0102E1303

Candidate's Seat No :__________

MSc Sem.-1 Examination

401

Medical Physics

February-2025

Time : 2-30 Hours] **[Max. Marks : 70**

Q.1 (A). What is a matrix? Discuss various properties of matrices. [14]

(B). For Contravarient tensors show that $A^{ij} + B^{ij} = C^{ij}$, and $A^{ij} - B^{ij} = D^{ij}$

OR

Q.1 (A). Define Levi-Civeta symbol, and write uses of it. Discuss various properties of it. [14]

(B). Find Eigan values and Eigen vectors of the matrix A= $\begin{bmatrix} -4 & -6 \\ 3 & 5 \end{bmatrix}$

Q.2 (a) Find the Fourier transform of

$$f(x) = 1, \ |x| \leq 1$$
$$= 0, \ |x| > 1$$

Using Parseval's relation evaluate $\int_{-\infty}^{\infty} \frac{\sin^2 t}{t^2} dt$.

(b) Determine sine and cosine representations of $\delta(t - x)$ that are comparable to exponential representation of Fourier transform. [14]

(c) The heat flow PDE is given as

$$\frac{\partial \Psi}{\partial t} = a^2 \frac{\partial^2 \Psi}{\partial x^2}$$

where Ψ**(x, t)** is a temperature in a space function of time. Solve this equation by Fourier transform method.

OR

Q.2 (a) Prove that (i) $\mathcal{L}\,[t^2\, f(t)] = \frac{d^2F(s)}{ds^2}$ (ii) $\mathcal{L}\left[\int_0^t f(t)dt\right] = \frac{F(S)}{S}$

(b) Determine the $\mathcal{L}\,[e^{2t}\, \mathrm{Sin}3t\,]$ and $\mathcal{L}^{-1}\left[\frac{S^2+3}{S(S^2+9)}\right]$. [14]

(c) The step voltage is applied to a series RC circuit at t = 0. Set up the differential equation for such a circuit and solve it to determine the current through the circuit by Laplace Transform method.

(P.T.O)

E 1303-2

Q.3 (a) Solve the following differential equation by the method of Frobenius:

$\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 2\alpha y = 0,$ where α is constant. [14]

(b) Solve the wave equation $\frac{\partial^2 u}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 u}{\partial t^2}$

subject to condition u = 0 at x = 0, x = π; u(x,0) = x, 0 < x <π and $\frac{du}{dt} = 0, t = 0$

OR

Q.3 (a) Separate Helmholtz equation $\nabla^2\Psi + k^2\Psi = 0$ in spherical polar co-ordinates.

(b) The motion of a parachutist falling with a velocity as a function of time according to Newton's equation of motion given by [14]

$$m\frac{dv}{dt} = mg - bv^2,$$

where *mg* = gravitational force and $-bv^2$ = air drag.

Solve the equation to determine velocity v in terms of terminal velocity v_0.

Q.4 (A). Find u (x,y) and v (x,y) of following functions. [14]

(i). f(Z) = $\frac{Z}{Z+1}$, where Z=x+iy

(ii). f(Z) = $\frac{2Z+3}{Z+2}$, where Z=x+iy

(B). If a function w = f(Z)) is analytic within and on closed contour C, except for a finite number of isolated singularities inside C, then show that

$\oint_C f(Z)dZ = 2\pi i\,(R_1 + R_2 + \ldots\ldots + R_i + \ldots\ldots + R_n)$, where R_i is residue of f(Z) at the singularity Z_i

OR

Q.4 (A) . Using Cauchy-Riemann's conditions find-out that following functions are analytic or non-analytic [14]

(i) W=f(Z)= $|Z|$, where Z=x+iy

(ii) W=f(Z) = exp (Z), where Z=x+iy

(B) If function is continuous in simply connected domain and if $\oint_C f(Z)dZ = 0$, then prove that the function is holomorphic throughout that domain (Morera's theorem)

E1303-3

Q.5 Attempt any **seven** out of twelve from the following (Each question is of **two** marks): [14]

(i) Check the singularity of $\frac{d^2y}{dx^2} + \frac{1}{x}\frac{dy}{dx} - \frac{a^2}{x^2}y = 0$ **at x = 0.**

(ii) Determine an indicial equation for the differential equation $\frac{d^2y}{dx^2} - \frac{6}{x^2}y = 0$ using series solution method.

(iii) Solve the linear homogeneous equation $\frac{dv}{dt} = -\alpha v$ by the method of separation of variables. (Here α is constant)

(iv) If $f(x) = \frac{1}{\sqrt{x}}$, is self-reciprocal under Fourier cosine transforms, then its Fourier cosine transform is ________

(v) $\mathcal{L}^{-1}\left[\frac{s-1}{(s-1)^2+4}\right] =$ ______.

(vi) $\mathcal{L}[\delta(t-2)] =$ __________.

(vii) Write two properties of Eigen values.

(viii) Write two properties of a Tensor.

(ix) What do you understand by dummy and real indices?

(x) Expand the function f(x) = cos x using Taylor series

(xi) If f(Z)= 2-3i then $Z^2 =$ ———

(xii) Express the given complex numbers in the form of x+iy.
f (x) = (1-i)- (1-i6)