z^2 k$ and V is the volume enclosed by the cube $0 \le x, y, z \le 1$.

Unit – III (Analytic Functions)

1. Show that $u = 2x - x^3 + 3xy^2$ is harmonic.

2. Verify whether the function $u = x^3 - 3xy^2 + 3x^2 - 3y^2 + 1$ is harmonic.

3. If $u(x, y) = 3x^2y + 2x^2 - y^3 - 2y^2$, verify whether u is harmonic.

4. Given an example of a complex –valued function which is differentiable at a point but not analytic at that point.

5. Find the map of the circle $|z| = 3$ under the transformation $w = 2z$.

6. Find the image of the line $x = k$ under the transformation $w = \frac{1}{z}$.

7. State the Cauchy-Riemann equation in polar coordinates satisfied by an analytic function.

8. Prove that a bilinear transformation has at most two fixed points.

9. Find the fixed points of mapping $w = \frac{6z - 9}{z}$.

10. Find the invariant points of the transformation $w = \frac{2z + 6}{z + 7}$.

11. Find the critical points of the transformation $w = 1 + \frac{2}{z}$.

12. Find the constants a, b, c if $f(z) = x + ay + i(bx + cy)$ is analytic.

13. Find the constants a, b if $f(z) = x + 2ay + i(3x + by)$ is analytic.

14. State the basic difference between the limit of a function of a real variable and that of a complex variable.

15. Verify whether $f(z) = \bar{z}$ is analytic function or not.

16. Show that the function $f(z) = \bar{z}$ is nowhere differentiable.

17. Are $|z|, \mathrm{Re}(z), \mathrm{Im}(z)$ analytic? Give reason.

18. Define Conformal.

19. Show that an analytic function with constant imaginary part is constant.

Unit – IV (Complex Integration)

1. Define Singular point.

2. Expand $f(z) = \sin z$ in a Taylor series about origin.

3. Evaluate $\int_c \tan z \, dz$ where C is $|z| = 2$.

4. Find the Taylor series for $f(z) = \sin z$ about $z = \frac{\pi}{4}$.

5. State Cauchy's integral formula.

6. Evaluate $\int_c \left(\frac{3z^2 + 7z + 1}{z+1} \right) dz$, where C is $|z| = \frac{1}{2}$.

7. Using Cauchy's integral formula, evaluate $\int_C \frac{\sin \pi z^2 + \cos \pi z^2}{(z+1)(z+2)} dz$, where C is $|z| = \frac{1}{2}$.

8. Evaluate $\int_C \frac{z \, dz}{(z-1)(z-2)}$, where C is the circle $|z| = 1/2$.

9. Evaluate $\int_C \frac{z+4}{z^2 + 2z} dz$, where C is the circle $\left| z - \frac{1}{2} \right| = \frac{1}{3}$.

10. Evaluate $\oint_C \frac{e^z}{z-1} dz$, if C is $|z| = 2$.

11. If $f(z) = \frac{-1}{z-1} - 2\left[1 + (z-1) + (z-1)^2 + ...\right]$, find the residue of $f(z)$ at $z = 1$.

12. Identify the type of singularities of the following function: $f(z) = e^{\frac{1}{z-1}}$.

13. Classify the singularity of $f(z) = e^{e^{\frac{1}{z^2}}}$.

14. Calculate the residue of $f(z) = \frac{e^{2z}}{(z+1)^2}$ at its pole.

15. Find the residue of the function $f(z) = \frac{4}{z^3 (z-2)}$ at a simple pole.

16. Find the residue of $f(z)=\frac{1-e^{-z}}{z^3}$ at $z=0$.

17. Find the residue of $\frac{1-e^{2z}}{z^4}$ at $z=0$.

18. Find the residue of $\left\{\frac{\sin 3z}{z^6}\right\}$ at $z=0$.

Unit – V (Laplace Transform)

1. State the conditions under which Laplace transform of $f(t)$ exists.
2. Find the Laplace transform of unit step function.
3. State the first shifting theorem on Laplace transforms.
4. Find the Laplace transform of $f(t)=\begin{cases} 0, & t<\frac{2\pi}{3} \\ \cos\left(t-\frac{2\pi}{3}\right), & t>\frac{2\pi}{3} \end{cases}$.
5. Find $L\left(e^{-3t}\sin t\cos t\right)$.
6. Find the Laplace transform of $\frac{t}{e^t}$.
7. Is the linearity property applicable to $L\left\{\frac{1-\cos t}{t}\right\}$? Reason out.
8. Find the Laplace transform of $\frac{1-\cos t}{t}$.
9. Find the Laplace transform of $f(t)=\frac{1-e^{-t}}{t}$.
10. Find the Laplace transform of $t\cos at$.
11. Find Laplace transform of $t\sin 2t$.
12. State initial and final value theorem in Laplace transform.
13. Verify the final value theorem for $f(t)=3e^{-t}$.

14. Verify initial value theorem for the function $f(t)=ae^{-bt}$.

15. Verify initial value theorem for $f(t)=1+e^{-t}\left(\sin t+\cos t\right)$.

16. Find $L^{-1}\left[\frac{1}{s^2+4s+4}\right]$.

17. Find the inverse Laplace transform of $\frac{1}{(s+1)(s+2)}$.

18. Find $L^{-1}\left\{\cot^{-1}(s)\right\}$.

19. Find the inverse Laplace transform of $\cot^{-1}\left(\frac{k}{s}\right)$.

20. Find inverse Laplace Transform of $\frac{e^{-as}}{s}$.

---- *All the Best*----